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Risk Prevention Model for Enhancing Safety in Educational Centers: Application of HIRARC, Signage, and Evacuation Maps according to ISO 45001, a Case Study

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Abstract

The peruvian education sector faces challenges in human development and security, particularly due to its location in the Pacific Fire Belt, where natural disaster risk is high. While risk management has advanced in other sectors, education has received less attention. This study addresses that gap by identifying key issues in a public educational institution, including students' lack of emergency preparedness, low engagement with safety topics, and infrastructure deficiencies. To enhance risk management, the PDCA (Plan, Do, Check, Act) methodology was applied alongside HIRARC (Hazard Identification, Risk Assessment, and Risk Control), signage and evacuation maps. The proposed model integrated signage design, evacuation procedures, usage instructions, and training for teachers and students. Results showed an increase in ISO 45001 compliance from 56.52% to 84.78%, a reduction in significant risks, and an improvement in vulnerability scores from 71 to 92 points. Additionally, the percentage of students who know how to respond in emergencies increased by 18.18%, confirming the model's effectiveness. This project provides a scalable framework for enhancing safety in both public and private educational institutions.

Keywords
Education center, HIRARC, signage, evacuation maps, ISO 45001

1. Introduction
The education sector is that set of services and actions that seek to provide this right to society, according to UNESCO (2021), which facilitates men and women to get out of poverty, overcome inequalities and achieve sustainable development, acting as a catalyst to ensure other essential human rights.

Risk management is also essential for the strategic plan in different sectors, including education, as institutions can face natural phenomena at any time and must have one to control students, avoid tangible and intangible losses and know how to evacuate the facilities safely.

Some of the Peruvian laws that institutions must comply with in relation to risk management are: Law N° 29783: Safety and Health at Work, Law N° 29664: Law of the National Disaster Risk Management System (SINAGERD). As well as taking into account the Methodological Guide for the elaboration of the Disaster Risk Management Plan and contingency actions in Educational Institutions and the international standard ISO 45001:2018.

The research work is directed to a state educational institution which has been in operation for more than 30 years and focuses on secondary education for young people between 12 and 17 years, according to the ministry's regulations. To learn about the standards of the educational institution, data were collected on current risk management at the center. This has implements such as fire extinguishers, stretchers and wheelchairs in case of an accident. They also have safe and delimited areas by each section and an evacuation route in case of earthquakes.

Among the indicators used to measure health and safety in the institution, a survey was carried out on a sample of 220 pupils, in which they were asked about their attendance for some occupational disease (cut, wound, lumbago, migraine, burn, etc.) or any common disease (allergy, stomach pain, nausea, high blood pressure, fever, etc.). The survey results show attendance at 49.55% and 60.45 respectively. However, with the data obtained from Barnuevo and Vilchez (2021), the percentage of attendance at other institutions is on average 38.45% and 37.28% in each case, indicating that the attendance of students is higher than the average for secondary education institutions.

Another indicator that is considered is the efficiency of ISO 45001 in the institution, where the rating from 0 to 2 was used, being 0 if not met and 2 that fully meets each chapter and subchapter, thus giving the overall weighted 56.52% compliance. But the sector indicator is 68%, so while the college meets the requirements of the Disaster Risk Management Plan, it must improve in terms of its resources use, communication and evaluation of management performance.

1.1 Objectives

According to the theme of development, the overall objective is: Develop a risk prevention model in an educational institution to improve the level of compliance with ISO 45001 and reduce risks for students, teachers and administrative staff.

The specific objectives are: to develop the background and state of the art of the Annual Work Plan (AWP); to carry out the diagnosis and analysis of the problem using tools such as HIRARC, in order to increase the efficiency index of the ISO by 30%; Design and develop solutions using engineering tools such as Signage and Evacuation Maps, increasing the awareness of students; and validate the proposed risk prevention model based on monitoring and inspection techniques in order to assess its economic viability and impact on the main stakeholders of the educational institution.

2. Literature Review

A total of 32 academic papers were selected on risk management in different sectors. Figure 1 shows the process of searching and screening articles using the Prisma flow diagram.

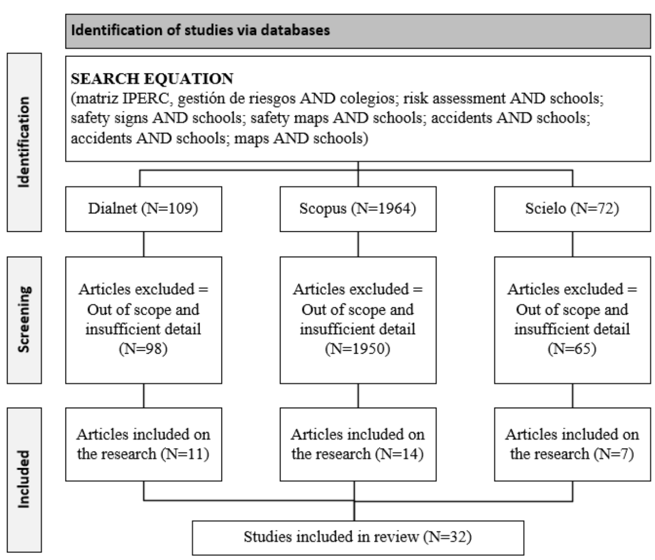

Figure 1. Prisma Flow diagram

In addition, four relevant typologies were defined in this study to offer varied perspectives on the use of safety tools in other sectors and to adapt them to the educational institution's context.

The first typology is "Efficiency of Risk Management in Educational Institutions." Previous research by Barnuevo and Vilchez (2021) applied safety tools to enhance the Disaster Risk Management Plan in a Peruvian basic education center. By using ISO 45001 to assess the initial and final safety status and incorporating HIRARC, the study demonstrated that compliance with the Occupational Health and Safety Management System (OHSGS) can be improved through corrective actions and the creation of specific risk management indicators.

The second typology examined was "Risk Identification in Industry." Key engineering tools identified in the literature include HIRARC, PETS (Privacy Enhancing Technologies), and HAZOP (Hazard and Operability Analysis), all of which focus on risk identification and mitigation. Miñan et al. (2020) effectively applied HIRARC to rank the significance of risks, facilitating prioritization of preventive actions that ultimately raised compliance with Peruvian Law 29783 from 8% to 39.9%. The PETS tool enabled an in-depth review of both the workplace and each task performed by employees (Cavero 2022), while the HAZOP method helped measure the probability of accidents occurring when variables deviate from established parameters (Duhon et al. 2023).

The third typology, "Risk Identification in the Education Sector," identified the use of HIRARC for risk assessment in education centers, specifically in high-risk areas such as classrooms, administrative offices, dining rooms, science and technology laboratories, and sanitary facilities (Barnuevo and Vilchez, 2021).

Finally, the typology "Signage and Maps in the Education Sector" underscores the importance of safety in education centers. Freitas et al. (2020) emphasizes that these tools should be accompanied by training in their use to foster awareness, noting that both tools are essential complements to the Disaster Risk Management Plan.

3. Methods

To identify the primary issues within the center, several steps were undertaken: on-site visits, student surveys, meetings with the principal, and a review of institutional documents, including the Annual Work Plan (AWP) and Institutional Education Project (IEP). These steps led to the identification of three reasons contributing to the institution's inefficient risk management, each aligned with the engineering tools selected in the literature review (HIRARC, signaling, and evacuation maps), as depicted in Figure 2.

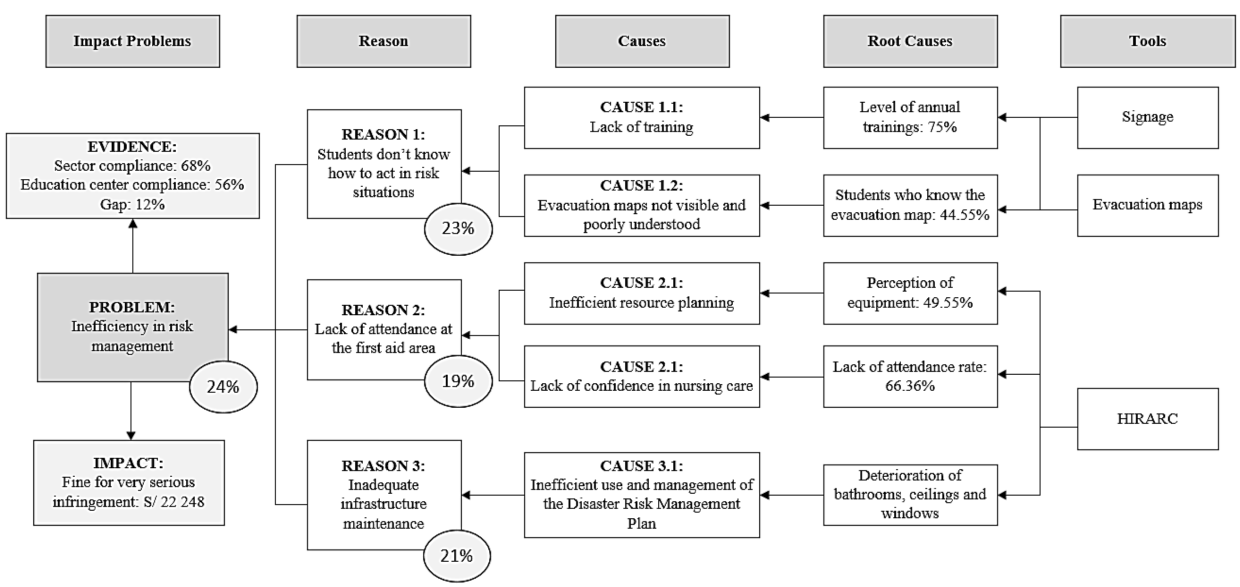

Figure 2. Root cause-tool mapping diagram

The identified root causes center on three main problems: students' lack of knowledge on responding to risk situations, low attendance at the first aid area, and inadequate infrastructure maintenance. Firstly, students' lack of emergency preparedness increases the risk of accidents; studies by Mora et al. (2021) and Rosales and Marcano (2022) emphasize the importance of safety tools, such as signage and evacuation maps, which aid in understanding necessary actions during emergencies.

The low attendance at the topic can primarily be attributed to a lack of trust in the available resources. This issue can be addressed through a risk assessment using HIRARC, which, according to Mayes et al. (2023), enhances resource planning and optimizes the education center environment. Furthermore, the inadequate maintenance of infrastructure presents a significant risk of major accidents. To mitigate this, Miñan et al. (2020) and Lengyel et al. (2023) recommend utilizing HIRARC to identify and manage risks, thereby ensuring compliance with Peruvian Law 29783 and fostering a safer environment.

Building on the updated laws and regulations, a proposal for implementation has been developed, emphasizing efficient risk management in accordance with ISO 45001 and the occupational safety and health policy. This approach leverages the PDCA cycle, which supports organizations in establishing goals, defining actions, and implementing processes to achieve those goals. Additionally, the PDCA cycle enables the evaluation of results and encourages continuous improvement (ISO, 2015). As a result, as depicted in Figure 3, the PDCA cycle enhances the efficiency of activities and projects, promoting overall organizational performance.

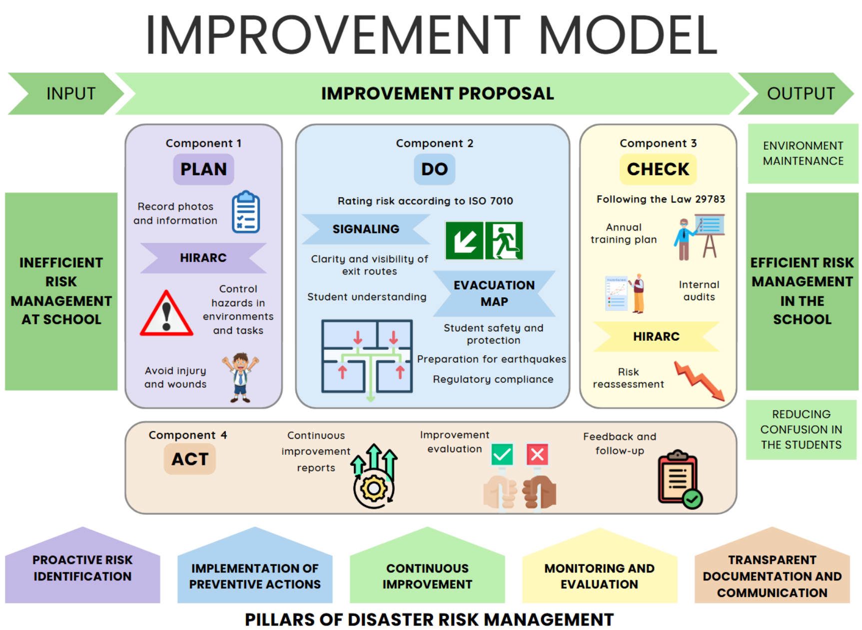

Figure 3. Improvement model

The first component utilizes HIRARC to gather and analyze risk data within the institution. This process begins with site visits and consultations with the center principal to identify the various environments across the three floors of the building. Next, the tasks and associated risks in each area are assessed, evaluating the likelihood of occurrence and the potential severity of their consequences. Based on this analysis, control measures are proposed, which may include the implementation of safety tools, infrastructure modifications, and training for both staff and students.

The second component focuses on the implementation of safety tools, including signage and evacuation maps. For signage, the types of signals required—such as prohibition, warning, action command, rescue, and fire safety information—are identified and classified in accordance with the risks and control measures outlined in the first component. The signage is then designed according to ISO 7010 standards, with careful planning regarding its location and size to ensure proper installation. Regarding the evacuation map, scaled plans for each floor of the center are developed to replace an outdated sketch. Utilizing HIRARC and a floor-by-floor checklist, critical points are identified, with hazard signs and emergency routes added. At the end, the results are presented to the principal and the Security Committee for approval, and a plan is developed for distributing the maps to the members of the institution.

The third component also employs HIRARC, this time to reassess risks based on their likelihood and severity, generating a new severity index that facilitates the evaluation of potential changes in risk levels. If the risks are adequately controlled through these assessments, training is provided to teachers, administrators, and students on the implemented measures. If, however, the risks are not sufficiently mitigated, new control measures are proposed and evaluated using the same HIRARC framework.

In the fourth and final component, the continuous improvement methodology is applied, though without a specific tool. The process begins with the creation of a review schedule for the previously discussed components, which enables updates to the annual work plan and visual inspections of the environment. This updated plan assesses the effectiveness of existing control measures and, when necessary, proposes additional actions. Finally, HIRARC is updated, and the changes implemented are thoroughly documented. Figure 4 shows the flowchart of the whole project.

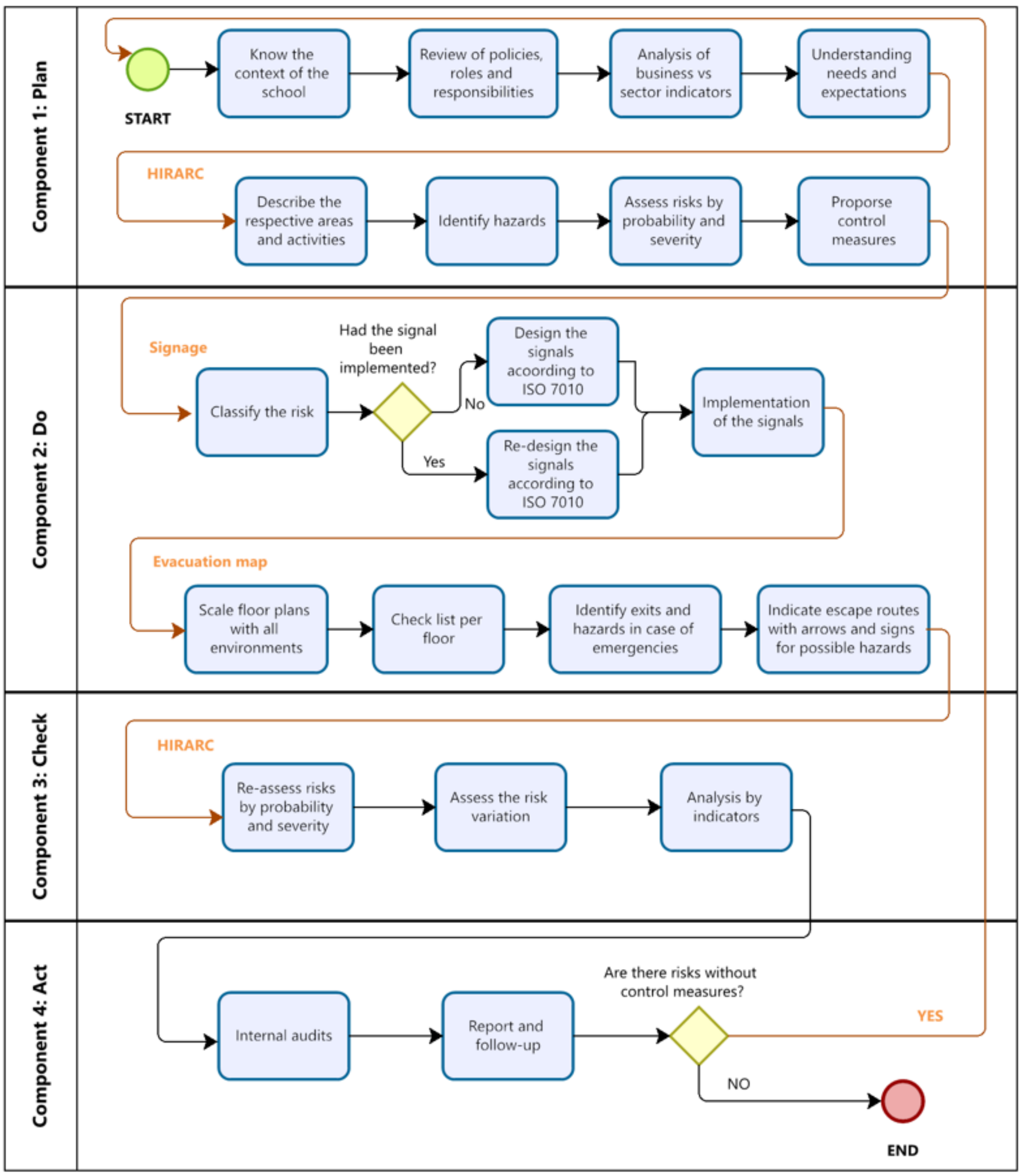

Figure 4. Implementation of the component Plan

4. Data Collection

To measure the impact of the project, visits were made to the institution to obtain data. We also proceed to obtain the sample in which each of the tools will be applied, considering that it varies between environments and people.

In the case of HIRARC tool, as this is used in the analysis of environments, all areas must be identified and their tasks and/or activities described. These environments are: 15 classrooms, 1 teacher's room, 4 administrative offices, 1 science laboratory, 1 computer room, 1 English room, 1 cafeteria, 1 coliseum, 1 topic, 1 auditorium, 1 main courtyard, 1 library and 3 to 4 corridors and stairs considering that the building has 3 levels.

On the other hand, for the signaling tools and evacuation map, students' perception will be used to have a better view of the dangers that need to be reinforced and made aware. For this purpose, the data is that the total number of students in 2024 is 508 students, therefore the sample size is 219 students. According to the formula, the sample size for a population of 32 professors is 29.

- N: 508
- Z: 95% (1.96)
- E: 5%
- P: 50%
- Q: 50%

$$n = \frac{p\ x\ q\ x\ N\ x\ Z^2}{e^2\ x\ N + p\ x\ q\ x\ Z^2}$$

The indicators to be measured will be:

- Efficiency according to ISO 45001
  For the calculation of compliance level of ISO 45001, the application guide of the international standard (Contreras and Cienfuegos, 2019) was used as a basis, where the rating from 0 to 2 was used, with 0 if not met and 2 fully meeting each chapter and subchapter.

$$Efficiency\ according\ to\ ISO\ 45001 = \frac{sum\ of\ compliance}{2 \text{ x } 23}$$

- Index of significant risks
  HIRARC is used, in which the hazards encountered are identified for each space. The level of probability and consequence level is completed with Tables 1 and 2. Finally, the value obtained is interpreted as the results from Figure 5.

$$Index\ of\ significant\ risks = \frac{significant\ risks}{\text{total risk}}$$

Table 1. Criteria for determining the level of probability

Probability				Value
A = People exposed	B = Existing procedures	C = Training	D = Exposure to risk	
1 to 3	Sufficient or satisfactory	Trained personnel, know about the danger and where it prevents.	Sporadic, at least once a year	1
4 to 12	Partially existing or not satisfactory	Staff knows about the danger, but doesn't take actions over control	At least once a month, monthly	2
12 to more	Not existing	Untrained personnel and unaware of danger, less take action	At least once a day, permanent	3

Table 2. Criteria for determining the level of consequence

Consequence	Meaning	Courage
Low	Injuries without injury, first cures	1
Middle	Injuries with low, lost working days	2
High	Great disability or death	3

LEVEL OF RISK	INTERPRETATION / MEANING
IMPORTANT (17 or more)	Operation is stopped, because work will not be started or continued until the risk is reduced. If it is not possible to reduce the risk, even with unlimited resources, work should be prohibited and closed.
MODERATE (9 to 16)	Fixed periods are determined to make efforts to reduce risk, determining investment. Furthermore, it must be understood whether this risk has any relation to harmful consequences (fatal or very serious), a subsequent action will be needed to establish more precisely the need for improvement of control measures.
TOLERABLE (5 to 8)	The effectiveness of preventive action is maintained; however, more cost-effective and economical solutions should be considered so that they do not become an economic burden. Regular checks are required to ensure the effectiveness of control measures.
TRIVIAL (1 to 4)	No action is taken as it doesn't require specific action.

Figure 5. Interpretation of risk

- Level of vulnerability
  According to the Ministry of Labour and Promotion of Employment (2023), the quantitative methodology proposed in its "emergency response guide" makes it possible to identify vulnerable areas in different risk management elements of an organization, Focusing especially on the design of escape routes. In the guide, it is necessary to select between options A, B or C the alternative that best fits the actual situation, within the letter A being a case where no improvement is needed, B where the employees know the improvement, but it has not been applied and finally C where the risk is unknown. These sentences refer to location, access, knowledge of evacuation routes and map visibility, which facilitates the assessment of each relevant factor and determination of vulnerability level.

  Once the analysis is done, we proceed to obtain quantitative value, considering the following score: A equals 4.0 points, B are 2.0 points and C are 0.4 points, the value obtained defines the actions to be taken. From 0 to 50 points, the building is interpreted as having a high functional vulnerability and all aspects that may be presenting some risk should be reviewed. From 51 to 70 the building has a high-average vulnerability and an incomplete emergency plan. From 71 to 90 the building presents a low vulnerability and an emergency plan barely functional that must be optimized. Finally, from 91 to 100 the vulnerability is minimal, and the plan presents an optimal state of implementation.

$$\text{Level of vulnerability} = \#A \times 2 + \#B \times 1 + \#C \times 0{,}4$$

- Number of students who know how to act in the event of earthquakes
  According to the sample of students calculated, a presentation was made in order to teach them the tools and show the results of the investigation, then a survey was conducted including a question on whether the student knows how to act correctly in the absence of a teacher or not.

$$\text{Index of students who know how to act in the event of earthquakes} = \frac{\textit{students who know how to act}}{\text{total number of students}}$$

5. Results and Discussion

5.1 Numerical and Graphical Results

Once the improvement plan had been drawn up and the validation model had been designed, the study center was approached to make the necessary improvements. As for HIRARC, changes were made to those risks that appeared to be significant to make them tolerable, such as slippery floors, little room to move and loose cables. These dangers were located in key areas of the institution as it has high circulation and for the activity the community does there. To mitigate these, changes were made such as adding extensions for computer cables or including signals near the power outlets, as well as installing warning signs. Finally, training was provided to the trainees on the identified hazards and their possible consequences with a view to raising awareness and encouraging preventive behavior, as depicted in Figure 6.

Workspace	Task	Danger	Risk	Legal requirement	Probability					Severity index (S)	P * S	Level of risk	Significant risk	Control measures
					A	B	C	D	P					
Classrooms	Learning	Slippery floor	Risk of falling	- Law N° 29783	3	1	1	3	8	2	16	Moderate	Yes	Train students to the risk
		Cables in a pile	Risk of electrocution	- Law N° 29664 - Law N° 28806	1	1	1	3	6	1	6	Tolerable	No	Don't overload plugs with extensions
	Displacement	Small space for circulation	Risk of tripping and falling	- RM 050-2013 TR - NTP 399010-1 2015	3	2	1	3	9	2	18	Important	Yes	Train students to the risk

Figure 6. Example of HIRARC in classrooms

With the actions taken, HIRARC was re-performed, and the identified hazards were reduced from a significant (moderate or significant) risk to a non-significant and tolerable risk. In the end, perceived risks were reduced from 33 to 31 and from 18 non-significant risks were reduced to 7. The efficiency of ISO was upgraded to 84.78%, which is more than expected.

As for the implementation of the security signaling tool, a total of 90 signals were installed, based on the risk analysis previously carried out through HIRARC. This installation process included both the design of new signals and the redesign of pre-existing signals to align them with international standards established by ISO 7010:2019 and the Peruvian standard NTP 39901:2015. Of the total number of installed signals, 25 warning signs were implemented, 51 warning signs and 9 mandatory signs. On the other hand, it was identified that there was no need to install rescue or distress signs; however, to complement emergency management, new signs were placed linked with items and equipment needed during an evacuation. In addition, the pictograms associated with fire extinguishers were redesigned.

With respect to the evacuation map tool, the map was designed with general routes and 9 maps that were located in different points of the institution so that all students and teachers know about the changes made, 4 on the first floor, 1 on the second and 4 on the third level. Once the maps were located, the vulnerability matrix was completed again to identify whether the changes made improved the score with respect to compliance with the standards set by the ministry of labor. After relating each statement to its respective answer as indicated in the guide, the quantitative calculation is made depending on its rating resulting in a score of 92 points that, according to the guide, the vulnerability is minimal, and the plan presents an optimal state of implementation. In figure 7, there is some evidence of some signs and maps have been implemented to help reduce the risk of accidents such as stumbling and falling.

Figure 7. Implementation of signals and evacuation maps

Then, the training of teachers on the 3 safety tools was carried out. At the end of the exposition, they completed a survey to analyze the efficiency and understanding of each new tool. Figure 8 shows the number of correct answers by each teacher considering that 25 questions were asked in total and the lowest score obtained was 14 points.

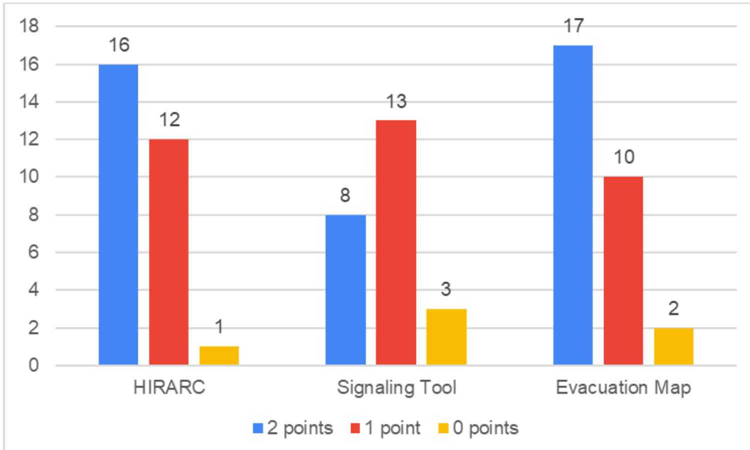

Figure 8. Number of correct answers – teachers

With a total of 25 questions, only the number of correct answers for each tool was considered. For this, 2 points were set for those teachers who had from 21 to 25 hits, 1 point for 10 to 20 hits and 0 for the rest. Table 3 shows the number of teachers who were in each score established. For HIRARC, signal and evacuation map were obtained 75.86%, 58.62% and 75.86% respectively.

Table 3. Efficiency of training for teachers

Score	HIRARC		Signaling Tool		Evacuation Map	
	# Teachers	Value	# Teachers	Value	# Teachers	Value
2	16	32	8	16	17	34
1	12	12	18	18	10	10
0	1	0	3	0	2	0
Total		44		34		44
Percentage	75.86%		58.62%		75.86%	

After the training for teachers was completed, the students' capacitation continued with the use of only 2 tools: evacuation signs and maps. Table 4 shows the efficiency results obtained by the students, with 70.41% in the signals tool and 69.77% in the evacuation maps. Also, Figure 9 shows the number of correct answers by each student considering that 15 questions were asked in total.

Table 4. Efficiency of training for students

Score	Signaling Tool		Evacuation Map	
	# Students	Value	# Students	Value
2	117	234	121	242
1	89	89	65	65
0	14	0	34	0
Total		323		307
Percentage	73.41%		69.77%	

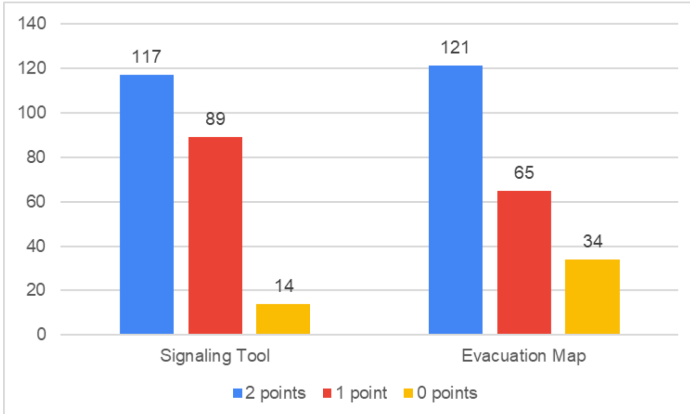

Figure 9. Total score obtained by students

At the end, the results obtained after implementation are shown in Figure 10 in traffic light assessment, where the previous value, the expected and the obtained are compared.

Component	Indicator	Formula	Unit	Traffic light assessment			As Is	To Be	Achieved	Improvement
				Red	Yellow	Green				
General	Efficiency according to ISO 45001	$\frac{sum\ of\ compliance}{2 \times 23}$	%	< 50%	50% - 80%	> 80%	56.52%	80.00%	84.78%	28.26% over the actual value
Plan	Index of significant risks	$\frac{significant\ risks}{total\ risk}$	%	> 85%	65% - 85%	< 65%	78.79%	50.00%	45.45%	Significat risk were reduced by a 33.34%
Do	Level of vulnerability	$\#A \times 2 + \#B \times 1 + \#C \times 0{,}4$	points	< 70	71 - 90	> 91	71.2	91.00	92.00	The actual value was exceeded by 20.8 point
Check and Act	Index of students who know how to act in the event of earthquakes	$\frac{students\ who\ know\ how\ to\ act}{total\ number\ of\ students}$	%	< 95%	95% - 98%	> 99%	76.94%	95.00%	98.18%	The actual value was exceeded by 21.24%

Figure 10. Traffic light assessment

When analyzing the UN's Sustainable Development Goals, three main SDGs are identified that positively influence them. These are: SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth) and SDG 11 (Sustainable Cities and Communities). This shows that this implementation contributes in a positive way to the institution not only analyzing the SGD, but it also algo helps with their social impact because the professors and student know how to act in any emergency.

5.2 Proposed Improvements and Validation

Regarding HIRARC tool, a customized matrix was developed, categorizing the different environments within the educational institution. For each area, existing hazards were identified, and the associated risks were assessed based on their severity and likelihood of occurrence. This analysis aimed to prioritize risks and define corrective measures. During a subsequent visit, preventive actions were implemented, and the risks were reassessed using HIRARC to evaluate improvements. As a result, two of the 33 identified risks were eliminated, and the number of significant risks was reduced from 26 to 15.

In terms of the signaling tool, a total of 90 strategically placed signs were installed across the center's three floors, as determined by HIRARC analysis. Notably, 46% of these signs were redesigned to comply with ISO 7010 standards, ensuring proper pictogram shapes, labels, and categorization. For the evacuation map, a scaled representation of the institution was created, detailing escape routes for each area while considering potential hazards and the maximum stairway capacity. This proposal was presented to the center principal for approval, after which training sessions and drills were conducted for teaching staff, administrators, and students.

To ensure continuous monitoring and improvement of risk management, detailed instructions were developed, outlining each tool's step-by-step application, responsibilities, definitions of key terms, and templates to facilitate use. Additionally, a procedural guide was created, including a flowchart summarizing the activities required for implementing security measures in the institution. This flowchart, shown in Figure 11, serves as a visual reference for the process.

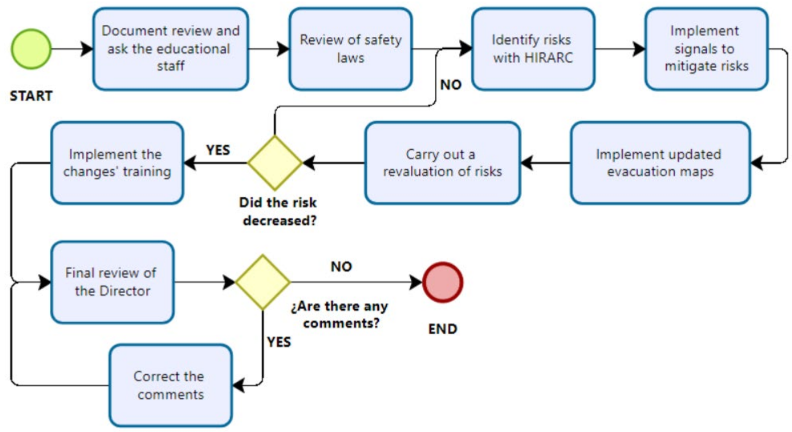

Figure 11. Flow chart of risk management procedure

5.3 Discussion

The reduction in risks from 26 to 15 demonstrates the effectiveness of HIRARC in improving safety at the educational center. By classifying risks based on probability and severity, this tool prioritized critical hazards, optimizing resource allocation. Similar findings by Barnuevo and Vilchez (2021) highlight HIRARC's role in enhancing safety conditions and increasing ISO compliance by 68%, reaffirming its effectiveness across sectors.

The installation of 90 safety signs, compliant with Peruvian Technical Standard NTP 399010-1:2015 and ISO 7010, improved the identification of evacuation routes and assembly points across all three floors, strengthening the institution's safety culture. Studies by Moyano et al. (2017) in Ecuador and Mora et al. (2021) in Colombia confirm that proper signage reduces risks and facilitates safe evacuations.

Evacuation maps, developed according to safety standards, increased the institution's vulnerability matrix score from 71.2 to 92, surpassing the benchmark of 90 and improving evacuation protocols. According to Rosales and Marcano (2022), community risk maps play a crucial role in identifying threats and available resources during emergencies. However, their effectiveness relies on their integration with other safety measures, such as proper signage for evacuation routes, designated assembly points, and clearly marked safe areas. This aligns with Peru's Ministry of Labor (2023) Emergency Response Guide, underscoring the importance of comprehensive risk management in educational settings.

6. Conclusion

- The implementation of the risk prevention model has allowed a significant advance in compliance with ISO 45001 within the educational institution. Through the design and use of evaluation tools such as HIRARC, risks were identified, and preventive measures were established that succeeded in increasing the efficiency level of the standard from 56.52% to 84.78%.
- When previous studies and applicable regulations, such as Law 29783, were analyzed, the need to adapt and strengthen safety management systems in educational institutions was understood. This analysis resulted in a theoretical framework and value proposition using safety-focused engineering tools that support the design of solutions tailored to the reality of the Peruvian education sector.
- Implementing evacuation signs and maps helps create a safer, more prepared environment that allows students to stay informed by, for example, quickly and effectively understanding evacuation routes and safe areas. This strengthens the culture of prevention in the institution, which benefits the entire educational community by reducing the likelihood of accidents and improving emergency response.
- This implementation has significantly improved safety standards, establishing a replicable framework for educational institutions, particularly in high-risk regions. Its scalability makes it valuable for schools facing natural disasters, yet long-term sustainability presents challenges, as maintaining engagement in safety

training requires continuous reinforcement. To ensure lasting impact, periodic evaluations and refresher training should be integrated, fostering a culture of prevention and strengthening institutional resilience.

References

Barnuevo, G. and Vilchez, L., Propuesta de implementación del Sistema de Gestión y Seguridad en el Trabajo en el colegio Concordia Universal del Callao, Accesed April 12, 2024.

Cavero, S., Procedimientos escritos de trabajo seguro y su efecto en los indicadores de seguridad y salud en el trabajo en la instalación de fibra óptica aérea, *Revista científica integración*, vol. 5, no. 1, pp. 42-52, 2022.

Duhon, H., Venkidasalapathy, J. and Kalantri, P., Towards Improved Risk Assessment and Accident Investigation, *SPE Western Regional Meeting Proceedings*, May 15, 2023.

Freitas, C., Rodrigues, M., Fontes, V., Barreiro, M., dos Santos, A., Lima, S., Leal, N., Cartaxo, K., and Mota, E. Risk and preventive factors for traffic accidents: Analysis of children's perception using the edutherapeutic method. *Revista Paulista de Pediatria*, vol. 38, 2020.

Lengyel, D., Mazzuchi, T., and Vesely, W., Establishing risk matrix standard criteria for use in the continuous risk management process, *Journal of Space Safety Engineering*, vol. 10, no. 3, pp. 276–283, 2023.

Rosales-Veítia, J., & Marcano-Montilla, A. Mapas comunitarios de riesgos, conceptualización y abordaje metodológico. Algunas consideraciones. *IPSA Scientia, Revista Científica Multidisciplinaria*, vol. 7, no. 1, pp. 38–57, 2022.

Mayes R., Keirns C., Hicks A., Menner, L., Lee, M., Wagner J. and Baltzer R., USAFSAM Aeromedical Consultation Service Medical Risk Assessment and Airworthiness Matrix, *Aerosp Med Hum Perform*, vol. 94, no. 7, 2023.

Ministerio de Trabajo y Promoción del Empleo, "Guía de respuesta ante emergencias", 1st Edition, Jesús María, 2023.

Miñan G., Monja-Palomo, J. Gonzales-Pacheco, O. Simpalo, W. and Castillo, W., Risk management implementing Peruvian law 29783 in a fishing company, *Ingeniería Industrial*, vol. 41, no. 3, 2020.

Mora, O., Báez, E. and Erazo, B., Diagnostico e implementación de señales de seguridad y análisis de ubicación de equipos para atención de emergencias en la universidad nacional abierta y a distancia unad pasto, https://repository.unad.edu.co/handle/10596/41338, Accesed May 13, 2024.

Moyano, J., Cayan, J., Maldonado, B. and García, E., Integral model of the institutional plan of risk management in the agro-environmental theme park ricpamba, *ECA Sinergia*, vol. 10, vo. 1, pp. 7–18, 2019.

The process approach in ISO 9001:2015, https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/iso9001-2015-process-appr.pdf, Accessed May 10, 2024.

UNESCO, Available: https://www.unesco.org/en/right-education#:~:text=Education%20is%20a%20basic%20human,inequalities%20and%20ensure%20sustainable%20development., Accesed on April 20, 2024.

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Jorge Antonio Corzo-Chavez is currently a professor in industrial engineering career at Universidad de Lima, chief executive officer at Conquista Lab, and associate consultant at Manpower Group for multinational companies. He holds a master's in business administration from Universidad ESAN (Peru), a Master in Marketing Science from ESIC Business & Marketing School (Spain) and is Industrial Engineer from the Universidad de Lima (Peru). He has experience in advising industrial and service companies to improve productivity and development of business models. He has worked in areas of entrepreneurship and innovation, marketing and commercial for the construction, metalworking, mining, services, and education sectors. His main research interests are lean manufacturing, master production schedules, logistics, machine learning, and innovation for small and medium-sized enterprises.