Victoria 4.0: platform for the intelligent management of work permits in high-risk tasks

Victoria 4.0: plataforma para la gestión inteligente de permisos de trabajo en tareas de alto riesgo

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Abstract

Introduction: The generation of a work permit involves the management of specialized documentation that reflects the employee's qualifications for a certain task, a process that is usually costly.
Objective: Create an integrated platform that allows user companies to intelligently and efficiently manage the processes of generating work permits for high-risk tasks.
Methodology: The characterization of the sector is addressed by raising requirements for high-risk companies. The design involves the use of technologies such as DigitalOcean®, Rails®, PHP®, Ubuntu®, MySQL® and Power BI. The platform follows a comprehensive process of data extraction, transformation and loading, supported by a Data Warehouse.
Results: The prevalence of manual methods in permit management stands out, justifying the relevance of Victoria 4.0 to streamline processes and guarantee the reliability of the data. User interaction is detailed, highlighting its intuitive interaction, and specific improvements in certain functionalities are described. In addition, the commercial prospects of Victoria 4.0 are discussed, comparing it with other market options and highlighting its adaptability to local regulations.
Conclusions: Victoria 4.0 is not only a valuable alternative for companies that have the obligation to manage work permits for their employees, but it also has significant growth prospects in a market estimated at more than 2 billion dollars.

Keywords: Work permits; High risk tasks; Risk management; Occupational Health and Safety Management System.

Resumen

Introducción: la generación de un permiso de trabajo involucra la gestión de documentación especializada que dé cuenta de la cualificación del empleado para determinada tarea, un proceso que suele ser dispendioso.
Objetivo: crear una plataforma integrada que les permita a las empresas usuarias gestionar de manera inteligente y eficiente los procesos de generación de permisos de trabajo para tareas de alto riesgo.
Metodología: se aborda la caracterización del sector mediante el levantamiento de requerimientos con empresas de alto riesgo. El diseño implica el uso de tecnologías como DigitalOcean®, Rails®, PHP®, Ubuntu®, MySQL® y Power BI. La plataforma sigue un proceso integral de extracción, transformación y carga de datos, respaldado por un Data Warehouse.
Resultados: se destaca la prevalencia de métodos manuales en la gestión de permisos, justificando la pertinencia de Victoria 4.0 para agilizar procesos y garantizar la fiabilidad de los datos. Se detalla la interacción del usuario, resaltando su interacción intuitivita, y se describen mejoras específicas en ciertas funcionalidades. Además, se discuten las perspectivas comerciales de Victoria 4.0, comparándola con otras opciones del mercado y destacando su adaptabilidad a regulaciones locales.
Conclusiones: Victoria 4.0 no solo es una alternativa valiosa y atractiva para las empresas que tienen la obligación de gestionar permisos de trabajo para sus empleados, sino que además cuenta con perspectivas de crecimiento significativas en un mercado estimado en más de 2 billones de dólares.

Palabras clave: Permisos de trabajo; Tareas de alto riesgo; Gestión del riesgo; Sistema de Gestión en Seguridad y Salud en el Trabajo.

I. INTRODUCTION

Every year there are almost 360 million work-related accidents, and about 1.9 million people pass away directly because of them. These situations cause the loss of more than 100 million years of work life due to disabilities resulting from them, while also costing the global economy more than 1.25 trillion dollars in financial losses [1]. Emphasizing that in many of these situations, the blame falls on the workforce being hired without the acquisition of the specific permits needed to perform high-risk activities.

The generation of a work permit involves—particularly in cases where high-risk tasks are being performed—the management of specialized documentation that backs up the employee's skills needed for a specific task [2]. This process compels the fulfillment of certain requirements that involve three factors: the hiring party, the person that's being hired, and the Occupational Health and Safety area (OHS) that's in charge of providing the necessary permits for the needed labor to be executed safely. The activities regarding the generation, validation, and certification of a permit also call for time and resources whose extent varies depending on the context, the complexity of the activity, and the amount of workforce needed.

When being executed between companies, contractors, and hiring parties from economic sectors like construction, energy mining, manufacturing, and transport, this process deems itself vital and highly demanding due to the risks that are natural to these fields [3]. In these cases, the number of permits needed becomes greater, adhering to a relationship of logical proportionality. Where the bigger the risk of the labor to be performed, the bigger the number of permits to be drafted. In situations where the workforce is large, the time and resources invested in the generation, validation, and certification of said permits grow, which not only involves delays and bigger expenses but also a larger possibility of mistakes being made during the drafting [4].

Despite this, most companies, regardless of their size, use traditional management systems where the permits are usually manually filled formats in software like Microsoft Excel®; these permits are also printed in multiple locations to be stored as a physical backup. This work method requires the completion, fulfillment, validation, and certification of the information regarding processes of human resources screening, survey of scenarios, equipment, and personal safety elements. Depending on the complexity and the risk of the solicited tasks, this process can become time-consuming, delaying the planned activity and the interdepartmental coordination, which affects the schedule and budget previously set.

Contemporary technological improvements offer compelling alternatives regarding the optimization of this vital process. Progress in artificial intelligence and the Internet of Things (IoT) provides more options for the systematization and management of given information, even though it is on rare occasions that companies have the resources to secure the structure of a functional digital platform for this [5, 6]. Therefore, considering external solutions that require small investments compared to their benefits is not an option but a necessity. However, the available options are far from being many and accessible.

This article analyzes the development process of one of them, Victoria 4.0®, a digital platform that specializes in optimizing the management, compilation, storage, and analysis of data from the execution of technical and high-risk activities by organizations. This tool allows companies to efficiently perform Job Hazard Analysis (JHA) tasks, considering things like electric and temperature risks, excavation work, confined spaces and height, as well as load lifting. The development of this tool aims to establish a framework that adapts to a specific objective, which is to create a platform that enables companies to manage the processes of drafting high-risk work permits in an intelligent and efficient manner.

II. LITERATURE REVIEW

Since 2012, in Colombia, companies that perform any activity considered high-risk need an Occupational Health and Safety Management System (SG-SST) in addition to managing and providing certain work permits. Generally, the Occupational Risk System nationwide presents itself as an objective liability where work insurances assume the employer's risks and becomes responsible for dealing with work-related accidents or labor-related diseases once the relationship between them and the performed labor, disregarding culpability, is

established [7]. Despite seeming simple, the process tends to be complex. Soliciting work permits involves verifying the employee's abilities, status, and competence (through tests that seek certification), a process that is commonly executed manually by the employee before obtaining the approval of a qualified supervisor.

In that matter, permit management provides multiple chances for improvement through modern technologies. A study by Manrique and Cortes [8] shows the variety of formats employed by companies in Colombia for occupational risk management regarding work at height, involving manual assessments by established supervisors. Other studies display the impact of technologies like blockchain and big data on the validation of certifications and other documents associated with work-related risk management [9, 10, 11], underlining the viability and effectiveness of systems that are developed to reduce the amount of manual work for managers and security personnel while bettering the efficiency and reliability.

Wisdom and information management in business compose a vital task for any organization, especially when being developed in an environment of continuous change and adjustments [12]. Regarding the fulfillment of present regulations, emphasizing the requirements for the prevention of work-related risks and the management of information, this process becomes incredibly important [13, 14]. This is the reason for organizations to be concerned about establishing effective Occupational Risk Management Systems (SG-RL), testing methods, and tactics that allow them to improve their processes to increase productivity and, overall, ensure the safety of their employees [15, 16, 17, 18, 19].

SG-RLs have a key role, contributing to better management of big losses that are often complicated or impossible to measure [20, 21]. As per the International Labor Organization [1], workplace accidents cause a loss of around 4 percent of the worldwide Gross Domestic Product (GDP), escalating up to more than 6 percent in some countries. Either way, any value determined to health and life is, in some ways, symbolic, and the ideal would be that, when performing labor, workers are not exposed to the loss of them.

In Colombia, work risk management is ruled by the Comprehensive Social Security System, which includes the Occupational Risk System (SRL). The SRL categorizes these risks into three levels: low, medium, and high, based on how probable they are to happen and their severity [22, 23]. Low risk means minimal probability (rare work-related accidents or illnesses that do not cause meaningful damage; activities in this category mostly do not require special supervision besides adhering to basic safety and security and health standards, are classified in this category), the medium risk has a higher probability of occurrence and some impact (accidents or diseases that can happen in certain frequency and cause significant harm; work activities that call for the establishment of control and prevention rules to minimize the probability of incidents and reduce their effects), and, lastly, high-risk ones have a high probability of occurrence and great impact (work accidents or illnesses that happen frequently and have serious effects; work activities that require even stronger control and prevention measures to reduce the significant amount of incidents and lessen their consequences are included in this category).

Taking the impact and probability of occurrence into account, in Colombia the way work risk levels are measured is determined through a numerical scale that goes from 1 to 5 [22, 24, 23]. This scale evaluates and classifies the magnitude of the risks that could affect workers in their workplaces. Each risk level represents a specific category that establishes the severity and probability of occurrence of workplace accidents.

Risk Level 1: This category regards work risks with the lowest probability of happening and the lowest impact on the safety and health of those who suffer them. Level 1 risks are considered of low priority and typically are associated with low-risk situations or successful control measures already in place. Companies with Level 1 risks are obligated to continue complying with work health and safety standards but do not require additional measures.

Risk Level 2: Level 2 risks mean a moderate probability of occurrence and relatively low impact when compared to higher levels. At this level, it is important to enforce additional prevention and control measures to minimize the probability of incidents and limit their effects if they occur.

Risk Level 3: Risks have a moderate probability of happening and a more significant impact on the health and safety of the employees. Companies that have Level 3 risks should

prioritize adding control measures, such as workplace safety seminars and the obligatory use of protective equipment for all personnel.

Risk Level 4: In this category, work risks face a high probability of occurrence and a considerable impact on the health and safety of the workforce. Companies facing Level 4 risks need to settle on more rigorous control measures, like full-on work health and safety management courses and consistent risk evaluations.

Risk Level 5: These represent the highest probability of happening and have a genuinely serious impact on the health and safety of workers. These risks are considered extremely critical and must be immediately cared for with the utmost urgency and attention. Companies must take extreme control measures and guarantee the implementation of comprehensive occupational risk management systems inside the workplace.

The segmentation on this scale is essential to determine the tariff rates for the social security system and the coverage given by work risk insurance companies in Colombia. It also acts as a guide for the adhesion of suitable prevention and control measures in the workplace to guarantee the health and safety of workers.

There are, of course, different types of risk. A common classification, upheld by various authors [22, 23, 25], is the following:

Physical Risk: Refers to environmental or physical factors that affect the well-being of workers, such as noise exposure, vibrations, ionizing radiation, non-ionizing radiation, extreme temperatures, extreme pressures, and other environment-related factors.

Chemical Risk: This type of risk involves exposure to hazards such as chemical leaks into the workplace, such as toxic chemicals, irritants, carcinogens, reactive chemical agents, etc.

Biological Risk: Refers to exposure to biological agents like bacteria, viruses, fungi, parasites, and other microorganisms that can be the cause of illness in employees. This is common in industries like healthcare and agriculture.

Ergonomic Risk: These relate to working conditions that affect the musculoskeletal system of employees, such as incorrect posture, having to lift heavy loads, repetitive movements, and poor ergonomics in the design of workstations.

Psychosocial Risk: Refers to situations that relate to the mental health of workers, including work stress, emotional burden, harassment, mobbing, and other factors that can affect the mental state of employees.

Mechanical risk: Related to the usage of tools and machinery that can cause significant damage to the user, like trapping, crushing, or cutting them in any way.

Some authors consider other factors in the classification for it to be more precise, such as environmental risks that are not under the manager's control [3, 26]. Regardless of the way they are defined or how the rating scale is used, risk management is critical for perpetuating safety and health at work. This is where appropriate workforce training, constant updating, and the correct disposition of the legal documents that regulate work safety become crucial.

Digital improvements have facilitated experiences in the area; however, despite offering exciting and innovative opportunities, many companies still do not adopt them as part of their processes [27]. Different research delves into using technologies such as live communication, Big Data [28, 29], cooperation between humans and machines [30, 31], remote sensing [32], monitoring and controlling processes [33], autonomous equipment, and interconnectivity [34, 35], in the context of Industry 4.0, as factors that influence work health and safety management [36].

Regarding artificial intelligence and IoT, in the literature, they are usually related mainly to the prevention of work risks in particular sectors or industries, such as energy infrastructure projects and supply chains, to list some examples [5, 37, 38, 39]. There is a vast amount of research that highlights the interest and scientific importance of the subject, which supports the evolution of rising studies and technologies that focus on optimizing the processes they're involved in.

Generally, empirical studies that connect professional risk management and technology focus on aspects such as sensors and constant monitoring, virtual reality, cybersecurity, and, of course, data analysis. It is in this last field where the aspects nearest to the present proposal can be identified, focused on processing information with the aim of steering permit management processes to perform high-risk activities.

There is a research gap in this matter, since empirical analyses are usually limited to classifying and managing data to seek a better understanding of the risks associated with each activity, setting aside the usefulness of this information when simplifying the processes of managing formal permits regarding the legal development of risky labor.

In this matter, Victoria 4.0 retaliates appropriately to the previously defined need, offering a rational technological response to the considerations addressed. In this regard, there are technological factors that support the development of the platform in question. The implementation of applications requires the setting of parameters that allow the establishment of a reliable framework.

Considering the features of the platform, it is crucial that, having identified the research gap in question, the procedural needs are defined in a firm manner based on the situational analysis of business organizations that might find in the platform an alluring alternative to simplify their processes; likewise, it is necessary to establish the functionalities to increase the value of the product so that its positioning in the market becomes solid before proceeding to its commercial implementation.

The accomplishment of the set technical objectives implies considering elements of Big Data and Machine Learning, considering the need to analyze a substantial volume of data that must not only be refined to obtain particular results but, by their nature, serve as a contribution to the ongoing enhancement of the platform.

Indeed, efficient data management and purification are needed and must be solved from the design, as indicated by the work of Ovallos et al. [40]. Nevertheless, establishing appropriate protocols so that the system can "choose" what answer it should provide based on the inputs that are indicated to it is part of the singularities that must be incorporated as differential protocols.

The success of the system is not set exclusively in its ability to analyze the data and needs of an organization objectively but in the speed with which the procedures are performed. However, the interaction process with the platform must be simple and intuitive so that the simplification of the processes not only has an impact on the decreasing of time but also on the data management.

Selecting the ideal server and choosing the platform hosting are essential components of the structuring process, along with identifying the requirements for a scalable database. (supplied with its respective management software (DBMS)) and the defining of the most appropriate programming languages to guarantee the multiplatform operability of the system. These vital aspects will be understood more consistently as the results are detailed.

III. METHODOLOGY

We tailored the methodological process to the phases outlined in Figure 1. In the first one, the functionalities of the platform have been designed and adjusted for the data management and analysis needed for decision-making in companies in the field. The first step was to collect requirements in hand with the guidance of field experts belonging to the SNCTI, whose guidance helped analyze the situation of three companies about the most common problems they come across in the processes of managing work permits for high-risk jobs. Then, the needed design and adjustments are made to improve the backend and frontend of the solution, in addition to modifications in the data storage infrastructure to line them up with the needs of Big Data. This phase also includes the integration process of state and private databases from where relevant information is obtained for validation.

In phase 2, the functionalities that are developed add value to the platform for its eventual commercialization. In this stage, the actors involved manage the development of new functionalities, the implementation of a dashboard to facilitate data visualization and decision-making, as well as defining the entire unit and functional tests that are performed on the platform. Lastly, phase 3 executes the analysis of Victoria 4.0's commercial positioning prospects.

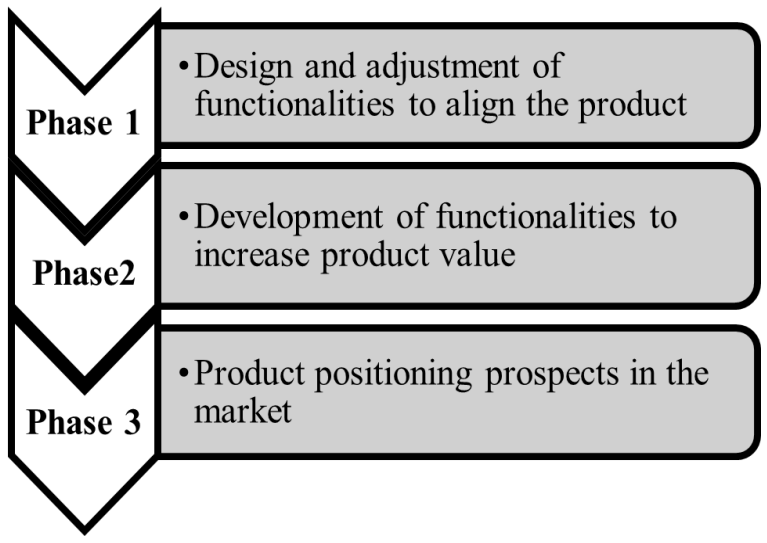

Fig. 1 Description of the methodological process.
Source: authors.

IV. RESULTS AND DISCUSSION

This section announces the results obtained from the design and display of the Victoria 4.0 platform. The presentation is done in the same way as the other in that the methodological phases were announced so that the sequence of procedures remains clear.

Design and adjustment of functionalities

The functionality design and adjustment process was preceded by a characterization of the field situation, aiming to identify the gaps that must be addressed within the platform's design. To accomplish this, a requirements collection was performed within three companies whose activities are considered high-risk. Table 1 shows the results of this requirements collection.

TABLE. 1. DESCRIPTION OF THE METHODOLOGICAL PROCESS.

Problematics	Company 1	Company 2	Company 3
Traditional Management Methods	Uses traditional paper–based and Excel management system	Relies on manual paper forms and spreadsheets	Uses a similar approach based on paper forms
Physical Flow of Documents	Requires multiple printed copies for physical flow	Uses hard copies for tracking and validation	Reliance on Physical copies for authorization
Manual and Complex Processes	Manual process for screening, inspection and validation	Completes manual inspection and validation processes	Performs laborious manual inspections and validations
Delays in Starting Activities	Possible delays in activities due to long process	There may be delays due to lengthy manual processes	Risk of delays in activities due to complexity
Compromised Interdepartmental Coordination	Difficulty in interdepartmental coordination	Coordination affected by manual processes and delay	Coordination between departments affected by processes
Impact on Project Schedule and Budget	Possible impact on schedule and budge	Possible deviation in Schedule and budget	Risk of deviations in schedule and budget

Source: authors.

This particular diagnosis allows one to easily characterize the present state of the processes of permit management for risky labor within a company, identifying the predominant execution of manual activities, which not only slows down the process but can also be a trigger for procedural errors. This assessment also allows one to recognize the relevance of a platform like Victoria 4.0, which tends to minimize the time and guarantee the reliability of the data.

The design and adjustment of the improvements regarding the backend and frontend of the solution were then provided. DigitalOcean® was chosen as the provider of a secure server. During the design process of Victoria 4.0, the use of the Rails® framework (for the mobile version) was measured; PHP® was used as the programming language for the web platform. Ubuntu® (an open-source distribution derived from Linux) was used to generate

the graphical interface, framed in the GNOME® desktop environment. MySQL® was used for the multiplatform management of databases (state and private) for the validation and digitalization of information in the web version, supported by Firebase® in the mobile version. Figure 2 describes the design support for the web version of Victoria 4.0.

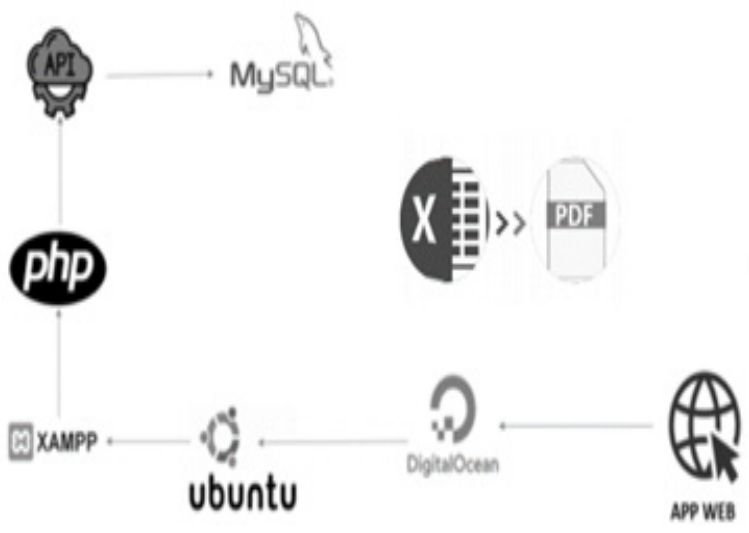

Fig. 2 Description of the Victoria 4.0 design process.
Source: authors.

The functional structure of the platform is as shown in Figure 3. The process begins with the generation of evidence that constitutes the input for the process of executing and completing the work permit, which passes—with evidence attached in dashboards—to the SST area in charge of evaluating the permit and responding to the request through two concepts: approved or denied. Finally, the cycle is closed.

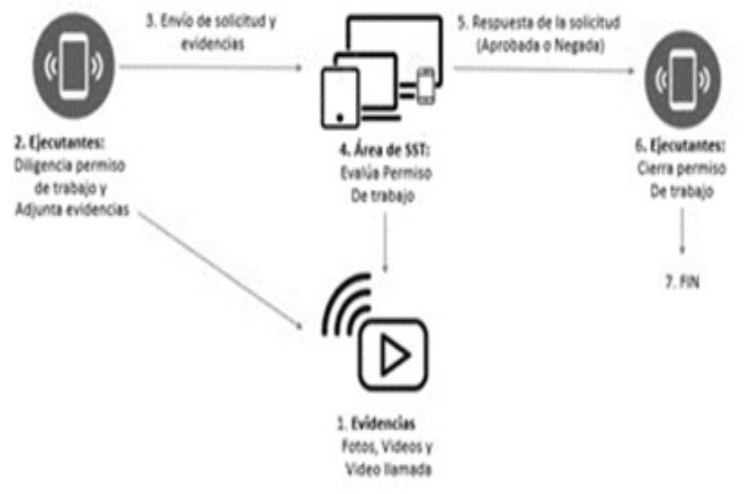

Fig. 3 Description of the functional structure of Victoria 4.0.
Source: authors.

It's important to remember that Victoria 4.0 is a digital tool for the optimization of the management, collection, storage, and analysis processes regarding data related to the execution of technical and high-risk activities within an organization. The information flow involves extracting data from multiple sources and displaying it in a dashboard for analysis. The information unification process, from which the system starts, refers to the action of gathering and consolidating data that comes from different sources so that a coherent and unique perspective of them can be provided. This process captures the full transition of information from one of its original sources to its storage and management.

Integration considers methods, tools, and architectural approaches that enable the combination and use of all types of data, whether structured or unstructured. As previously mentioned, extractors obtain the information from a variety of sources, including transactional systems, applications, and sensors. A centralized repository then stores it. A thorough analysis of the existing data is performed, and the key sources necessary for the analysis are identified.

Next, the Extraction, Transformation, and Loading (ELT/ETL) process goes on, in which the extracted data is subjected to a transformation and cleaning process to guarantee its quality and consistency through data normalization, aggregation, and enrichment tasks. Given the significant volume of data being handled and processed, it is essential to securely

load it into a suitable environment designed for this purpose. Having a data warehouse—a database optimized for analysis and reporting—not only allows this requirement to be met but also favors the generation and backup of dimensional tables and fact tables. The former contains descriptive and contextual information, while the fact tables store numerical data and vital metrics.

The previously performed dimensional model efficiently organizes the data and facilitates its analysis. Dimensions and grouping hierarchies are defined, while data is filtered by its level of significance. Relationships are also established between dimensional and fact tables to allow for a comprehensive analysis of the information. These activities precede the generation of reports and analytics.

With the data stored in the Data Warehouse, reports and analysis are generated using Business Intelligence (BI) tools such as Power BI, from which interactive reports, dashboards, and scorecards are designed and developed that provide a clear and understandable visualization of the data. This process is iterative and requires continuous maintenance. Therefore, it is imperative to continue monitoring, updating, and improving the performance of the Data Warehouse, while at the same time analyzing changes in data sources and analysis needs so that the integrity, relevance, and accuracy of the generated reports can be guaranteed.

Figure 4 describes the platform's interactive process. It starts with the login and creation of the user. Then the general module is deployed, in which there are five different options for interactions (secure work analysis). Work at heights, in confined spaces, in high temperatures, and in electric jobs. On the left side of the main screen, the different interaction sections are presented, in which each of the factors required for the generation of the respective work permits is managed.

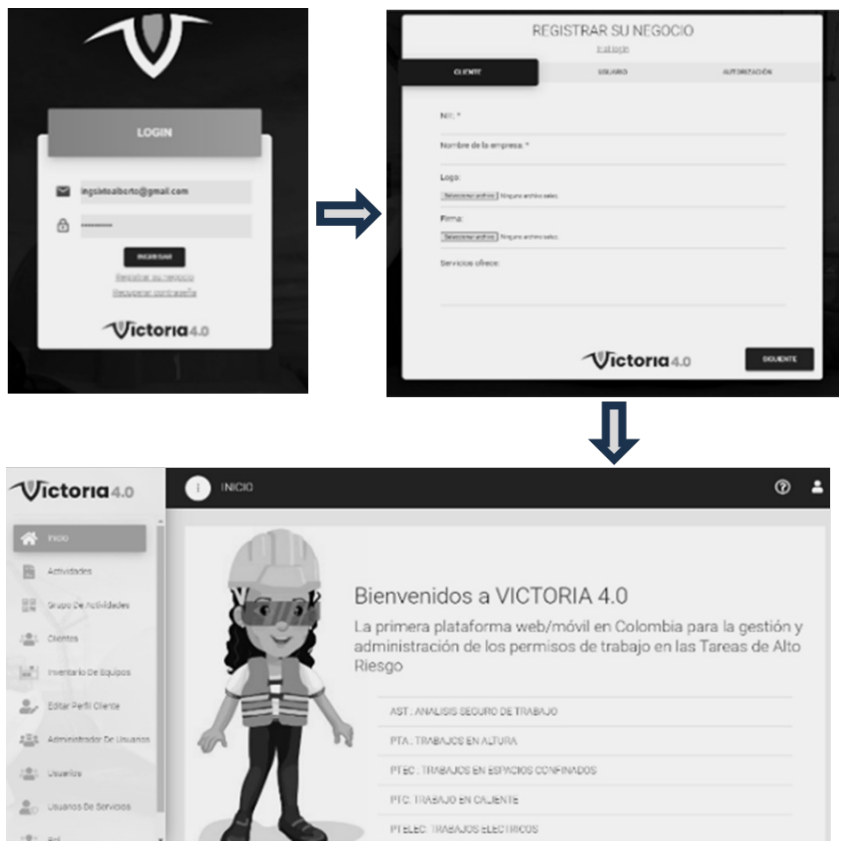

Fig. 4 Process of interaction with the Victoria 4.0 platform.
Source: Victoria 4.0 interface.

The process is highly intuitive, and the records can be completed quickly and in an organized manner until the respective work permit is obtained (see Figure 5). Furthermore, the suppression of a self-registration option requires pre-configuration and guidance in parameterization, which ensures that the company receives personalized advice to make efficient use of the platform.

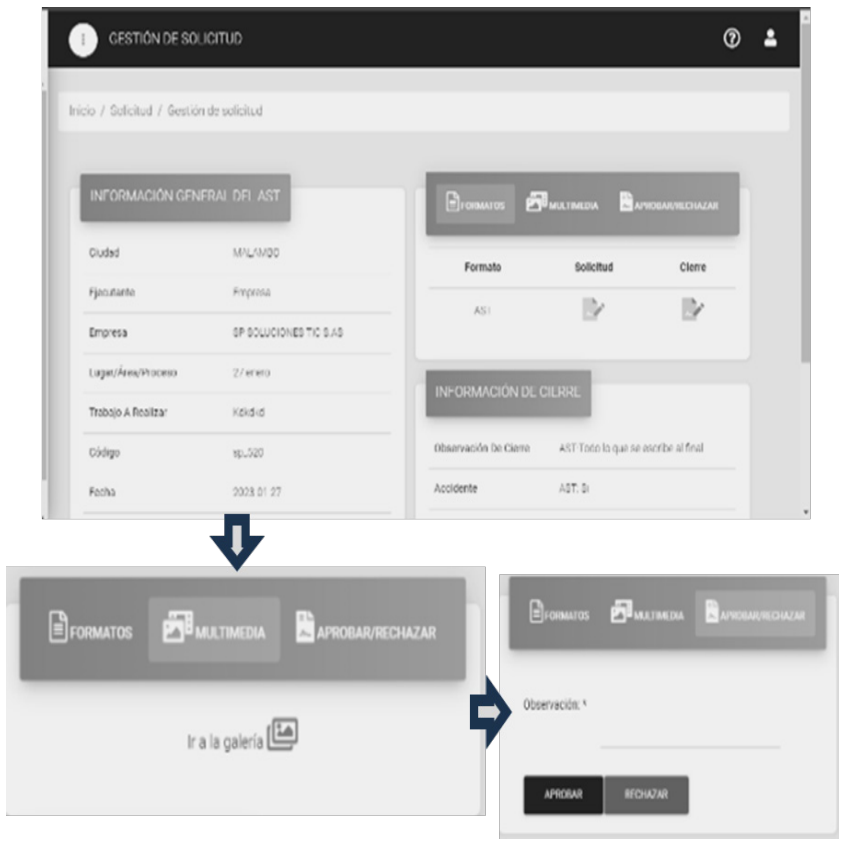

Fig. 5 Permission management process in Victoria 4.0.
Source: Victoria 4.0 interface.

A. Development of functionalities to increase value

After assessing the platform's operability, the aspects that could be destined for improvement for each functionality were identified. The following were classified as specific needs:

- Record validation.
- Activities view.
- User profile.
- Form view.
- Information tab.
- Tasks tab.
- Workers tab.
- Controls tab.
- Closing tab.

For each of these functionalities, specific changes were incorporated to enhance their value by improving the platform's usability. Regarding the validation of records, reinforcement was carried out so that the user is not only validated by email but also by their ID number. In the main activities view, an icon was added to update the status of the requests made. Additionally, in the user profile, the name of the company to which the profile belongs and its NIT (Tax Identification Number) were added.

In the forms view, the module's title has been changed (initially they were called "permits"), and the functionality was introduced to allow viewing the image that was uploaded for submission. The contractor's session has been added to the "information" tab so that the employees can be classified by their roles.

In the "tasks" tab, a section was added for the systematization of hazards, with preloaded data that allows the user to select those that most frequently occur in the company's activities. Similarly, the "procedure" and "equipment and tools" sections were added, in which preloaded data is also presented for the selection of the procedures and elements that have the highest recurrence in each company.

The employee's log-in has been added to the "workers" tab, in which pre-uploaded data is being shared for the selection of workers who are registered by the organization, as well as allowing the uploading and modification of the employee's role and signature. In the "controls" section, a "validation question" option has been added, where the pre-uploaded data are presented so they can be used to answer the questions provided by the company.

Finally, on the "log out", a "type of accident" section has been added, which includes a modal list with three types of accident for the selection of those that apply. This tab concludes the permit management process before allowing for the acceptance to be sent.

Other additional improvements included limiting the functions of the Mobile APP so that it was only a tool for data collection and the inclusion of fields for data analytics. For the web version, it was allowed to read the path of the generated PDF file and display it in the activity button, a functionality removed from the mobile version.

B. Perspectives of commercial positioning

The technology that Victoria 4.0 encompasses can be classified within the category of "environmental health and safety software (EHS software)." This type of development aims to better the communication and management of risks inside the workplace. They are platforms that generally offer tools for data collection, record management, hazard monitoring, customized reports, form submission, and document review.

A bibliometric analysis in indexing databases such as Lens® and Scopus® based on the search parameter "HSE management software" allows us to recognize that this type of technology is in a growth phase. Recently, the development of two hundred and thirty-eight (238) patents and numerous scientific publications has demonstrated a clear upward trend. Therefore, it is pertinent to conclude that the market for this type of solution is entering a new growth phase associated with the use of cloud-hosted tools, configurability, and mobile applications linked to the platforms.

The United Kingdom, the United States of America, Holland, and China are the main research territories, with the most relevant thematic areas being engineering, medicine, and business. The United States (with 166 patents) and China (with 21) are the leaders in the protection of this type of technology.

Regarding the financial aspects, specialized sources estimate a global market of 1.35 trillion dollars for the technology in question, with potential growth up to 2.2 trillion dollars by 2025, with a compound annual growth rate of 10.1%. The principal drivers of this great development are innovation and the interest of companies concerning the reduction of work-related accidents in hopes of minimizing related expenses (Verdantix, 2021).

An analysis of the current market allowed the identification of the following alternatives with similar characteristics (see Table 2). Being a national option, Victoria 4.0 can enjoy high acceptance since each nation has its own regulations, and it is more attractive to have specialized advice in the region.

TABLE. 2 SIMILAR SOFTWARES ON THE MARKET.

Name	Company	Description	Link
CorityOne ™	Cority	Integrated HSE SaaS platform covering the full spectrum of environmental, health, safety, quality, and analytics across the organization.	https://go.cority.com/ehsq-software/
Integrated EHS Compliance and Risk Management Solutions	Dakota Software	Combine up-to-date environmental regulations and safety requirements with easy-to-use software tools to manage sustainability and HSE programs.	https://www.dakotasoft.com/solutions/ehs-compliance
Software de Gestión SST	Zyght HSEQ Technology	Integrates HSE SaaS platform.	https://www.zyght.com/
Software HSE	HSE Soft Excellence	Modular tool, customizable and adaptable to the needs of the company	https://hse.software/software-hse/
Software HSE/ SSOMA	ISO Tools Excellence	Modular and customizable software adapted to the needs of the company. Total control of the Health, Occupational Safety and Environment Management System.	https://www.isotools.org/software/hse-ssoma

Source: authors.

In relation to the feasibility of contracting the Victoria 4.0 platform, aspects such as the growing demand for robust solutions that integrate workplace safety practices while considering the risk of facing severe sanctions, the pay-per-use pricing model that is affordable

for all organizations regardless of their size, and the change in risk perception after the pandemic are highlighted.

V. CONCLUSIONS

In the development of the Victoria 4.0 platform, the Ruby® programming language was used for the mobile version and PHP® for the web version. Ubuntu® was employed in the generation of the graphical interface, while MySQL® was used for information validation and digitalization in the web version, supported by Firedatabase® in the mobile version.

Substantial improvements were made in the options: Registration Validation, Activities View, User Profile, Form View, Information Tab, Tasks Tab, Workers Tab, Controls Tab, and Closure Tab. By improving its interface and offering better usability perspectives, we increased the value of the platform in its two versions.

Finally, good commercial positioning prospects for Victoria 4.0 —classifiable in the category "Environmental Health and Safety (EHS) software"— were identified based on the analysis of patent registration trends and empirical development on the subject. Besides, and active market with multiple alternatives has been recognized on a projected market of 2.2 billion dollars in 2025.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

F. Jiménez-Bolívar: Conceptualization, Methodology, Research. **D. Ovallos-Gazabon:** Methodology, Research, Formal Analysis, Supervision, Project Management, Writing - Proofreading and Editing. **K. Santiago-Almanza:** Methodology, Research, Formal Analysis, Supervision, Project Management, Writing - Proofreading and Editing. **J. Bernal-Peralta:** Validation, Visualization. **N. Alfaro-Parada:** Data Curation, Visualization. **R. Callan-Bacilio:** Validation, Visualization.

CONFLICT OF INTEREST DECLARATION

The authors of this article expressly declare that there is by no means any type of conflict of interest underlying the preparation and publication of the document.

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