


DIAGNOSIS ABOUT WORK ACCIDENTS IN TEXTILE INDUSTRY: INSIGHTS TO IMPLEMENT OCCUPATIONAL HEALTH AND SAFETY SYSTEMS

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 17 October 2023</p> <p>Accepted 16 January 2024</p>	<p>Purpose: This study aimed to analyze the occupational health and safety data in the textile industry to guide the implementation of the ISO 45001 standard.</p>
<p>Keywords:</p> <p>Work Accident; Textile Industry; Brazil; Occupational Health and Safety.</p>	<p>Theoretical Framework: The global estimates of the International Labor Organization show that the world economy loses about 4% of GDP annually to occupational diseases and accidents, which, in addition to human losses, result in a loss of productivity due to unsafe or unhealthy environments. Motivated by the transition from the OHSAS 18000 standard to the ISO 45001, it is necessary to understand the scenario of industries and the impact that accidents cause.</p>
	<p>Design/Methodology/Approach: From the collection of data from the state of Santa Catarina in the southern region of Brazil, a diagnosis is presented that may serve as a starting point for improvement actions regarding worker health and safety and as a benchmark for other companies in other sectors. The methodology began with analyzing the state of the art in occupational health and safety management, accident concepts, and the history of this theme worldwide.</p>
	<p>Findings: The results showed that the main accidents that occurred in the textile factories of Santa Catarina from 2012 to 2022 were with machinery and equipment, followed by accidents with chemical agents, transport vehicles, and biological agents. As for the most affected body parts, these were the fingers, followed by feet, hands (except wrists and fingers), and eyes. Another research question was to identify the sectors of the textile industry that had the most accidents in the period, which were the spinning, weaving, and textile processing sectors. Also, there were two thousand days lost in 2021 alone and, cumulatively, 45,900 days lost in this interim.</p>
	<p>Research, Practical & Social Implications: The absence of studies of this type for the textile industry and also a starting point for improvement actions regarding worker health and safety and as a benchmark for other companies in other sectors. The adoption of an Occupational Health and Safety Management System with the application of the ISO 45001 standard is a preventive and necessary measure to reduce the rates of accidents and diseases raised in the research carried out.</p>
	<p>Originality/Value: The relevance of the topic is demonstrated by the large number of accidents registered in Brazil and worldwide and, at the same time, the absence of</p>

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studies of this type for the textile industry. The clipping of this sector helps to understand the data regarding the most affected body parts, the number of registered work accidents, expenses and waste for companies, their causes, and the sector in which the most accidents occur, thus guiding managers to the implementation of an effective occupational health and safety management system.

Doi: <https://doi.org/10.26668/businessreview/2024.v9i1.4289>

DIAGNÓSTICO SOBRE ACIDENTES DE TRABALHO NA INDÚSTRIA TÊXTIL: DICAS SOBRE COMO IMPLEMENTAR OS SISTEMAS DE SAÚDE E SEGURANÇA OCUPACIONAL

RESUMO

Objetivo: Este estudo teve como objetivo analisar os dados de saúde e segurança ocupacional na indústria têxtil para orientar a implementação da norma ISO 45001.

Referencial Teórico: As estimativas globais da Organização Internacional do Trabalho mostram que a economia mundial perde anualmente cerca de 4% do PIB devido a doenças e acidentes profissionais, que, além das perdas humanas, resultam numa perda de produtividade devido a ambientes inseguros ou insalubres. Motivado pela transição da norma OHSAS 18000 para a ISO 45001, é necessário compreender o cenário das indústrias e o impacto que os acidentes causam.

Design/Metodologia/Abordagem: A partir da coleta de dados do estado de Santa Catarina, região Sul do Brasil, é apresentado um diagnóstico que poderá servir de ponto de partida para ações de melhoria em relação à saúde e segurança do trabalhador e como referência para outras empresas de outros setores. A metodologia começou com a análise do estado da arte em gestão de saúde e segurança ocupacional, conceitos de acidentes e a história deste tema no mundo.

Resultados: Os resultados mostraram que os principais acidentes ocorridos nas fábricas têxteis de Santa Catarina no período de 2012 a 2022 foram com máquinas e equipamentos, seguidos dos acidentes com agentes químicos, veículos de transporte e agentes biológicos. Quanto às partes do corpo mais afetadas, foram os dedos, seguidos dos pés, das mãos (exceto punhos e dedos) e dos olhos. Outra questão de pesquisa foi identificar os setores da indústria têxtil que mais sofreram acidentes no período, que foram os setores de fiação, tecelagem e processamento têxtil. Além disso, foram dois mil dias perdidos só em 2021 e, cumulativamente, 45,9 mil dias perdidos nesse ínterim.

Pesquisa, Implicações Práticas e Sociais: A ausência de estudos deste tipo para a indústria têxtil e também um ponto de partida para ações de melhoria em matéria de saúde e segurança do trabalhador e como referência para outras empresas de outros setores. A adoção de um Sistema de Gestão de Saúde e Segurança Ocupacional com aplicação da norma ISO 45001 é uma medida preventiva e necessária para reduzir os índices de acidentes e doenças levantados nas pesquisas realizadas.

Originalidade/Valor: A relevância do tema é demonstrada pelo grande número de acidentes registrados no Brasil e no mundo e, ao mesmo tempo, pela ausência de estudos deste tipo para a indústria têxtil. O recorte deste setor ajuda a entender os dados referentes às partes do corpo mais afetadas, ao número de acidentes de trabalho registrados, aos gastos e desperdícios das empresas, suas causas e ao setor em que ocorrem mais acidentes, orientando assim os gestores para a implementação de um sistema eficaz de gestão de saúde e segurança ocupacional.

Palavras-chave: Acidente de Trabalho, Indústria Têxtil, Brasil, Saúde e Segurança Ocupacional.

DIAGNÓSTICO DE ACCIDENTES DE TRABAJO EN LA INDUSTRIA TEXTIL: CONSEJOS PARA IMPLEMENTAR SISTEMAS DE SEGURIDAD Y SALUD EN EL TRABAJO

RESUMEN

Propósito: Este estudio tuvo como objetivo analizar datos de seguridad y salud ocupacional en la industria textil para guiar la implementación de la norma ISO 45001.

Marco teórico: Las estimaciones globales de la Organización Internacional del Trabajo muestran que la economía mundial pierde alrededor del 4% del PIB anualmente a causa de enfermedades y accidentes ocupacionales, que, además de las pérdidas humanas, resultan en una pérdida de productividad debido a entornos inseguros o insalubres. Motivado por la transición de la norma OHSAS 18000 a la ISO 45001, es necesario entender el escenario de las industrias y el impacto que causan los accidentes.

Metodología: Estimaciones globales de la Organización Internacional del Trabajo muestran que la economía mundial pierde alrededor del 4% del PIB anualmente debido a enfermedades y accidentes laborales, que, además

de las pérdidas humanas, resultan en una pérdida de productividad debido a entornos inseguros o insalubres. Motivado por la transición de la norma OHSAS 18000 a la ISO 45001, es necesario comprender el escenario de la industria y el impacto que causan los accidentes.

Conclusiones: Los resultados mostraron que los principales accidentes ocurridos en las fábricas textiles de Santa Catarina en el período de 2012 a 2022 fueron con máquinas y equipos, seguidos de los accidentes con agentes químicos, vehículos de transporte y agentes biológicos. En cuanto a las partes del cuerpo más afectadas fueron los dedos, seguidos de los pies, las manos (excepto muñecas y dedos) y los ojos. Otra pregunta de investigación fue identificar los sectores de la industria textil que sufrieron más accidentes en el período, que fueron los sectores de hilado, tejido y procesamiento de textiles. Además, solo en 2021 se perdieron dos mil días y, en total, 45,9 mil días perdidos mientras tanto.

Implicaciones de la Investigación: La ausencia de estudios de este tipo para la industria textil es también un punto de partida para acciones de mejora en materia de seguridad y salud de los trabajadores y como referencia para otras empresas de otros sectores. La adopción de un Sistema de Gestión de Seguridad y Salud en el Trabajo aplicando la norma ISO 45001 es una medida preventiva y necesaria para reducir los índices de accidentes y enfermedades identificados en las investigaciones realizadas.

Originalidad/Valor: La relevancia del tema queda demostrada por el gran número de accidentes registrados en Brasil y en el mundo y, al mismo tiempo, por la falta de estudios de ese tipo para la industria textil. La eliminación de este sector ayuda a comprender los datos relativos a las partes del cuerpo más afectadas, el número de accidentes de trabajo registrados, los gastos y desperdicios de la empresa, sus causas y el sector en el que se producen más accidentes, orientando así a los gestores hacia la implementación de una estrategia eficaz. sistema de gestión de seguridad y salud en el trabajo.

Palabras clave: Accidente de Trabajo, Industria Textil, Brasil, Seguridad y Salud en el Trabajo.

INTRODUCTION

Companies are increasingly seeking the implementation of management systems that integrate Occupational Health and Safety (OHS) to reduce risks, improve communication, and reduce operational failures that cause accidents (Da Silva & Amaral, 2019). These systems may be considered as the formalization of a set of tools aimed at minimizing the risk of accidents and diseases related to the activities of all processes in companies. The tools are presented in manuals, procedures, and systems, with organizations seeking to engage all employees to achieve their objectives and seek continuous improvement in OHS results (Szaryszov & Kleinová, 2014; Hemphill & Kelley, 2016).

According to the International Labor Organization, there are more than 2.78 million deaths per year due to work accidents or work-related diseases, in addition to 374 million injuries and non-fatal diseases. In addition to the significant impact on families and communities, the cost to businesses and economies is high: estimates by the United Nations (ILO, 2018) show that, worldwide, the total cost of diseases, injuries, and deaths accounts for 3.94% of the global gross domestic product (GDP), or about US\$ 2.99 billion, for the direct and indirect cost of injuries and diseases (ILO, 2018; Gasiorowski-denis, 2018).

The author Altunkaynak (2018) identified more than 37 thousand accident occurrences in Turkish industries in 2012. They observed that accidents that result in serious injuries occur at older ages, but also with young people due to inexperience and excess reliable. The type of

industry that had the most accidents at work was metallurgy, with a period of absence from 30 to 59 days, with workers up to 40 years old and companies with up to 500 employees.

Two standards commonly used in Integrated Management Systems have recently undergone significant updates: ISO 9001 and ISO 14001, which address quality management and environmental management, respectively. Risk management also brings a greater emphasis on the leadership and commitment requirements of senior management and seeks to aggregate the supply chain to the company management systems more closely, among other specific changes. One of the objectives of creating the new health and safety standard, the ISO 45001 (2018), was to present a line closer to these updates, in addition to creating an international standard of reference in OHS (Jones, 2017).

Focused on Occupational Health and Safety Management Systems, the ISO 45001 standard was published in March 2018. Malinda and Soediantono (2022) studied the Portuguese reality regarding the relevance attributed to OHS, regardless of the sector of activity or size of the companies. As a contribution, they realized that 98% of the companies that participated in the study were aware of the benefits that an Occupational Health and Safety Management System (OHSMS) offers or can offer, with 75% of them meeting the ISO 45001 standard requirements regarding the establishment and monitoring of measures. The new international standard, designed to help organizations of all sizes and sectors of the economy, is expected to reduce workplace injuries and diseases worldwide. In Brazil, OHS operations with a managerial approach occur mainly in large companies. Small and medium-sized companies also work with aspects of OHS, yet with specific actions aimed at compliance with standards, i.e., the knowledge about the ISO 45001 standard has still proved incipient (Campanelli, Ribeiro, & Campanelli, 2021).

The authors Gajek et al (2022) reinforce that even with the advent of the fourth industrial revolution, it is still necessary to improve the involvement and training of workers for safety 4.0. They assessed the list of knowledge needed to be available in companies and universities in Chemical Engineering courses that have a strong relationship with Textile. Furthermore, security also concerns digital, social and business skills, in addition to preparing future professionals in topics such as regulations and procedures, general aspects (risk and perception, environmental protection, PPE, SMS, inherently safer processes, hazard identification, reliability, fires and explosions, toxicology, protective systems, cost benefit analysis, human factors, safety culture, learning from accidents, safety in design) and process safety tools.

Therefore, this study aimed to analyze the OHS data from Santa Catarina, Brazil, focused on the textile industry, one of the strongest economic sectors in this state. This panorama may be used as a benchmark and as the starting point for actions to implement the ISO 45001 standard and management focused on worker health and safety. The southern Brazilian state of Santa Catarina ranks first in the production of clothing and accessories in Brazil and accounts for approximately 27% of the national production (Fiesc, 2021).

The remainder of this paper is organized as follows: Section 2 introduces the research methodology. Section 3 describes theoretical concepts such as the Brazilian legislation on Occupational Health and Safety and its importance and the transition from the OHSAS 18001 standard to the ISO 45001, in addition to analyzing the worldwide publications on the topic concerning the textile industry. Section 4 is intended for the results that will present the data on work accidents in the state of Santa Catarina. Finally, the conclusions are presented in Section 5.

LITERATURE REVIEW

This part is intended to describe theoretical concepts, such as the history and key concepts of occupational health and safety, and analyze papers addressing the textile industry.

The Brazilian Legislation on Occupational Health and Safety

While, at the beginning of the nineteenth century, England was already concerned with protecting textile industry workers, it was only at the end of that century, around 1870, that there was news of the installation of the first textile factory in Brazil, in the state of Minas Gerais (Camisassa, 2023).

In Brazil, the industrial revolution occurred around 1930. Since then, Brazilian legislation has focused on worker health and safety, i.e., preventing the ever-greater and vertiginous diseases associated with work and accidents. In 1943, the Consolidação das Leis do Trabalho (CLT, Consolidation of Labor Laws) came into force in Brazil. And finally, in 1978, the Ministry of Labor and Employment published Ordinance No. 3214/78, which approved the Regulatory Standards, being a reference of the Brazilian health and safety legislation. Currently, worker safety and health protection are fundamental rights provided for in the Brazilian Constitution of 1988.

Following the international guidelines of the ILO, Brazil started contemplating in its legislation the obligation of the Ministry of Labor and Employment to establish standards related to OHS in 1977. Thus, the following year, in 1978, this agency established Ordinance

No. 3214 to meet the requirements of the law and created the 28 Regulatory Standards (RSs). These standards have mandatory basic instructions and requirements for each topic. There are currently 36 RSs in Brazil, all of which are mandatory for private and public companies and for all institutions with CLT regime workers, as provided for in Article 157 of this law (Almeida & Lima, 2018; Dias, 2011).

Occupational Health and Safety is included in legal provisions provided for in the Brazilian Constitution, the Consolidation of Labor Laws, and Regulatory Standards, thus being of mandatory compliance by all companies. In Article 157 and its items, the CLT states that it is up to companies to:

- I – Comply and enforce occupational health and safety regulations;
- II – Instruct employees, through service orders, as to the precautions to be taken in order to prevent work accidents and occupational diseases;
- III – Adopt the measures determined for them by the competent regional agency;
- IV – Facilitate the exercise of oversight by the competent authority.

According to Law No. 8213/91 (2023), a work accident is an accident that occurs due to performing work in the service of a company or by the performance of work, causing bodily injury or functional disturbance that leads to death or a permanent or temporary loss or reduction of one's capacity for work. Zóccchio (2002) stated that safety is divided into concrete safety, which involves the working conditions and environment, and abstract safety, which refers to the feeling of workers regarding the protection that a company offers. The causes of work accidents and occupational diseases are found in working conditions, such as unsafe techniques, inadequate environments and technologies, disorganization, lack of protection or control, and people's disinterest. The frequent consequences are personal injury, diseases, partial or total incapacity, and even death, causing financial and social losses for the company and society.

The occupational health and safety are the conditions and factors that affect or may come to affect employees and temporary or outsourced workers in the workplace. Chiavenato (2020) complemented that occupational safety is the set of technical, educational, medical, and psychological measures employed to prevent accidents, either by eliminating unsafe conditions in the environment or by instructing or convincing people to implement preventive practices (Ribeiro Neto, Tavares, and Hoffmann, 2019).

The Importance of the International Labor Organization

The International Labor Organization (ILO) may be considered the first institution that sought improvements in working conditions. The organization was created in 1919 after the signing of the Treaty of Versailles, including all signatory countries, and with the aim of creating better conditions for workers of that time. It is formed by a so-called tripartite structure composed of representatives of governments and employers' and workers' organizations from 183 member states (Szaryszov & Kleinová, 2014; Jones, 2017; ILO, 2018).

Since the foundation of the ILO, several Conventions and Protocols have been established that have mandatory implementation by member countries, while Recommendations may be analyzed for implementation or not by local agencies. The first ILO Conference resulted in six conventions that addressed subjects such as regulating working hours and protecting employees from occupational accidents and diseases, for example (Leitão, 2016; ILO, 2018).

In 1944, the ILO texts underwent their most relevant modifications. The so-called Declaration of Philadelphia was responsible for presenting the charter of principles and objectives of the Organization based on four fundamental values. In 1969, the ILO received the Nobel Peace Prize, which affirmed the influence of the organization in the world and served as the basis for national reference institutions, such as the BSI (British) and OSHA (American), for example, to be created to strengthen the OHS discourse in the world further (ILO, 2014).

Occupational Health and Safety Management Systems – The Transition from the OHSAS 18001 Standard to the ISO 45001

The origin of management systems goes through contributions in the area of quality to specific standards for each area of activity of organizations. Implementing a management system brings benefits such as greater cost control, a systemic view of processes, reduced rework, minimization of occupational health and safety risks, and increased customer satisfaction (Torp & Moen, 2006).

OHS management began to be modeled on guidelines, laws, and recommendations from local governments, trade unions, and customer demands. Companies that had lower accident rates began to have their practices adapted to other markets and even to competitors through benchmarking. The characteristics they had in common were, for example, the concern and involvement of management in building a safety culture, a high number of training sessions focused on safety in activities, best hiring practices, and risk analysis methods, among other

factors that make up an OHS management system today. These practices became more common and came to be adapted from company to company, being aligned with the strategies of the corporation and with goals and objectives to be met (Robson, 2007; Vinodkumar & Bhasi, 2011; Walters & Wadsworth, 2020).

In 1996, the British Standards Institution (BSI) published the most representative guide to OHS: BS 8800. Despite not being published as an international standard at the time, it started being used as a reference for OHS Management Systems worldwide, especially in Europe. OHSAS 18001, short for Occupational Health and Safety Assessment Series, was created with the support of other OHS certification institutions, experts, and agencies and became certifiable due to international demand. At this point, OHSAS was already based on continuous improvement, using the PDCA cycle in its development, and brought important requirements for the creation of OHS procedures in the management system (Vinodkumar & Bhasi, 2011; Nagyova et al., 2018).

In 1998, through a group of certifying bodies and national standardization entities gathered in England, the first standard for the certification of Health and Safety Management Systems was created. The objective of the Occupational Health and Safety Assessment Series (OHSAS 18001) was to help companies control the environmental risks that exist or may come to exist in the workplace, taking into account the preservation of the health and integrity of workers.

Stemming from the considerable international use of OHSAS 18001, which in 2006 was already present in 80 countries, the BSI carried out a survey with several institutions and analyzed the need for an update in the standard, having as a critical point the compatibility with standards ISO 9001 and ISO 14001, seeking the Integrated Management System. In addition to facilitating the integration between the standards, OHSAS 18001 was published with updates on the previous standard on points such as concern for workers' health and the importance of the risk analysis method, among other updates. The standard compared its requirements with the important publication from the ILO in 2001: the ILO OHS 2001 (Segundo & Souza, 2016; Nagyova et al., 2018).

In 2007, a new consultation was held at the International Organization for Standardization (ISO) to evaluate creating an international OHS Management System standard. Subsequently, in 2010, the Associação Brasileira de Normas Técnicas (ABNT, Brazilian Association of Technical Standards) published Brazilian standard NBR 18801– Occupational Health and Safety Management System – Requirements, through its Special Commission for Occupational Health and Safety Studies.

According to Saracino et al. (2015), OHSAS 18001 is the most recognized international OHS certification in the world. It is a relevant basis for an OHS Management System and is considered a prerequisite by many clients for the provision of services. It is carried out by specialized certification companies, and the occupational health and safety processes must follow the required requisites and the

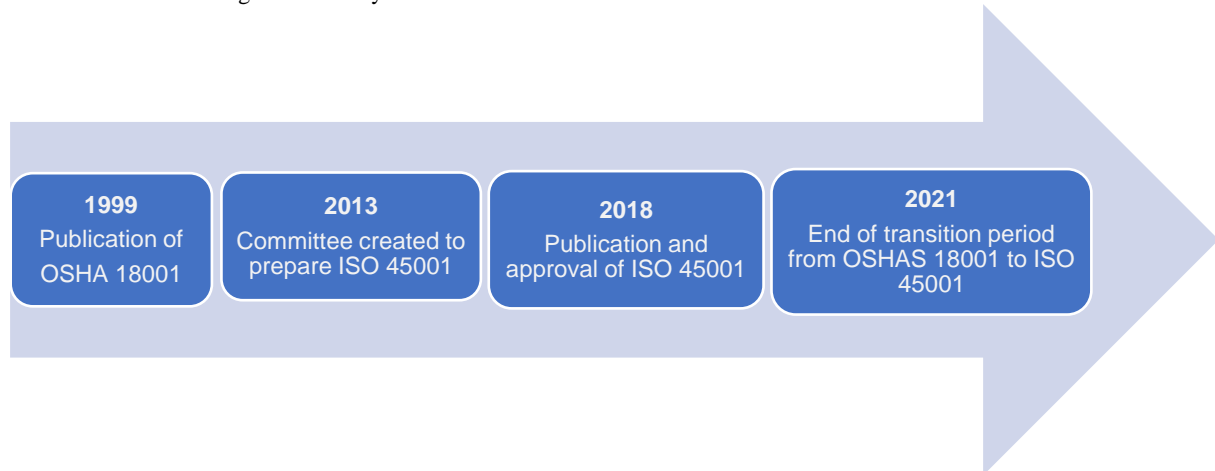
proof of negotiations, the mapping of the processes, and the measures for mitigating the worker exposure risks, which makes companies obliged to follow the processes of the system. The standard ensures that companies have documents such as a health and safety policy, procedures for identifying risks, and negotiation tools for deviations, accidents, or failures in processes, in addition to the implementation of control measures related to the identified risks (BSI, 2007; Lo et al., 2014).

Afterward, in 2013, the ISO created a committee to prepare the ISO 45001 standard, with its project finalized and approved in 2018, representing a significant advance for occupational health and safety management in companies worldwide for being a risk-based approach and following a high-level structure, just as the ISO 9001 and ISO 14001 standards. It is applicable to any organization, regardless of size, type, and nature. This standard considered within its content international standards such as the OHSAS 18001 and the international labor standards and conventions of the ILO.

In 2018, the ISO published standard ISO 45001 – Occupational Health and Safety Management Systems – Requirements with guidance for use, an international standard that aims to provide organizations, regardless of size, type, and activity, with the framework to establish, implement, maintain, and improve an OHS system, eliminating hazards and minimizing risks. The ISO 45001 standard may replace the OHSAS 18001 (BSI, 2007), the previously used standard. Although ISO 45001 is the world's first international standard on occupational health and safety, it was based on the OSHAS 18001, which until then was the reference for occupational health and safety.

In March 2021, the deadline ended for migrating from the OSHAS 18001 standard to the ISO 45001, which applies as an international standard certifying the occupational health and safety system. Figure 1 shows a summary of the chronological stages of the origin of the ISO 45001 standard.

Figure 1. History of the evolution of the OHSAS 18001 standard to the ISO 45001



Source: Prepared by the authors.

One of the motivations of this paper also arose from the information that the OHSAS 18001 standard would be discontinued and, thus, companies would have until September 2021 to transition to the ISO 45001 standard. To Trivelato (2002), implementing a management system has been the

primary strategy of companies to minimize the social and economic problem of accidents and work-related diseases, also being a significant factor in increasing competitiveness.

The requirements introduced by the ISO 45001 standard after the negotiation period included a point related to the OHSAS 18001: the representation and effective participation of workers. This issue had not been addressed previously, but the ISO 45001 standard included a modification regarding employees as a fundamental part of the management system. One of the main differences is that the ISO 45001 standard is centered on the interaction between the organization and the work environment, whereas the OSHAS 18001 focuses on the prevention of possible health risks and other safety procedures, stimulating the proactivity of all employees and those involved concerning accident prevention, thus creating a much safer and more comfortable environment for all. Table 1 shows some differences between the two certifications.

Table 1. Differences between the standards ISO 45001 and OSHAS 18001

ITEMS	OHSAS 18001	ISO 45001
View of the organization	Without a sustainable view	With stable and sustainable view
Focus	Segmented internal procedures	Integrated processes
View of the risk	Only analyzes the risk itself	Analyzes the risk as an opportunity for improvement
Opinions of the stakeholders	Does not include the opinion of the stakeholders	Considers the opinions of the stakeholders
Dynamism	Static	Dynamic in all aspects

Source: Pereira, 2023.

Analysis of Publications on Occupational Health and Safety in the Textile Industry

The study by Bathrinath et al. (2021) in a textile factory in southern India concluded that most employees in this region were unaware of the occupational health and safety risks because they were illiterate workers from rural areas. Also, the primary threat of noise exposure in the textile factory was due to old machinery. Therefore, in an attempt to neutralize the identified risks, the authors proposed the hybrid method AHP-TOPSIS, with the AHP defining the weights and identifying the most relevant risks and the TOPISIS being applied to determine the critical situations in the textile factory based on the exposure coefficient. The most critical risks of the textile factory were poor lighting and ventilation, high noise, and dust. In this method, the managers used the results to understand the severity of the risk and program preventive actions as a safety measure.

Heras-Saizarbitoria et al. (2019) concluded that companies certified in the OHSAS 18001 standard required high levels of commitment from management (especially senior management) and, together with the commitment from all employees, were able to bring about

profound changes in values and behavior necessary for a true culture of occupational safety. The paper also stated that companies with higher rates of work accidents per employee were more likely to adopt the OHSAS 18001 standard.

In 1950, Ribeiro (1950) analyzed 150 commercial establishments and more than 28 thousand workers in the textile industry in São Paulo, Brazil. Out of every 12 workers, one had had an accident that year. The methodology adopted was that of the American Standards Association, resulting in a frequency coefficient of 35.43, a severity of 1.41, and an average of 40 days debited per accident. When compared to factories in the United States at the same time, the values were 11.44 and 0.78, respectively, for the coefficients of accident frequency and severity. For the textile industry, acceptable values are 7.77 for frequency and 0.45 for severity.

The study by Menegon (2020) carried out with the textile industry in Santa Catarina from 2008 to 2017 evaluated the correlations of accidents by classifying them in terms of education level and comparing them with other countries, having also found that the accidents occurred with workers who had been at the company for less than ten years. Also, in the average of this analyzed period, there were 156 days lost per injured worker each year due to typical work accidents, 131 days lost due to commuting accidents, 169 days due to work-related diseases, 94 days due to non-work-related diseases, and 115 days for other reasons. However, there was a drop in accidents in the period, and a correlation was the implementation of the lean approach in the companies.

In this same vein, Maroclo (2003) compared the number of work accidents of the companies that adopted the polyvalence of functions in manufacturing cells (Just in Time) relative to the conventional production system and found that the lean system presented the lowest number of work accidents and occupational diseases in 1999 and 2001.

Martignago and Depiné (2008) stated that the vast majority of the risks of occupational accidents and diseases in the textile industry are due to ergonomic inadequacies in machinery and equipment and the organization of the work, aggravated by the impropriety of environmental conditions (noise, lighting, temperature, and air quality, among others).

A similar yet dated paper was found in the Portuguese textile industry, with Fernandes et al. (2009) verifying that the main materials causing "non-fatal" accident-causing were shrapnel and dust, affecting the upper and lower extremities and head.

Van Rossem, Deboosere, and Devos (2017) reconstituted the industrial mortality rates of Belgian cities with more than 25 thousand inhabitants and verified that the companies that did not have regulation of health and safety systems and artisanal factories were where the most

significant work accidents occurred. However, the textile factory was already classified as non-rural in this scenario. However, the problem was the old data given the period considered (1890–1910) and also that, in the comparisons, the authors based themselves only on the gender (men × women) and age of the people who had work accidents considering the classification of 17 industrial sectors, such as the manufacturing of art, ceramics, and pottery, chemicals, clothing, construction, food, glass, leather and fur, metals, mining, paper, printing, quarrying, textiles, wood and furniture, tobacco, and transport.

Silva (2018) analyzed the chemical and environmental risks in a textile factory in the city of Caruaru (PE), Brazil, and identified that the main types of risk for this sector were physical and chemical. The first type involved the risk of noise from the processes of tapping the comb and forming the weft, the motors, and the belts. In turn, the chemical risks were characterized by Barsano and Barbosa (2018) as those involving substances, compounds, or products that one's organism may absorb through chronic or non-chronic exposure, perceived through the dust. The dust particles are suspended with the products used to manufacture the threads in the work environment.

A recent study published in the *Revista Brasileira de Epidemiologia* (Brazilian Journal of Epidemiology) in 2021 analyzed the incidence and temporal trend of work accidents in the textile and clothing industries in Santa Catarina, Brazil, from 2008 to 2017. The study was based on data from the *Relação Anual de Informações Sociais* (RAIS, Annual List of Social Information) and showed that there was a downward trend in the incidence of work accidents in Santa Catarina in the studied period (8.8%). The highest accident rates occurred in 2008 among men (12.6%) from 40 to 49 years old (6.7%) who were black (7.4%), had had less than 12 years of study (5.0%), received an average remuneration of three to seven times the minimum wage (7.0%), had been on the job up to four years (6.9%), and worked in manufacturing textile products (10.3%) in medium-sized establishments (100 to 499 workers) (7.9%) in the metropolitan area of Florianópolis (7.0%) or in region of the Vale do Itajaí (6.8%) (Menegon et al., 2021).

In the textile industry, the machines with the most accidents were the loom, the warp, and the Jacquard, and, in finishing, the cutting and folding and laser machines. The risks identified in the loom were unprotected machines, defective equipment, fire, electric shock, and noise (Silva, 2018). Complementarily, Brazil classifies risks into five groups: noise, dust, viruses, intense physical effort, and intense physical arrangement (Brasil, 1994). Figure 2 illustrates these risks, highlighting the most evident in the textile industry.

Figure 2. Classification of risks

Group 1, Physical Risks, color Green	Group 2, Chemical Risks, color Red	Group 3, Biological Risks, color Brown	Group 4, Ergonomic Risks, color Yellow	Group 5, Accident Risks, color Blue
Noises	Dust	Virus	Intense physical exertion	Intense physical arrangement
Vibrations	Smoke	Virus	Manual lifting and carrying of weight	Unprotected machines and equipments
Ionizing and non-ionizing radiation	Fumes	Bacteria	Improper posture requirement	Inadequate or defective tools
Cold	Mists	Protozoa	Strict productivity control	Inadequate lighting
Heat	Gases	Parasitic fungi	Imposition of excessive rhythms	Electricity
Abnormal pressures	Vapors	Bacilli	Shift and night work	Likelihood of fire or explosion
Moisture	Chemical substances in general		Long working hours	Inadequate storage
			Monotony and repetitiveness	Venomous animals
			Situations of physical and/or psychological stress	Other situations that may cause accidents

Source: Adapted from Brasil, 1994.

Heras-Saizarbitoria et al. (2019) evaluated the financial impact of companies certified in the OHSAS 18001 standard, and one of the reported works by Fan and Lo (2012) with 44 fashion factories in the United States had a positive impact on sales performance and a negative impact on the return on assets (ROA) of the companies. However, as it was in the transition period from the OHSAS 18001 standard to the ISO 45001, caution was highlighted at that time, either academically or in the practice of managers, for there not to be biased opinions and interpretations. As with the other certifications and management systems on this long journey, the commitment of senior management and employees is a daily task in the success and absorption of a culture of health and safety.

Finally, the authors Ranganathan and Sujatha (2022) analyzed the impact of culture on safety in the workplace of assembly workers in 104 companies in India, applying a questionnaire classified into Management Commitment, safety priority, involvement and work environment. The results showed that improving safety also impacts productivity and reduces space and stock.

DATA AND METHODOLOGY

This paper was motivated by the transition of the law and the need for companies to adapt to the requirements of the ISO 45001 standard. In this sense, the initial step was the literature review to understand concepts and benchmarking with other countries about data on textile industry accidents.

Thus, the research questions to be answered were:

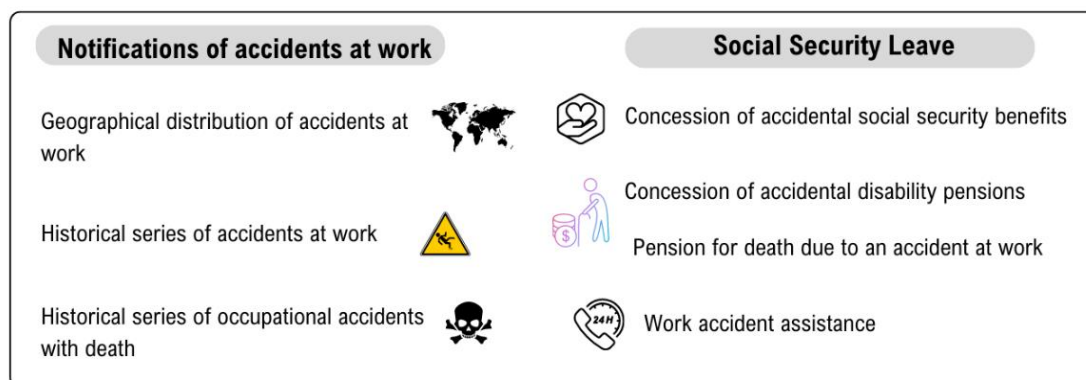
- a) What have been the main accidents that occurred in the textile industry?
- b) Which body parts have been most affected?
- c) What have been the sectors of the textile industry with the most accidents?
- d) What have been the social security expenses with work accidents since 2012?
- e) How many disability retirements have been generated by work accidents? Of these accidents, how many deaths have there been?
- f) How many work accident claims have been registered since 2012 in Brazil?
- h) What have been the main work accident-causing agents?

For this, the data of the platform SmartLab (2023) were analyzed and stratified for the state of Santa Catarina due to its representativeness with the textile industry. This platform has been viewed by more than one million users in 80 countries, and the evidence from digital observatories aims to assist in decision-making for public policies to promote decent work. The information is organized into 12 dimensions, as recommended by the International Labor Organization: 1. Economic and Social Context; 2. Adequate Earnings and Productive Work; 3. Decent Work Hours; 4. Combining Work, Family, and Personal Life; 5. Work that Should Be Abolished; 6. Stability and Security of Work; 7. Equality of Opportunity and Treatment in Employment; 8. Safe Work Environment; 9. Social Security; 10. Social Dialogue and Workers' and Employers' Representation; 11. Employment Opportunities; 12. Enterprises and Decent Work.

The data was stracted by SmartLab (2023), which is presented only in Portuguese; the contribution of this paper was to obtain accident data in the textile industry, and we reinforce that this information, even with open data, is not easily found on the platform. We searched the options by topic, with the following observatories: decent work in Brazilian municipalities; occupational health and safety; prevention and eradication of child labor; eradication of slave labor and human trafficking; diversity and equality of work opportunities.

Thus, from the classification of the 12 dimensions, the information used in this research was that of Dimension 8, corresponding to the "Safe Work Environment", which has the data in Figure 3.

Figure 3. Data to be stratified from the SmartLab platform



Source: SmartLab, 2023.

This is the initial step of the ISO 45001 standard compliance checklist, composed of 218 items to be verified in companies and used to determine the Global Compliance Performance Index (GCPI) developed by Pereira (2023). Thus, the items were checked for the clauses of this standard and correlated with the diagnostic data to devise the improvement plan. Therefore, the clauses of the ISO 45001 standard and its dimensions are the following:

- a) **Context of the organization** (Clause 4) – the company must establish the scope of the OHS management system and be available with the documented information to meet the requirements of the ISO 45001 standard for workers, suppliers, and other interested parties (third parties);
- b) **Leadership and worker participation** (Clause 5) – the company must implement and maintain one or more processes for the participation of workers and leadership (including consultation) in the development, planning, implementation, evaluation, and actions for the improvement of the OHS management system of the productive sectors through audit programs, investigating incidents and non-conformities, and determining corrective actions and their implementation;
- c) **Planning of the OHS management system** (Clause 6) – refers to implementation to achieve continuous improvement. Risks continue to be evaluated, identifying opportunities that may cause harm related to health and safety in the workplace. Thus, actual changes in operations and processes relevant to the intended outcome of the OHS management system are proposed, maintaining documented

information about their legal requirements, evaluating results and the effectiveness of these actions, ensuring that they are updated to reflect any changes;

d) **Support** (Clause 7) – refers to the resources that a company provides for establishing, implementing, maintaining, and continuously improving the OHS management system. It involves determining the necessary competencies of workers and their awareness, i.e., whether the workers have knowledge about OHS management and associated hazards and risks. Finally, this category also involves internal and external communication and the information to be documented, as well as its frequency of updating and control;

e) **Operation** (Clause 8) – in the operation of operational control to meet the requirements of the OHS management system, there must be a place for storing documented information on the OHS policy and objectives. In addition, the requirements to be foreseen also include planning to eliminate hazards and risks and the preparation of emergency responses;

f) **Performance evaluation** (Clause 9) – responsible for implementing the criteria in relation to the organization for evaluating the performance and efficacy of the OHS management system, retaining the documented information with the evidence of the monitoring, measurement, analysis, and evaluation results. An audit scope must be carried out, implementing and maintaining one or more audit programs with the participation of worker representatives and relevant stakeholders that include criteria, frequency, methods, responsibilities, consultations, and planning and reporting requirements, retaining documented information as evidence of the implementation of the audit program and the results of audits, as a continuous improvement system that must take into account the importance of the processes involved and the results of previous audits.

g) **Continuous improvement** (Clause 10) – finally, the incident, non-conformity, and corrective action requirements are verified, along with the continuous improvement objectives.

RESULTS AND DISCUSSION

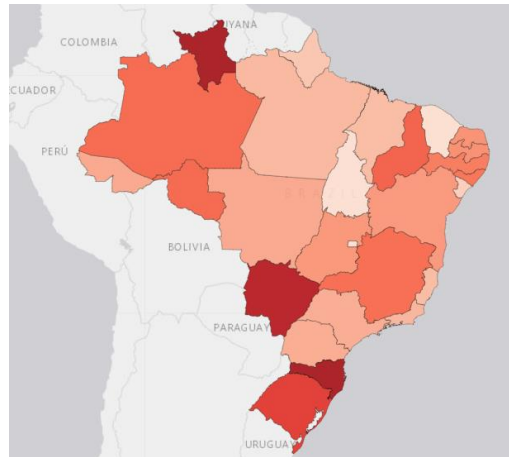
This section will present the answers and analyses of the research questions involving the main accidents that occurred in the textile industry, the body parts most affected, the sectors with the most accidents, the expenses with social security, the number of employees in

disability retirement due to work accidents, and the number of employees who died. Also listed are the number of work accident claims since 2012 in Brazil and the main work accident-causing agents.

Scenario in Brazil and Santa Catarina Relative to Textile Industry Work Accidents

In Brazil, approximately 720 thousand work accidents occur annually, of which 2,800 are fatal and imply a cost of roughly 2% of the GDP (Garnica & Barriga, 2018). The map of Brazil represented in Figure 4 shows the annual incidence of sick leave due to work accidents, occupational diseases, or resulting from the workplace. White tones mean the lowest values, going up to the highest values in dark red. Santa Catarina, the focus state of this paper, is highlighted, with a proportion of 68 such accidents per 10 thousand inhabitants, with the average in Brazil of 42 concessions per 10 thousand inhabitants in 2021.

Figure 4. Annual incidence of sick leave due to work accidents



Source: Adapted SmartLab, 2023.

Body Parts Most Affected by the Work Accidents

The database of the Occupational Health and Safety Observatory (SmartLab, 2023) showed that, in the state of Santa Catarina from 2012 to 2021, the most affected parts with work accident claims were fingers, followed by hands (except wrist and fingers), feet (except toes), hands (except wrist and fingers), and eyes, as illustrated in Table 2.

Table 2. Body parts most affected by accidents in the textile industry from 2012 to 2021

Affected body part	Number	Percentage
Finger	65,014	23.97%
Foot (excluding toes)	21,485	7.92%
Hand (except wrist or fingers)	18,726	6.91%
Eye (including optic nerve and sight)	17,571	6.48%

Affected body part	Number	Percentage
Multiple parts (applies when more than one part was affected)	14,489	5.34%
Knee	12,590	4.64%
Leg (from ankle, exclusive to knee)	9,548	3.52%
Leg (between ankle and pelvis)	9,516	3.51%
Shoulder	9,161	3.38%
Arm (between wrist and shoulder)	9,137	3.37%
Forearm (between wrist and elbow)	8,178	3.02%
Ankle joint	8,115	2.99%
Back (including dorsal muscles, spine)	7,354	2.71%
Fist	6,370	2.35%
Head (various parts)	6,323	2.33%
Upper limbs (various parts)	4,293	1.58%
Lower limbs (various parts)	3,986	1.47%
Face, Multiple Parts (any combination)	3,729	1.38%
Upper limbs (multiple parts)	3,315	1.22%
Head, multiple parts (any combination)	2,762	1.02%
Arm (above the elbow)	2,747	1.01%
Chest (including internal organs)	2,467	0.91%
Lower Limbs (multiple parts)	2,417	0.89%
Elbow	2,391	0.88%
Trunk (multiple parts)	2,170	0.80%
Hips (including Pelvis, pelvic organs)	2,130	0.79%
Trunk (multiple parts with any combination)	2,047	0.75%
Respiratory tract	1,884	0.69%
Abdomen (including internal organs)	1,620	0.60%
Thigh	1,558	0.57%
Toe	1,471	0.54%
Nervous system	1,128	0.42%
Mouth (including lips, teeth, tongue, and throat)	1,051	0.39%
Nose (including nostrils, sinuses)	980	0.36%
Neck	752	0.28%
Skull (including brain)	554	0.20%
Ear (outer, middle, inner, hearing)	347	0.13%
Musculoskeletal system	327	0.12%
Systems and tracts	322	0.12%
Jaw (including chin)	318	0.12%
Various systems and tracts	263	0.10%
Digestive system	239	0.09%
Genito-urinary system	160	0.06%
Diverse lesion location	119	0.04%
Circulatory system	58	0.02%
Total accidents from 2012 to 2021	271,182	100%

Source: Adapted from SmartLab, 2023, and Pereira, 2023.

Accidents-Causing Agents in the Textile Industry

The main accidents-causing agents most cited in work accident claims were the machines and equipment, followed by chemical agents and transport vehicles. These first three represented 45% of the causes, as shown in Table 3.

Table 3. Percentages of participation of the different groups of work accident-causing agents

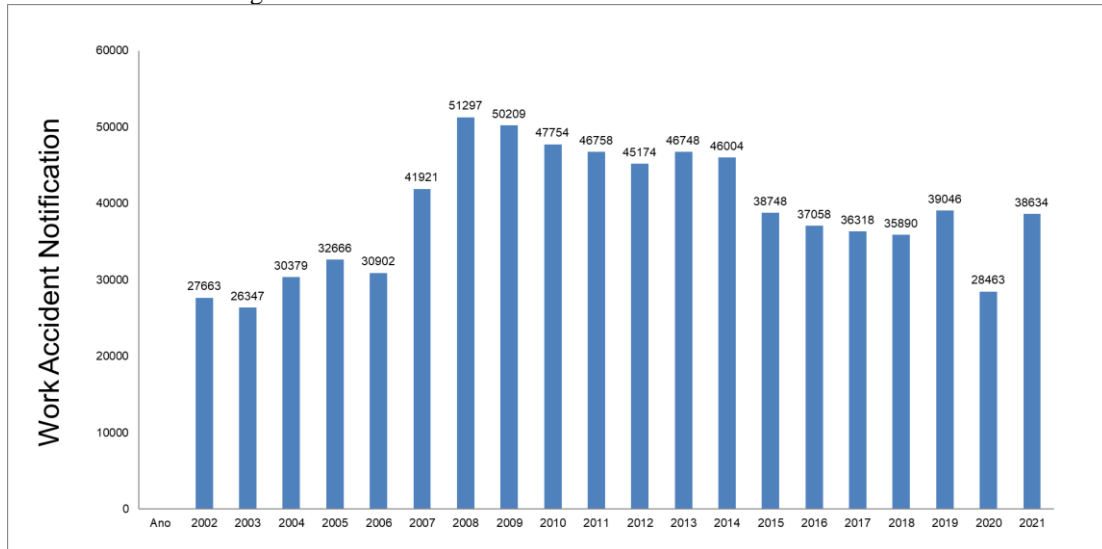
Element	Amount	Percentage
Machines and Equipment	50,989	18.91%
Chemical Agent	35,546	13.18%
Transport Vehicles	35,298	13.09%
Biological Agent	29,331	10.88%
Fall from the same level	25,445	9.44%
Motorcycle	23,786	8.82%
Hand Tools	22,425	8.32%
Fall from Height	16,536	6.13%
Furniture and Accessories	13,351	4.95%
Physical Exertion	4,360	1.62%
Impact Against Person/Object	4,189	1.55%
Packaging and Tanks	3,594	1.33%
Fall from the same level	1,583	0.59%
Fire	838	0.31%
Others	813	0.30%
Electric Shock	516	0.19%
Physical Agent	375	0.14%
Hot and Cold Substances	280	0.10%
Assault	165	0.06%
Animals	82	0.03%
Foreign Body	80	0.03%
Ionizing Radiation	19	0.01%
Physical Agents	18	0.01%
Total work accident claims	269,619	100%

Source: Adapted from SmartLab, 2023, and Pereira, 2023.

Work Accident Expenses in the State of Santa Catarina

Brazil recorded 2500 deaths and 571.8 thousand work accident claims in 2021. The figures represent a 30% increase from the previous year. From 2012 to 2021, 22.9 thousand deaths and 6.2 million work accident claims were registered in the Brazilian formal labor market. Additionally, in 2021, there were more than 153.3 thousand accident sick pay concessions and 4.1 thousand disability retirements resulting from accidents. According to the National Social Security Institute, an agency of the Brazilian government, spending on social security benefits was R\$ 17.7 billion in accident sick pay and R\$ 70.6 billion in retirements due to accidents. From 2002 to 2021, the state of Santa Catarina registered 38 thousand accidents, with a trend of increase in the number of work accident claims of 35.73%, as shown in Figure 5.

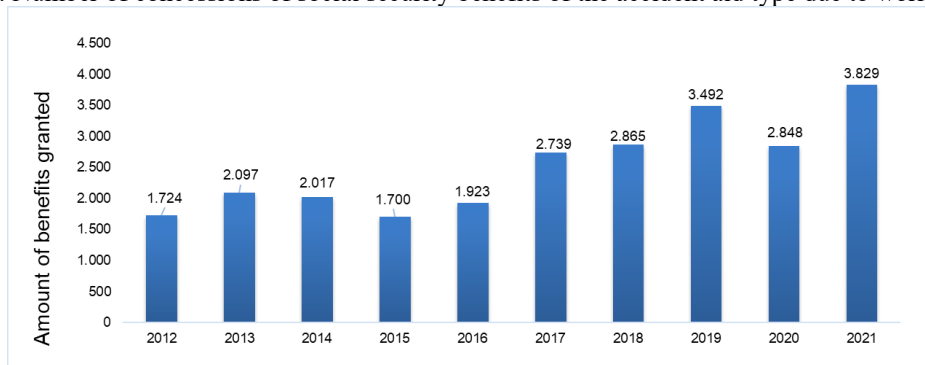
Figure 5. Work Accident Claims in the state of Santa Catarina



Source: Adapted from SmartLab, 2023, and Pereira, 2023.

The database of the Occupational Health and Safety Observatory (SmartLab, 2023) showed that the state of Santa Catarina had an increasing trend in the concession of this benefit from 2012 to 2021, as shown in Figure 6.

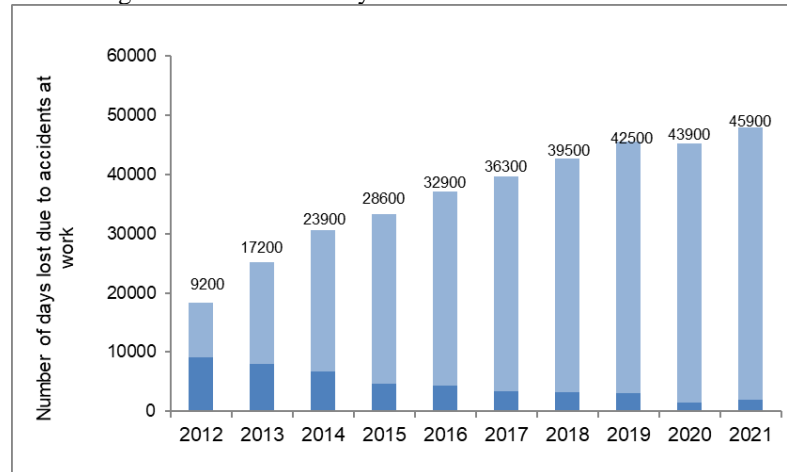
Figure 6. Number of concessions of social security benefits of the accident aid type due to work accidents



Source: Adapted from SmartLab, 2023, and Pereira, 2023.

Relative to the expenses for payment of accident aid social security benefits, the data obtained indicated a trend of increasing expenditure by around 20%. Regarding leave due to the concessions of social security benefits of sick pay due to work accidents, the numbers of lost workdays from 2012 to 2021 in the state of Santa Catarina revealed not only human and family losses but also economic losses in terms of productivity of employers and the economy in general. The stratified research recorded that, in 2021, a total of two thousand days were lost, and, in the accumulation, almost 46 thousand days were lost in the period, as shown in Figure 7.

Figure 7. Numbers of days lost due to work accident leave



Source: adapted from SmartLab, 2023, and Pereira, 2023.

The municipality of Blumenau was the first in the state with the highest number of accident social security benefit concessions in 2017, according to data from the Digital Occupational Health and Safety Observatory (SmartLab, 2023), with 589 occurrences recorded, representing an annual cost of 8,30 million reais^G, generating a loss of 152 thousand work days (Pereira, 2023).

CONCLUSION

This study aimed to obtain a scenario of work accidents in the textile industry of Santa Catarina, Brazil. From the results obtained, it was possible to observe that the main accidents that occurred in the textile factories of Santa Catarina from 2012 to 2021 were with machinery and equipment, followed by accidents with chemical agents, transport vehicles, and biological agents. These accident-causing agents mentioned represented 56% of accident claims in the textile industry.

As for the most affected body parts, according to the work accident claims, these were the fingers, followed by feet, hands (except wrists and fingers), and eyes. These affected body parts accounted for 45.28% of accident notifications in the textile industry. Another research question was to identify the sectors of the textile industry with the most accidents in the period considered. These were the spinning, weaving, and textile processing sectors. Also, there were two thousand days lost in 2021 alone and, cumulatively, 45,900 days lost in this interim, something very significant.

^G One dollar means five reais.

Regarding the social security expenses with work accidents through accident aids from 2012 to 2021 in Santa Catarina, the data obtained indicated a trend of increased expenditure of about 20%, with accumulated payment in the period of 1.828 billion reais. Concerning disability retirement due to work accidents, the data showed an increasing trend, with accumulated payments in the period of 28.7 billion reais. Social security expenses with pensions for death due to work accidents indicated an increasing trend, with accumulated payment in the period of 1.155 billion reais.

The adoption of an Occupational Health and Safety Management System with the application of the ISO 45001 standard is a preventive and necessary measure to reduce the rates of accidents and diseases raised in the research carried out. Hence, when a company in the textile industry invests in occupational health and safety management guided by the ISO 45001 standard, it demonstrates that it really cares about the well-being of its employees. There are several benefits of investing in occupational safety and health, such as:

- a safer and healthier work environment;
- reduction of accidents in the medium and long term;
- reduction of financial losses (fines, labor liabilities, and regressive actions);
- reduction of leave rates and employee turnover;
- improvement of the company image.

This study served as a warning that the textile sector, considered low-tech and traditional, needs to adapt to the requirements of digital transformation. In this sense, as reinforced in the literature, accidents cause productivity losses and affect the culture of companies. In addition, the requirement to migrate from the OHSAS 18001 standard to the ISO 45001 must be aligned with the other management systems and the evolution to industry 5.0, in which humans are at the center of actions.

As highlighted by Rahmat et al. (2023), who carried out a survey in 129 pharmaceutical companies in Malaysia to correlate the influence of passive and active management commitment and environmental awareness, all management approaches need to be implemented in a systemic way. The results showed that all these variables have a positive impact on employee retention. Thus, once again it appears that investments in improvement programs directly impact employee productivity.

For future work, a comparison of the textile sector with the other sectors of the manufacturing industry is recommended regarding successful actions that serve as references and are reflected in the decrease in accidents at work.

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