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Keywords: fire safety. kisslaw. engineering courses. curricular structures.

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Stefania Chaves Ferreira [α], Priscilla Chantal Duarte Silva [σ], Anna Rita Tomich Magalhães Felippe [ρ] & Ricardo Luiz Perez Teixeira [ω]

Abstract- Fire protection has gained the spotlight, in large part, as a result of some disasters that have occurred in recent years. The subject has evolved and gained considerable prominence, thus requiring changes in current legislation, as well as the formulation of new Standards and Laws, capable of mitigating the risk of fire occurrence. It is necessary to understand the role of the future engineer on the fire protection policy, to avoid possible fire occurrences in institutions. Therefore, the goal of this study is to analyze how and how often the fire protection approach is included in the curriculum of engineering courses. To achieve it, a systematic review in the Google Academic, Scielo and Eric databases was carried out in a quantitative analysis. Secondly, in a qualitative analysis, a case study was carried out, starting with an investigation of the curriculum of nine engineering courses at a Brazilian university, to verify the consistency of the fire protection approach and compliance with the *"Kiss* Law" in the courses studied. The results indicate a certain insufficiency of disciplines when analyzing the curricular matrices of each course. In most cases, the adoption of contents or disciplines that address the topic present fire protection generically and inconsistently. It is concluded that there is still a lack of knowledge about the relevance of the topic and effective non-compliance with legislation on the subject. There is, therefore, a need for implementation measures in the learning topics of engineering curricula.

Keywords: fire safety. kisslaw. engineering courses. curricular structures.

I. Introduction

The history of tragic accidents involving fires leaves irreparable marks on the people involved (Pereira, 2007). According to the author (2007), large fires can be linked to causes such as failures during the execution of the initial combat, or when there is an absence of public policies in the management of prevention and control of fires in buildings. According to Braga (2018), before the events with fire occurred in São Paulo in the 70s, the current regulation related to the subject of Fire Safety (SCI) in Brazil was little addressed, and the scarce mentions to it were only present in the building codes of some municipalities. The occurrence of these tragedies brought about a change in SCI requirements in Brazil.

Virginio (2013) states that there is an intense debate on the application of new laws, standards and technologies. The difficulty grows from the perspective of legally qualified professionals (engineers and architects), who, in some cases, are responsible for preparing fire-fighting projects that comply with current legal and technical requirements.

The general purpose of fire safety is to reduce the property damage risk, while its main objective is to be applied to the safety of people. According to Virginio (2013), in Brazil, the fire safety theme has evolved and gained considerable prominence, going through a continuous improvement of the current legislation, which brought the themes of quality and safety to it. According to Lazaroto (2004), people's attitudes when faced with emergency situations, whether individual or collective, are often desperate and irrational, so they need to have prior knowledge on how to operate firefighting equipment, for it to have some practical effect on their actions.

Higher Education Universities have a social fundamental role not only in the training of human, but also with the education, being agents capable of acting in the process of creating and propagating new knowledge, teaching new technologies, through basic research and applied research. Every year, universities and undergraduate institutions train dozens of new engineers for the job market, who are responsible for developing projects and applying new technologies.

For Franco (2019), the issue of Fire Safety (SCI) is approached in some countries as a science, becoming an area with a fundamental role in research,

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development, and teaching. The demand for professionals working in the SCI area is growing among engineers, researchers, and technicians, but there is still a lack of manpower in the market. Brentano (2015) and Seito et al (2008) attest that the greatest difficulty presented by professionals in the elaboration of projects comes from the deficiency during their training in higher education institutions. Braga (2020) states that as the teaching of Fire Safety is still deficient in the training of qualified professionals, the sanctioned Law 13,425 define that engineering and architecture courses in Brazil would have to address themes related to SCI in their curricula.

The loss of human life and material (economic) damages involved in fires enabled the development of research and investigations in the areas of engineering, as well as in firefighting safety in recent decades. Law No. 13,425, enacted on March 30, 2017, became known as the "*Kiss Law*", in reference to the fire at the *"Kiss"* nightclub, which took place in the city of Santa Maria (RS), where 242 people died in January 2013. The referred Law aims to tighten the rules on safety, prevention and protection against fire.

Negrisolo (2011) states that 88% of engineers and architects, in their graduation courses, had not learned anything or only had basic notions about fire safety, its objectives and regulations. According to the "*Kiss Law*", engineers from any segment must know what is necessary when it comes to fire protection, jointly applying their scientific methods on research and on engineering practices to safeguard life, and to protect movable and immovable property against fire. The present work seeks to analyze the fire safety approach in the curricular structures of engineering courses at a Federal University in Minas Gerais countryside, using the provisions of article 8 of Law 13.425/2017, also known as the "*Kiss Law"*, as parameters.

The main goal of this study is to check how the subjects present in the curricular structures of all engineering courses at a Federal University address the theme of "fire safety", and how they provide technical qualification to the professionals graduated in these engineering courses, enabling them to design projects and to adopt measures aimed at protection against fire, according to the parameters set out in art. 8°, established in the "*Kiss Law*". From this point on, the study will verify the presence of disciplines related to the technical and legal aspects of fire safety that meet the specification of article 8 of Law 13,425/2017; and will analyze the existing failures on fire safety in the elaboration of the curriculum structures of the engineering courses of our study subject and evaluate if the content of the "*Kiss Law*" meets the educational demands.

II. Major Accidents Involving Fire in Brazil

For Mentz (2017), the 70s and 80s were a milestone for the change in the paradigms of perception about fire prevention, resulting from tragic facts related to large fires that occurred in Brazil, such as those in the Andraus buildings in 1972, due to an overload in the internal electricity system in São Paulo (16 dead); and Joelma, in 1974, due to a short circuit in an air conditioning unit on the 12th floor, also in São Paulo (188 dead and more than 300 injured). All these events had great repercussions and an inestimable loss of life, not only for their victims, but also for all the people whose lives were directly affected by these fires, in the form of behavioral changes and psychological trauma.

According to Lima Neto (2020), failure to comply with fire safety standards causes serious and irreversible inconveniences. Another remarkable event was the tragedy of the Gran Circus Norte-Americano, in 1961, when a former employee acted criminally by setting fire to the canvas of the circus in Niterói, killing 503 people.

Lima Neto (2020) also states that, although the vast majority of fires occurred decades ago, it is noteworthy that, at the time, some resources could have been used to increase fire safety, such as fire doors, among other simple measures of fire prevention. Even without today's technological advancements in fire safety, these simple measures were still quite effective and could prevent loss of lives and property damage in the event of accidents. According to Carlo (2008), a large number of countries have learned from the great fires, and Brazil was no different. These tragedies caused changes in legislation, motivated the creation of fire brigades and the investment in fire safety research institutes and, above all, it started the practice of training technicians and researchers concerned with the area of fire and panic safety.

III. The *"Kiss"* A Nightclub Disaster and its Socio-Economic Impacts

One of the greatest fire accidents of Brazil's history happened in 2013, at *"Kiss",* a nightclub in the city of Santa Maria, Rio Grande do Sul. The incident marked Brazilian history and is considered the biggest fire in the last 50 years, causing 242 deaths and 680 injuries, most of them young students from the town's university (Previdelli, 2013).

According to Palma (2016), there were several design errors and failures in the adequacy of fire-fighting equipment that contributed to the intensity of this fire accident. Luiz (2015) states that, according to the Report carried out by the Regional Council of Engineering and Agronomy (CREA-RS), the conflagration was caused by a succession of primary

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errors. One of the failures that culminated in the incident were found in the preventive fire-fighting systems, such as: problems with fire extinguishers; sirens; fire alerts and emergency lighting that did not work, and other specifications that were inadequate, such as the size of the emergency exit, the acoustic lining without the anti-flame treatment and poor signalization.

Another factor observed, according to Rebello and Cavalheiro (2013), was the maximum capacity of the site. According to the Fire Prevention and Protection permit, the place could accommodate only 691 people. However, on the day of the accident, the Military Police found that there were more than 1000 people inside. Thus, such failures, combined with the divergences of an effective Fire Fighting and Panic Safety Project (PSCIP) were fundamental to cause this fire accident.

Orlandini (2018) provides, as a justification in his research, that failures such as those that occurred in the "Kiss" Nightclub fire prevention have many origins: the lack of knowledge and negligence of the organizations' owners regarding the current norms of Protection against Fire and Panic; the lack of expertise in PSCIP and the limited qualification of many graduated professionals of this field of knowledge. Shortly after the tragedy at the *"Kiss"* Nightclub, there was a large national mobilization, boosting the support for the bill that has been in the National Congress since 2007. According to Almeida (2017), this bill culminated in the approval of the Law No. 13,425, also known as the "*Kiss Law*", which was edited on 30th of March 2017. This law establishes the general guidelines on measures to prevent and combat fire accidents in establishments, buildings and public gathering areas.

IV. Legislation Applied to Fire Safety: Legal Speech in Favor of Safety

There is an interdependence between the major accidents involving fires in the 70s and the emergence of laws and their regulations, technical-scientific forums, changes in procedures (Rodrigues, 2016). According to Braga (2018), after the fire in the Joelma Building, the first concrete measure regarding Fire Safety was incorporated, instituting special rules for the safety of buildings, into the Building Code of the Municipality of São Paulo (Law No. 8,266, of 1975).

According to Xavier (2018), laws are commonly developed by the State to establish and centralize the rules that must be followed, thus creating a structure and giving the maximum power to the Federal Constitution. Braga (2018) explains that, after the implementation of Law No. 8,266/75, each Brazilian state defined its own SCI standard, based on the Brazilian Standards (NBR) and Regulatory Standards (NR).

Some municipal and state agencies are responsible for drafting laws and regulations on the subject of "fire safety". According to Brentano (2015), the only federal fire safety regulation would be Regulatory Norm 23, but this law still shows a generic background in terms of fire safety for the work activity. Xavier (2018) says in his study that the NBR's aim is to foster the improvement of information, the establishment of rules, and the implementation of effective guidelines with the main objective of maintaining a standard of quality and efficiency.

> None of the articles of the Federal Constitution that deal with the competences of federative entities specifically deals with fire safety, unless we take this matter to civil defense matters (private competence of the Union, in accordance with item XXVIII of art. 22), for the protection of the environment (common competence of the Union, States, Federal District and Municipalities, in accordance with item VI of art. 23, is concurrent competence of the Union, States and Federal District, in accordance with the item VI of art. 24) and the urban planning law (concurrent jurisdiction of the Union, States and Federal District, in accordance with item I of art. 24).

Negrisolo (2011) also states that the regulation on this subject is still insufficient, relying only on the Work Codes of each municipality and their Fire Departments, which had their regulation coming from the security field, presenting fire control measures, a concern in hydrants and fire extinguishers, in addition to the signaling of these kinds of equipment. According to Brentano (2015), the existence of this legislative variety ends up demanding a greater effort of compliance from the professionals and from inspection organizations, as these requirements change in each state. This whole panorama also ends up forcing professionals in the field to be constantly studying and learning, and to be always attentive to new developments (Xavier, 2018) in the legislation.

Law 13.425/17 leaves it to the Municipal Government to establish specific rules and to the Military Fire Department, the most executive part, according to Articles 2 and 3 of Law No. 13.425 (Brasil, 2017). A very important point in the development of this law is the implementation of article 8 and its sole paragraph, relating to the training of engineering and architecture professionals, which includes:

> Art. 8 Undergraduate courses in Engineering and Architecture in operation in the country, in universities and public and private education organizations, as well as related technology and secondary education courses, must include content related to the prevention and fight against fire and disaster in their curricula.

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> Single paragraph. Those responsible for the courses referred to in the caput of this article will have a period of six months, counted from the entry into force of this law, to promote the necessary complements in the content of the subjects taught, in order to comply with the provisions of the caput of this article (Brasil, 2017).

For Braga (2020), the creation of this law highlights the importance of learning the SCI theme in Engineering and Architecture courses in Brazil. This helped to mitigate the negligence of Educational Institutions in the egress of professionals unprepared for the labor market, even with the existence of ABNT technical standards and specific state and municipal regulations for the SCI. Lima Neto (2020) believes that the measures included in the Law 13.425/17, in its art. 8th, will bring advances to professionals working in the area, thus providing a good evolution and improvement in the subject of fire protection. However, Lima Neto (2020) emphasizes that it would still be essential for this law to have its own regulation for an effective implementation to be carried out. Silva (2019) addresses another opinion regarding that applied by Law 13,425/17, highlighting the fact that, as it was restricted to public meeting establishments, it did not encompass other economic activities that are also subject to risks.

Xavier (2018) exposes the existence of this variety of standards and points out that, while some laws provide more detailed and current content, others still have an old and vague approach to fire safety content, leaving gaps for interpretation which culminates in errors and, consequently, greater risks. As for Silva (2018), the fact addressed in the issue exposed by art. 8 of Law 13,425/17, on mandatory education on fire and disaster prevention, is still ignored.

V. Curriculum Map-Matrix in Engineering Courses

According to Brasil (2020), all content determined to be part of the training of an engineer and knowledge of the curricular structure - the so-called curriculum matrix or curriculum map-matrix - follow a pattern and formative logic to present their themes. Brasil (2020) also argues that, in order to carry out the creation of the curriculum map-matrix, the organization of contents can either meet regulatory documents, such as curriculum guidelines, or be defined based on the understanding of a group responsible for developing the curriculum map-matrix. All these contents must always be focused on the student's egress profile.

When it comes to the profile of graduates of undergraduate courses in engineering, it is necessary to understand some of its main characteristics. According to Brasil (2019), engineers must be critical, creative and capable of doing research, of developing new technologies, and of adopting transdisciplinary perspectives in their professional practice. For Brasil (2020), when defining the profile of the graduate, he/she must present consistency in all aspects and be aligned with the National Curriculum Guidelines for the Undergraduate Course in Engineering (DCNs of Engineering).

With the establishment of article 53, paragraph II of Law No. 9,394, it was determined that the guidelines and bases of national education, together with the autonomy of universities, would define the fixed attributions to be implemented in the curricula of their courses and programs (Brasil, 1996).

Brasil (2020) states that the DCNs have the role of guiding the courses in the development of their students' competences, which have as a guiding axis the elaboration of the text of the Pedagogical Project of the Course (PPC). According to Brasil (2019), the PPC is responsible for presenting strategies and intends, based on the reality in which the course is inserted, and in view of the profile of the incoming student, to analyze the egress profile, and the description of the skills that must be developed, from general or specific characteristics, considering the qualification of the course and the professional market.

Brasil (2019) brings in its 6th article, that undergraduate courses in engineering "must have a PPC that covers the set of learning activities and ensures the development of competences". Brasil (2020) considers the PPC as a guiding document for the development of the course and its structure must be followed by a transparent, broad standard, which matches reality and with quality, guiding actions related to student education. According to Brasil (2019), the document must also present the instruments and actions necessary for the training of the engineer, which, in addition to a solid technical training, should also include a generalist, humanist, critical, creative and reflective training.

According to Brasil (2020), all the actions that are contained in the PPC also serve to motivate and engage students in their training process, in line with the skills expected for the labor market. The initial formulation and periodic review of this project are the responsibility of the Structuring Teaching Nucleus (NDE) made up of professors, masters and doctors, with experience in the fields of knowledge of the course. Normally, any changes regarding the curriculum of the undergraduate courses of the university under study are periodically evaluated and structured by the NDE, meeting the institution's demands and the MEC's determinations.

Medeiros (2020) points out that, in the texts of the DCNs of the architecture courses (Resolution CNE/CES No. 2/2010) and engineering (Resolution CNE/CES 2/2019), the mandatory content for fire safety

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is not explicit. In this regard, it is observed that there is a need for reformulation in response to reality and the national legislative demand. Perrenoud (1990) recalls that curricula in higher education must first define the skills needed for professional training, in order to later outline the contents. In this sense, the curriculum is, therefore, a continuous construction and an ordering of competences, which must be guided by the demands of the current market.

The curriculum is the essential component to understand how pedagogical practices work. In general, these practices are governed or guided by the curriculum. Therefore, the curricula of engineering courses should follow the changes, molding their competences according to the established parameters. For this, the assessment of the approach to the content must be continuous, allowing for more frequent updates. In this aspect, the author draws attention to a competency-based curriculum. Normally, competency-based curricula are more open to the possibility of changing traditional methods, allowing for greater reformulation of teaching methodologies (SOUZA; VARELLA and BRANCO, 2015). Thus, once fire protection or safety is established as a necessity, curricula can insert it as one of the essential skills for the future engineer.

VI. Teaching Fire Safety in Engineering Courses

According to Silva and Cecílio (2007), perhaps more than in other times, engineering education must conform to the needs that the market has in seeking professionals with the capacity to perform activities inherent to different development sectors. According to Crivelli (1998), a large part of the changes that take place in the curriculum structures of engineering courses in Brazil is derived from a concern of the Federal Government in promoting technical training to meet the demands of industry and the market, also aiming to integrate the professionals with the international scenario. Domitiano (2017) points out that fire prevention is a matter of paramount importance, being referred to as a set of procedures that must be respected, in order to prevent dangerous situations from getting out of control. Observing the aspect of professional qualification, Silva (2014) says that higher education institutions have a substantial role in the education and training of engineers, who will be the professionals responsible for implementing actions and fire prevention systems, and that these help to prevent accidents and conflagrations in buildings, or if these accidents happen, they would guarantee the safety of their occupants. According to Seito et al (2008), fire safety is considered a science, which requires investments in research, teaching and new technologies. Franco (2019) emphasizes that this field has a very broad labor market and growth possibilities, since the demands for preventive safety measures on the part of organizations has been increasing. Reis (2019) states that engineering professionals must have a good fire safety education, and that the SCI market is very promising.

For Santos (2018), a correct guidance is needed to implement the teaching of Fire Safety in the curriculum, as Brazilian universities keep delivering to the job market professionals who are not yet prepared when it comes to fire protection, who are not attentive to the fire safety legislation and who do not pay attention to what is demanded in inspections and regulations. Rodrigues (2016) states that the association of technical-scientific evolution with legal instruments is essential, since a minimum knowledge of regulations, a good understanding of the development, structuring and interpretation of laws is essential for professionals working in the Fire Safety area.

Rodrigues (2016) says that the development of Fire Safety education and the filling of existing regulatory gaps can only be done if combined with three factors, which are: the professional education, formalized through teaching and improvement actions of skills; the effective and clear structuring of regulations and the investigation and improvement in the field of research, which will provide a continuous advance in the knowledge of the management system in SCI.

Due to the responsibilities assigned to engineering professionals, Jesus (2017) addresses how important it is to have a good understanding of the risks to which your team is exposed, and to have adequate knowledge of how to efficiently prevent fire and raise awareness to fire safety. Medeiros (2020) states that students put into practice what they learn, with preliminary information. Negrisolo (2011), in his thesis concluded that 17.8% of the universities still do not include the fire safety theme in their curricular matrices, and, in the ones that include it in their curricula, fire safety is not developed in an effective or solid way. Negrisolo (2011) points out that there is also no consolidated workload or a completely accepted analogous bibliography, and the theme is not a consecrated focus.

When the engineer gets his degree, according to Silva (2018), from him to learn about the SCI field, it is necessary to seek this knowledge as a complement, by a subsequent education, training or updating. Furthermore, the legislation does not require the architect or engineer to have this additional training to carry out the projects, monitor the building constructions, and to develop the application of technologies and action plans that are within their area of competence.

Ongaratto (2017) points out that the subject, when taught in courses, has insufficient study hours for the complexity that the fire safety theme presents. Xavier

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(2018) says that most universities in the country still do not effectively address the topic of fire safety in their curriculum, which ends up leaving a gap in the professional's knowledge when they complete their graduation, making it necessary to seek this training in other places and in other circumstances. For Ongaratto (2017), the professional, upon completing his training, ends up having to seek professional courses and specializations on the subject. He must always be aware of new laws, decrees, standards, which are constantly being updated.

According to Silva (2018), when it comes to teaching fire safety, each educational institution was tasked with introducing in its curriculum subjects on safety, prevention and protection against fire. However, reality shows the, up to now, the teaching of the content in undergraduate courses in engineering and architecture, when it exists, is presented in an insufficient way.

VII. Methodology

The study focuses on the systematic literature review method, whose methodological principle is the synthesis of scientific literature focused on a scientific issue, in an attempt to identify, select, evaluate and synthesize the evidence of high-quality research relevant to the issue. (Bettany-Saltikov, 2012). The high quality of the research, according to the author, is related to the explicit methodological rigor that allows for an effective understanding of the research conclusions. Systematic reviews differ from narratives in that they adopt a more rigorous method, a transparent scientific process in order to minimize bias through exhaustive research in the literature, providing an audit trail of the reviewers' decisions, procedures and conclusions (Cook, Mulrow and Haynes, 1997). Furthermore, systematic reviews play an important role in evidence-based practices[1].

For this study, the following steps were followed, based on a systematic review of the literature: (i) choice of theme and elaboration of the research question; (ii) establishment of inclusion and exclusion criteria for studies; (iii) categorization of selected studies; (iv) analysis and interpretation of results; (v) presentation of the review and synthesis of knowledge. The guiding question presented at the end of the introduction was elaborated from the PI(E)CO strategy, for framing the research, whose letters indicate: Problem or Population, Intervention, Indication of interest or exposure, Comparison/Standard procedure and Outcomes/expected results.

The PI(E)CO strategy calls for a complete search on research platforms, directing the question to obtain keywords that point to answers (Santos; Pimenta; Nobre, 2007). In this context, it was adopted as PI(E)CO: Population/Problem > the lack of parameterization of engineering courses regarding the implementation of a curriculum that addresses and contemplates the requirements of the "*Kiss Law*" in the courses of future engineers; Intervention > exposure to a curriculum that does not meet the requirements of a fire safety or protection approach, and the need for NDE intervention to enforce regulatory requirements; Comparison/Standard Procedure > establish a comparison between the curricula of engineering courses and check the procedures of each course regarding the approach to fire protection; Outcome/expected results > it is expected to infer not only the importance of implementing fire protection in engineering curricula, but also to identify the possibilities of compliance with the "*Kiss Law*" in the school environment, studying and pointing out measures for the application of educational content aimed at this end.

Therefore, the guiding question of this one focuses on: how and how often is the fire protection approach inserted in the curriculum in engineering courses? In a second moment, the relevance of the theme "protection or safety against fire" for engineering curricula was discussed.

The next step refers to data crossing. For that, an extraction of data from the researchers was carried out, in order to minimize their relevant information about the topic in focus. The selected research, therefore, answered the guiding question, made available in full and published in the period from 2016 to 2021 (the last 5 years). The selection of this period is due to the fact that the "*Kiss Law*", which guides the entire study, dates from 2017, which justifies the lack of literature on legislation prior to that date. All studies of the bibliographic research were selected, from an analysis of the topics, containing as search key terms on the research theme, whether in the title, abstract or keywords. The search keys and logical Booleans adopted were: fire protection [MesSH Terms] OR fire safety AND curriculum AND engineering. In Portuguese: ("fire protection" OR "fire safety" AND "curricular matrix" OR "curriculum" AND "engineer" OR "engineering"). At first, the search was carried out in English. However, in a second moment, the refinement in Portuguese was chosen due to the fact that the research discusses the curricular matrices of Brazilian undergraduate courses in engineering and Law 13,425/17 is also national.

The following databases were selected for consultation: Google Academic; ERIC; Scielo. These databases were chosen due to the scope and dimension of the databases indicated, as in the case of Google Academic and Scielo, as well as the affinity of studies, as in the case of ERIC, which normally publishes studies focused on the area of Education. Scielo was selected because it is a database that brings

[1] Methodology for clinical practice disseminated among health professionals. It consists of the use of scientific evidence, produced by studies developed with methodological rigor

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together many essays from Latin America, which could include essays in the Portuguese language.

The consultation sample was determined based on the following inclusion criteria, which comprised the cluster of this study: i) scientific studies with a publication date between 2016 and 2021; ii) scientific studies published in peer-blind or double-blind journals; iii) empirical and descriptive studies; iv) the language used for selection was Portuguese, since it is a Brazilian law and the study refers to the curriculum of engineering courses nationwide; v) original research and review studies were included, whose theme answered the guiding question; vi) studies that contain in the title, abstract or keywords the search terms according to the logical Booleans adopted. As for the exclusion criteria: i) studies without specific methodology were excluded; ii) other studies that did not include articles from journals with blind review were excluded; iii) studies published in other languages were excluded; iv) studies that did not focus on the main theme and its connection to an educational approach were excluded. For the selection of studies on the "*Kiss Law*" to cover the review on this theme, in the introductory chapters, the term "*Kiss Law"* was added to the previous search key. Subsequently, duplicate articles were excluded.

The inclusion and exclusion criteria, in this case, was the approach of the "*Kiss Law*" with other areas, prioritizing, in this case, the correlation with the educational area. A systematic review attempted to gather all relevant evidence that fits pre-specified eligibility criteria to answer a specific research question. For data collection and presentation, the PRISMA protocol or recommendation was used, which according to Moher (2015) has the main objective of helping authors to improve the reporting of their systematic reviews and can also be used as a basis for reporting reviews of systematic results of other types of research. The PRISMA-P aims to guide the development of protocols for systematic reviews and meta-analyses.

The PRISMA recommendation consists of a 27-item checklist to be included in the systematic review or meta-analysis report) and a four-step flowchart (Figure 1 - Prisma flowchart). The aim of PRISMA is to help authors improve reporting in systematic reviews and meta-analyse.

In a second moment, a documented case study was carried out, selecting a university that had several engineering courses, to observe how fire protection or safety was being addressed in the curriculum of each course, as well as the frequency that this content was included in the curriculum.

According to Yin (2010), the case study refers to a type of empirical investigation that addresses a contemporary phenomenon within a real-life context. The case study method seeks to understand a phenomenon from its in-depth exploration (Costa et al. 2013). Our purpose was to establish whether the topic "Fire Protection or Safety" is taught during the graduation of an Engineer at a Higher Education University, as established by article 8 of Law 13.425/2017, known as the "*Kiss Law*". The Pedagogical Course Project (PPC) of each undergraduate degree in engineering at the institution selected for study was analyzed, based on the curricular structure on the topic of fire safety, and the inclusion or removal of mandatory or optional components in the curriculum. For ethical reasons, the name of the institution was not disclosed.

The information collected through the analysis of the curricular structures referred to the 2015 update of a total of nine undergraduate courses in engineering, all with five years of completion and minimum workload required by the MEC. An analysis of the curricular components in the basic, specific and professional nuclei was carried out, in order to verify if their curricular structures present the competences of the subjects that address the subject fire safety in a mandatory, elective or optional manner, or at least related topics to the subject of Safety for engineering undergraduate courses. Thus, the exploratory character of this study is due to the fact that there is little systematic research focused on the topic. These surveys on fire safety knowledge assessment have been developed with some professional categories in the field of architecture. Thus, we did not find studies that have been carried out with engineering professionals, and even if their graduation courses met the specifications contained in art. 8, of Law No. 13.425/2017 - the "*Kiss Law*".

VIII. Results and Discussions

Two results were achieved in this work: the first consisted of a survey of references addressing the topic of Fire Safety, presenting the main causes for disasters involving fire, the accident that occurred at *"Kiss"* Nightclub and its role in the creation of Law 13.425/17, focusing on its article 8, as the development of legislation regarding Fire Protection and the application of the Fire Safety theme in the curricula and teaching of undergraduate courses in Engineering occurred.

The second consists of verifying the fire safety approach in the curriculum of engineering courses at a Federal University, based on an analysis of the PPC's of each course, since, according to what is established by art. 8 of Law 13,425/17, Brazilian universities must include content related to fire safety in their curricula.

a) Systematic Literature Review and Selection of Studies

From the research that took place on the literature research platforms, a total of 1,595 studies were identified that guided the subject addressed in the guiding question. In the end, only 16 relevant studies on the subject were presented, which served as the basis for the creation of the framework. To meet the selection criteria of potential studies, it was necessary to remove

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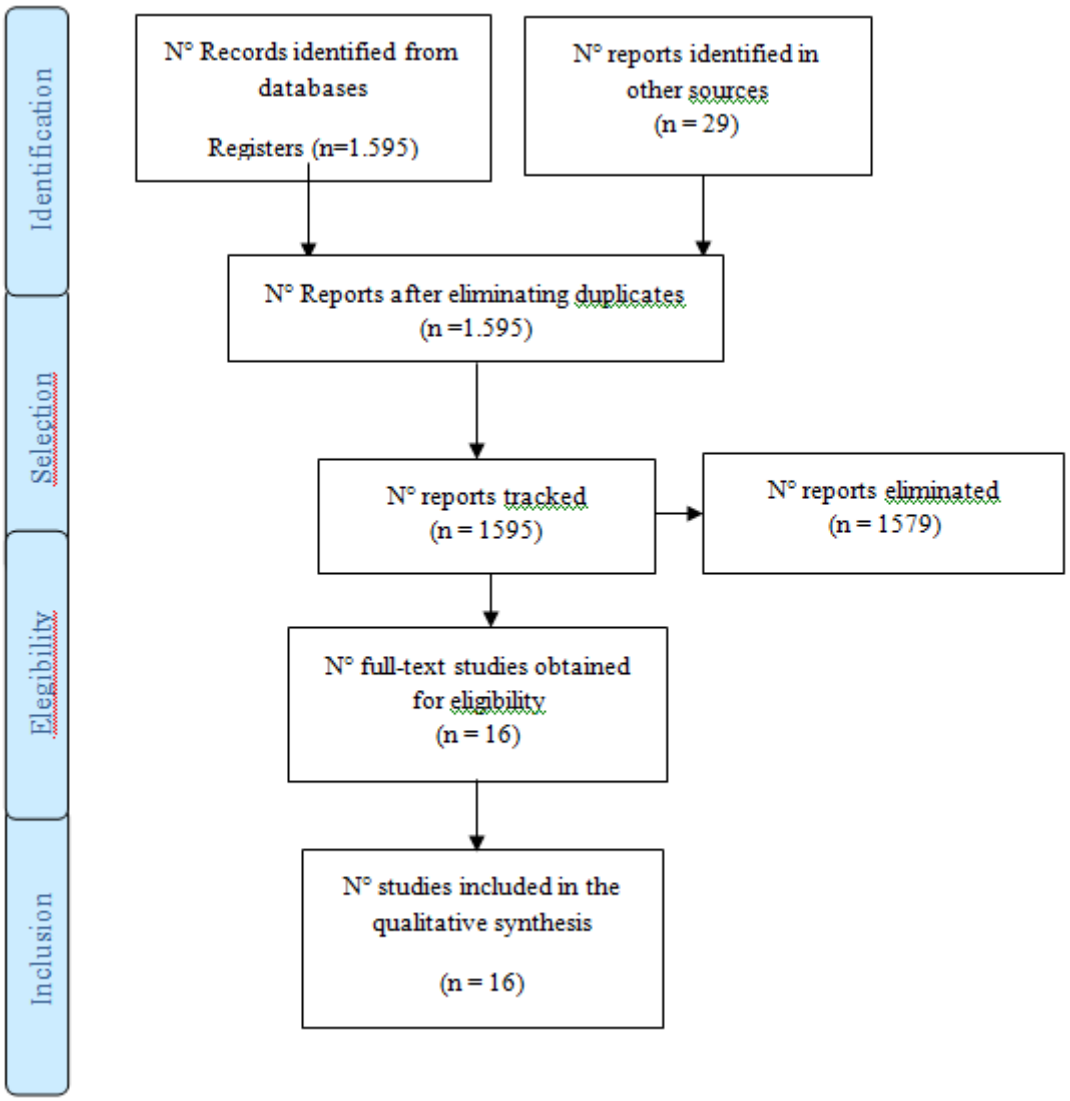
the duplicates. At this stage, no study was found that met the criteria for extraction, as shown in Figure 1 - Prism.



Source: Prisma Group (2015)

Figure 1: Prism Flowchart

As can be seen from Figure 1 - Prism Flowchart, the topic is still very scarce in studies. Even when filtering the searches for after the update of Law 13.425/17, it is noted that researchers still do not address and discuss the subject.

b) Characteristics of Selected Studies

According to Table 1 - Theoretical scientific material analyzed (2016-2021) below, the collection was carried out and organized according to the categorization of the selected studies. The objective was to identify, select and evaluate the studies indicated in the table, based on the presented relevance, while trying to establish a link with the guiding question, related to the Fire Safety approach and the insertion of the discipline in the curriculum map-matrix in engineering courses, according to what is demanded in art. 8 of the *"Kiss Law"*. Thus, it was possible to understand the speeches of the authors implicit in each excerpt.

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Table 1: Scientific theoretical material analyzed (2016-2021)

N	Author/Year	Title
1	Lima Neto (2020)	Fire Safety in the Curriculum Matrix of the Electrical Engineering course
2	Franco (2019)	Fire and Panic in Brazil: A systematic study on the role of the Engineer in ensuring safety conditions and measures against fire
3	Jesus (2017)	Teaching Work Safety in Engineering Graduation Courses in Curitiba-PR
4	Pereira (2016)	Fire Safety: an interface between public and private interests under the reflections of teaching in skills training
5	Palma (2016)	The importance of PPCI for society: the perception of professionals, users of buildings and creator of the *"Kiss Law"*
6	Orlandini (2018)	Proposal for a verification tool that acts on the main causes of re-analysis of Fire and Panic Safety projects
7	Xavier (2018)	Development of a Spreadsheet for the preparation of Fire and Panic Prevention and Fighting projects based on the technical instructions of the São Paulo Military Fire Department
8	Reis (2016)	Fire Prevention and Protection Plan: case study of a multi-paved school building - Mechanical Engineering building
9	Rodrigues (2016)	Fire and Panic Safety Management System in Buildings: Rationale for National Regulation
10	Silva (2018)	Risk of fire in cultural heritage: the importance of preventive maintenance actions
11	Braga (2018)	Analysis tool of Fire Safety measures in architecture projects applied to the teaching of Architecture and Urbanism courses
12	Medeiros (2020)	A plan for teaching Fire Safety in the Faculties of Architecture and Urbanism
13	Ongaratto (2017)	Architectural Proselytism and Fire Prevention and Protection Plan
14	Braga (2020)	The teaching of Fire Safety in an Architecture course in Brazil
15	Domiciano (2017)	Verification of Fire Protection in Small Industry in the State of São Paulo
16	Vicente (2017)	Overview of Fire Safety in Buildings: Analysis of Reports in the Military Fire Department in Paraíba

Source: Author's data

The selection of the studies and the absorption of information contained in scientific productions were listed according to the units of interest. In compliance with the checklist of the Prisma protocol, all items on the list were checked, excluding those specific to meta-analysis studies. The risk of bias, systematic error in conducting the study, whether in recruitment, outcome assessment or data analysis, which could lead to incorrect results, was addressed. "The validity of a study is directly related to two dimensions, internal and external validity. The first concerns whether the study answers a research question properly, that is, free from bias" (Carvalho; Silva; Grande, 2013, p.38).

To minimize the risk of bias in data collection, multiple databases were tested and the studies fully verified to ensure that no relevant information was lost. Data extraction was performed independently by two reviewers. Differences were resolved by consensus. The risk of quality bias was considered while analyzing the selection process by titles and abstracts, as well as the evaluation of the full text reported. To minimize the risk of evaluation, the quality of the study was analyzed by the reviewers. A bias to be considered is that of selection regarding the choice of national studies. However, it is believed that it can be addressed in future research.

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c) *Analysis of Curricular Matrices According to the Parameters of Art. 8th of the "Kiss Law"*

The deadline established for the implementation of the disciplines in the curricular structures of the undergraduate courses in engineering, as established by art. 8, of the "*Kiss Law*", was stipulated within a maximum of 6 months after the law came into force. However, most engineering education institutions try to give their own interpretation of the law without effectively making a change in the curriculum of said courses.

From the analysis carried out in the graduation PPC of each course, it was possible to ascertain the strategies and actions to be undertaken by students and teachers for the formation of an engineer, in accordance to the objectives proposed by the National Curriculum Guidelines, the Institutional Development Plan and the Institutional Pedagogical Project.

The proposal of modular formation of the curricular structures and the teaching methodologies used during the engineering courses at the University have a main objective of forming the egress profile according to the guidance of the National Curriculum Guidelines for the Undergraduate Course. In principle, the courses constantly update the PPC, according to the institution's demands. Therefore, there is a certain regularity between courses in terms of attendance. However, this approach to the contents of the curriculum matrix deserves further discussion. The base of the curricular components is divided into three training centers: Basic Nucleus, Vocational Nucleus and Specific Nucleus.

Table 2: General Composition of the Pedagogical Course Project

Course	Last update date	Training Centers
Materials Engineering	December 2017	Basic Core Vocational Center Specific Core
Health and Safety Engineering	May 2019	
Environmental Engineering	May 2018	
Control and Automation Engineering	Jully 2020	
Mechanical Engineering	December 2016	
Computer engineering	Octobre 2020	
Mobility Engineering	No date	
Electrical engineering	December 2020	
Production Engineering	November 2016	

Source: Author's data

As shown in Table 2 - General Composition of the Pedagogical Course Project, all courses point to the same division of training nuclei, with variations only with regard to the curricular components (type of activity, menu and minimum workload), this composition being specifically targeted at each course. All courses are organized into ten semesters, and, in nine semesters, the curricular structure is organized into mandatory and optional curricular components. Students must also carry out supervised internship, their graduation's final essay and complementary activities.

According to what was exposed in the column "date of last update" of the PPC of all undergraduate courses listed in Table 2, four courses, equivalent to 44% of the total courses, made some kind of change in the document after the date of the "*Kiss Law*", but only the Undergraduate Courses in Health and Safety Engineering and Environmental Engineering were in strict compliance with Article 8 on the subject of fire safety.

The analysis of the syllabus of all disciplines in the courses active at the University is presented and organized according to their disposition in the curricular structure. In the Environmental Engineering course, as provided for in the PPC, it was planned that Fire Safety would be taught together with the content of the Ecology, Water Management and Environmental Geotechnics disciplines, content related to the prevention and combat of fire and disasters, not specifying the workload for each topic.

However, it could be verified by the analysis of the curricular components, in the syllabus and up to the time of this research, that these have not yet been changed or implemented for the routine of the classrooms.

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As for the Health and Safety Engineering course, the importance of analyzing preventive actions is notorious in relation to the topic of fire safety. The subject of Fire Safety is addressed in five curricular components, which are presented in Table 3 - Analysis of the curricular structure that addresses the theme of fire safety, specifying in detail the curricular component, the syllabus and its total workload.

Table 3: Analysis of the curriculum that addresses the topic of fire safety

Curricular component	Menu	Hours total
Security Engineering I	Security Engineering Objectives. Adverse events. Theory of the causes of accidents. Various risks. Technological accidents. Analysis of accidents and accidents without injuries. Accident Investigation and Reports. Regulatory rules of the MTE. Specialized Services in Safety Engineering and Occupational Medicine. Internal commission of accident prevention. Personal protective equipment. Occupational Health Medical Control Programs. Environmental Risk Prevention Program. Hazardous Activities and Operations. Work in the Construction Industry. Explosives. Flammable Liquids and Fuels. Outdoor work. Occupational health and safety in Mining. Fire Protection. Industrial Waste. Safety Signs. Inspection and Penalties. Safety and health in port and waterway work. Confined spaces. Safety and Health in health care establishments. Health and Safety in shipbuilding. Standards in public consultation.	64h
Fire Engineering I	Concept, importance and participation of work safety engineering in fire protection. Fire protection legislation and regulations. Study on fire, fire and combustion and their effects. Active protection – fire and explosion protection and fighting equipment. Passive protection – structural protection. Explosives – conceptualization, identification and control. Rescue techniques. Fire Brigades.	64h
Fire Engineering II	Practical activities involving concepts of Concepts for Fire Safety Projects. Passive Protection Elements. Active Protection Elements. Fire Risk Management. Extension projects.	64h
Fire Engineering II	Practical activities involving concepts of Concepts for Fire Safety Projects. Passive Protection Elements. Active Protection Elements. Fire Risk Management. Extension projects.	64h
Fire Engineering II	Practical activities involving concepts of Concepts for Fire Safety Projects. Passive Protection Elements. Active Protection Elements. Fire Risk Management. Extension projects.	64h
Risk Control Engineering Methods I	Removal and control of industrial contaminants; measurement, isolation, dilution and exhaustion strategies. Industrial ventilation. Risk control technologies: noise, vibration, heat, explosions, fire. Fire prevention and fighting.	64h
Risk Control Engineering Methods II	Methodology of environmental risk control engineering projects. Economic aspects in engineering projects. Development of engineering projects for risk control: noise, vibration, heat, explosion, fire, radiation and biological hazards.	64h

Source: Author's data

It is possible to observe that there are two subjects which their titles refer to the analyzed context, Fire Engineering I, which belongs to the 2015 curriculum structure presented in a mandatory manner and Fire Engineering II, which is usually approached as an optional course, but which was planned by the Structuring Teaching Nucleus (NDE) of the course with the objective of inclusion in the next update of the curricular structure, both with a workload of 64 hours focused on the topic of Fire Protection and Firefighting. The disciplines of Safety Engineering I, Risk Control Engineering Methods I and Risk Control Engineering Methods II are related to the theme of fire safety, addressing topics such as: fire protection, development of projects, fire risk control engineering, fire risk control technologies, with an average workload of 2 hours on each subject.

As for the approach to fire safety, regarding the syllabi of other courses, it was evident that there is no such discipline in their curricular structures, in the basic cores and/or specific cores, topics directed to the subject, as well as matters related to the theme, thus

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signaling the need for curricular revision in view of the importance of this discipline in the training of these professionals.

IX. Final Considerations

Law 13,425 of March 30, 2017, known as the "*Kiss Law*", has been in force for more than four years. In addition to establishing stricter fire safety, prevention and protection standards in establishments, the "*Kiss Law*" proposes that the development of fire prevention projects must be done by professionals of this field.

In addition to these issues, our research also focused on art. 8, of the "*Kiss Law*", which made inspection more rigorous and determined that universities and/or organizations that have graduate courses in Engineering and Architecture, have disciplines with content related to prevention and combating fire and disaster.

According to this study, the theme "fire safety" is still not present in a systemic way in the curriculum structures of undergraduate courses in engineering at the analysed federal university. In this university, only one of the undergraduate courses offered has addressed the theme in its curricular components, researching and teaching about the subject. Among the curricular components and syllabus analyzed, fire safety is specifically expressed in a subject called Fire Engineering I, in an optional subject called Fire Engineering II, and in some topics in the syllabus of three subjects in the course of Health and Safety Engineering, where it is presented with an approach with a minimum workload of 128 hours, which was considered complete and engaged to the referred subject.

It is undeniable that there are few undergraduate courses in engineering that are concerned with researching and teaching about fire prevention. Therefore, untrained professionals are being delivered to the job market. However, the fire safety issue has evolved quickly and these new professionals need to cope with this reality, being attentive to legislation, inspections, having a vision profile and with the ability to develop new technologies throughout their professional life, acting as a builder and multiplier of knowledge, regardless of their specialization, being proactive and ethical in society and intervening in it with a sense of responsibility.

It is also important to emphasize the need to address this issue in the curriculum structures of the engineering courses at this Federal University, as not only the legitimacy brought by the law is being discussed, but also the amount of information and studies that have been produced in this area, as well as the surveys carried out. Therefore, there is a need for rapid changes to take place in the curriculum, so that fire safety is addressed with due importance in the courses and with the main focus on graduates of engineers trained to deal with their various possibilities of action.

The engineering profession has become more and more requested to update themselves and present themselves open to the incorporation of technical innovations and scientific research methods. Thus, as these changes are taking place, the engineering profession needs this training in its undergraduate courses. However, despite fire safety being a fundamental discipline, which has also been changing due to the new conceptions of work and technology, it is evident that essential particularities are still lacking for the effective realization of what was determined in art. 8, of the "*Kiss Law*".

It is important to highlight the fact that article 8, of the "*Kiss Law*", is presented in a generic way, containing flaws in the details, notably, in relation to what could be the established disciplines and the minimum contents adopted. Therefore, there is no understanding about the contents and the stipulation of a minimum total workload, and which professional is qualified to teach the content, thus resulting in dubious and imprecise interpretations.

Another fact is that the law 13,425/17 is silent with regard to the specific or optional character of the subjects that would integrate the curricular structure, according to the types of courses, since there are numerous specializations in engineering.

It was understood that Universities do not effectively change their curricular structures of undergraduate courses with the inclusion of any discipline that deals with the subject of fire safety, as they do not interpret the provision of the law that determines the obligation of the inclusion of disciplines with content related to fire disaster prevention and combat, together with the lack of knowledge on the subject.

In short, taking into account the analysis of art. 8, of the "*Kiss Law*" and the observations made in the curricular structures of the aforementioned courses, it was found that a legislative review is necessary to remedy the omissions in the aforementioned article, with regard to the mandatory inclusion of subjects in the curriculum. In addition to this fact, it was found that there is an insufficiency of content and of the teaching hours on Fire Safety in the undergraduate courses in engineering at the University studied, as 88% of the courses of this institution have not enabled their undergraduates for technical qualification on the subject and, consequently, do not train them to prepare of a fire-fighting project.

In view of the results obtained in this work, it was possible to establish some suggestions for future research. It is suggested a study involving the knowledge acquired by the students from different periods of undergraduate courses in engineering on the

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topic of Fire Safety, and from its analysis and corresponding NDEs, to address the decision-making process on this subject in curriculum structures. Another suggestion would be the adoption of a minimum content, a minimum workload and the professional qualified to teach Fire Safety topics, based on methodological studies brought by the "*Kiss Law*".

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