International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 20, Issue 6 (June, 2024), PP. 56-62

Three-dimensional graphic interfaces in preparing intuitive risk maps

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ABSTRACT
Risk analysis is a fundamental tool for worker safety in their work activity, and also serves as the basis for several other documents and occupational safety programs. Its current construction based on two-dimensional modeling of the environment on a floor plan and the presentation of multiple groups of risks proves to be insufficient and can lead to doubts from both occupational safety teams and the employees themselves. Therefore, this article proposes a complementary analysis to the current methodology, with the use of a three-dimensional interface to better present these environments with greater visual demand, as well as presenting a case study carried out in the outpatient medical health sector of the Natal-Central do Rio campus. Federal Institute of Education, Science and Technology of Rio Grande do Norte.
Keywords: *Occupational Safety, Health Administration, risk maps, Engineering planning*

Date of Submission: 08-06-2024 Date of Acceptance: 21-06-2024

I. INTRODUCTION

Risk analysis or management can be defined in the context of occupational safety as a process that seeks to identify, qualitatively or quantitatively, threats to worker health within the work environment, with the aim of minimizing them, containing them and avoid them. Subsequently, according to Hubbard (2009), the coordinated and economical application of resources is necessary to enable these actions related to combating the impact of undesirable events.

One of the possible tools for risk management are risk maps, which were defined by Mattos (1994) as a graphic presentation in the form of a table of a set of factors present in the workplace, capable of causing harm to workers' health. According to the regulatory standard referring to the internal accident prevention committee (NR-5), recording the perception of workers' risks through a risk map is an attribution of the Internal Accident Prevention Committee (CIPA) with the advice of the Specialized Service in Safety and Occupational Medicine (SESMT).

Although risk maps objectively point out threats to workers' health, they also present some difficulties in their formulation, understanding and reading. As also presented by Mattos (1994), these difficulties occur due to limitations in terms of their theorization, ordinance and methodology. Furthermore, the difficulty regarding understanding and locating risk groups by workers could be mentioned here.

In this work, a proposal is presented to complement the risk mapping methodology, through three-dimensional modeling of the work environment so that the places where the work activity is being carried out can be consulted and risk groups can be identified there. in a direct and punctual manner, enabling workers to have a more precise view of risk points.

II. RISK MAP

The risk map is the graphic representation of the risks of accidents in different workplaces, whether or not inherent to the production process, easy to view and posted in accessible places in the workplace, for information and guidance to everyone who works there and others. that eventually transit through the location, regarding the main risk areas (SANTOS, 2017).

According to NR-5, recording workers' risk perception through a risk map is a responsibility of the Internal Accident Prevention Commission (CIPA) with the assistance of the Specialized Service in Safety and Occupational Medicine (SESMT) . To achieve this, it is necessary for CIPA to seek information from workers in all production sectors. The risk map is a document created collaboratively.

As also defined by Santos (2017), on the risk map, circles of different colors and sizes show the locations and factors that can generate dangerous situations due to the presence of physical, chemical, biological, ergonomic and mechanical agents.

As previously presented, CIPA has the function of preparing the risk map with the collaboration of all workers and with the advice of SESMT, following the regulations established through ordinance number 25, of December 29, 1994 of the then Ministry of Labor and Employment (BRAZIL, 1994).

Risk groups are defined as derived from chemical, physical, biological, ergonomic and mechanical agents, however the aforementioned ordinance does not present a definition for these groups, only a table in its annex that determines which agents make up the groups, as discussed by Mattos (1994) as a limitation that creates difficulties for CIPA when preparing the maps.

According to NR-5, in Brazil,, risk groups can be classified as:

- Physical risks presented in green are agents of different forms of energy to which workers may be exposed;
- Chemical risks presented by the color red are substances, compounds or products that can penetrate the worker's body through the respiratory tract, or absorbed by the body through the skin or through ingestion;
- Biological risks presented in brown are biological agents that can contaminate or make workers ill;
- Ergonomic risks presented in yellow are any factors that may interfere with the worker's psychophysiological characteristics, causing discomfort or affecting their health;
- Accident or mechanical risks are presented in blue and refer to any factor that places the worker in a vulnerable situation that could affect their integrity, physical and psychological well-being.

Group 1	Group 2	Group 3	Group 4	Group 5
Physical Risks	**Chemical Risks**	**Biological Risks**	**Ergonomic Risks**	**Mechanical Risks**
Noises	Dust	Virus	Intense physical effort	Inadequate physical arrangement
Vibrations	Fumes	Bacteria	Manual lifting and transport of weight	Unprotected machines and equipment
Ionizing radiation	Mists	Protozoa	Requirement of inappropriate posture	Inadequate or defective tools
Non-ionizing radiation	Mists	Fungi	Strict productivity control	Inadequate lighting
Cold	Gases	Parasites	Imposition of excessive rhythms	Electricity
Heat	Vapors	Bacilli	Shift and night work	Probability of fire or explosion
Abnormal pressures	Substances, compound or chemicals	Others	Long working hours	Improper storage
Moisture	Others		Monotony and repetitiveness	Venomous animals
Others			Others	Others

Figure 1: Environmental risk groups

The degree of risk must be indicated through circuits of different sizes, where the smallest one defines the small degree of risk, the intermediate one represents the medium degree of risk and the largest one indicates the large degree of risk. For each work environment, a level of risk is defined and within it are placed the colors corresponding to the risk groups present in the environment. The mapping must be done annually, every time the CIPA is renewed and must be easily accessible to workers, with fixing on the workplace door being recommended.

2.1 Problems and difficulties in implementing and reading current risk maps

The risk map is an element of information and indication for workers of regions at risk for their work activity, as well as a tool for various other documents and work safety programs. Therefore, its clarity needs to be a point of greater prominence and importance for its development. A point of great discussion concerns the location of the elements of each risk group, as, with the current indication where the risk group is represented within the work environment inserted together with the degree of risk, this indication is not objective, giving the worker doubts about where exactly the identified risk group is located.

Due to the risk map being a collective construction tool, it is possible for different teams to find answers and produce different risk maps for the same work environment, as demonstrated by Secchin (2022), thus, the precision in pointing out risk groups risks become important for future CIPA reviews

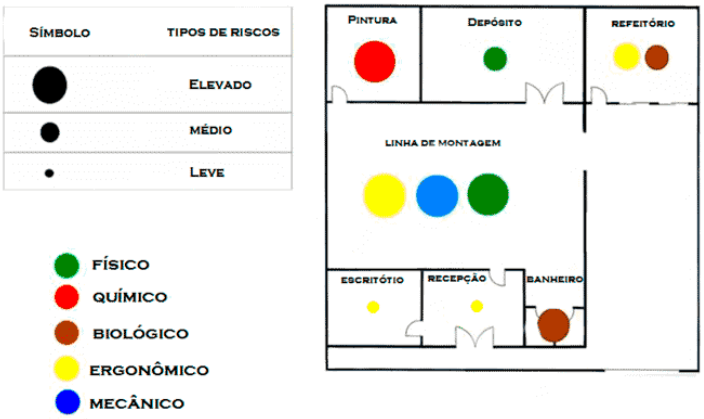

Figure 2: Example of risk map. Source: Crucial Value

Amid this imprecision of the current model, there still exists a corporatist factor as discussed by Zocchio (1993) where technical aspects pointed out mainly by SESMT professionals come into conflict with empirical aspects pointed out by workers, generating points of inconsistency and conflicts that can imply a distortion of the risk map.

The use of three-dimensional environments in virtual reality is increasingly present due to the technological advancement of computers, access to modeling software and the low cost in general (CASTRO, 2014). AutoCAD, BIM, SketchUp, among others, has become common. As well as online platforms to support engineers, architects and the public such as Mooble.

As an initiative to implement three-dimensional interfaces for creating a risk map, we can mention the project developed by the Innovation Center – OSH Management Systems of SESI (CisLab) in the state of Mato Grosso do Sul, which created a virtual model using virtual reality and augmented reality technologies, to immersive simulate risk situations in training and provide innovative ways of studying and recognizing risks in three-dimensional graphic environments (VENDIMIATI, 2020).

III. METHODOLOGY

To prepare the risk map in a three-dimensional environment, we start from the floor plan of the location, using the real dimensions to model the physical space, which we call structural modeling. With the technical visit to the workspace and photos of the environment, the composition of the place is complemented through spatial modeling, with the positioning of furniture, machines our equipment.

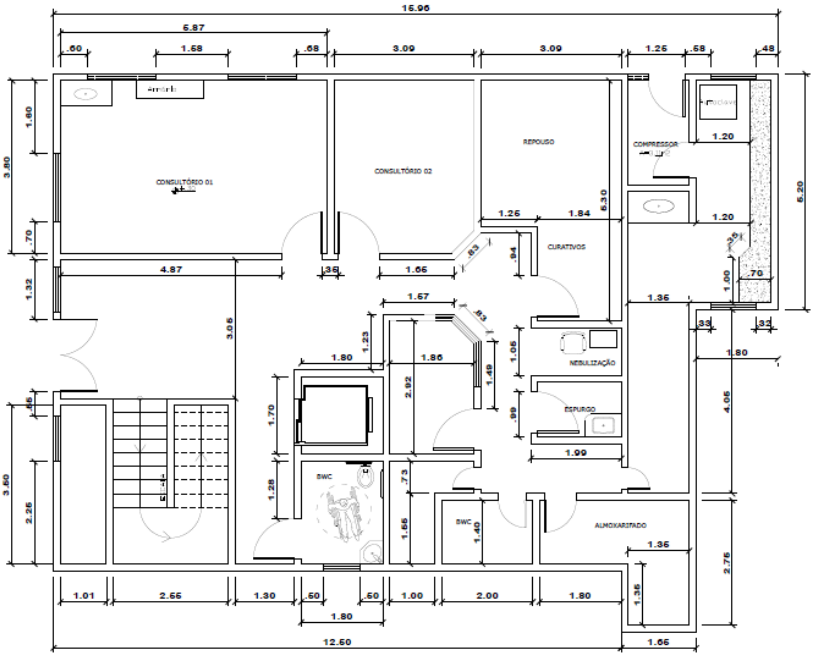

Figure 3: Floor plan of the health sector of the Federal Institute of Education, Science and Technology of Rio Grande do Norte

Once the dimensions of the work environment are defined, the graphical interface is modeled using the team's preferred software. It is recommended to use an intuitive platform with a quick learning curve, so that the focus of the procedure is not on mastering a platform, but on creating a risk map.

Figure 4: Example of a medical consultation room modeled on the Mooble platform

The structuring of the risk map can follow the model previously created by CIPA or based on a new review. Therefore, risk groups must be identified through spheres within the three-dimensional environment and must be located as close as possible (without interfering with visualization) to the object or structure.

Figure 5: Risk map created in a three-dimensional environment

Risk maps created in a three-dimensional environment are thought of as a technology that complements the current model. The proposal here is to maintain the current system based on the floor plan and that in environments where doubts may arise about the locations where the risk group is located, or even where there is a high number of risk groups in the same environment , it is modeled on a three-dimensional platform and presents in detail and precision where the risk groups are located, in order to eliminate possible doubts.

The global risk map, therefore, would be a set of documents in which the conventional risk map (based on the floor plan) was found and all three-dimensional risk maps created were attached to it, where they would be in an easily accessible location. and consultation.

IV. CASE STUDY: HEALTH SECTOR OF THE FEDERAL INSTITUTE OF EDUCATION, SCIENCE AND TECHNOLOGY OF RIO GRANDE DO NORTE

To validate the model presented, a case study was carried out in the health sector of the Federal Institute of Education, Science and Technology of Rio Grande do Norte (IFRN), located on the Natal-Central campus, at Avenida Senador Salgado Filho. , 1559, in the Tirol neighborhood in Natal/RN. With the help of the engineering and occupational safety engineering sector, it was possible to have access to the floor plan (figure 3) and the risk map of the site, so that structural modeling of the site could be carried out

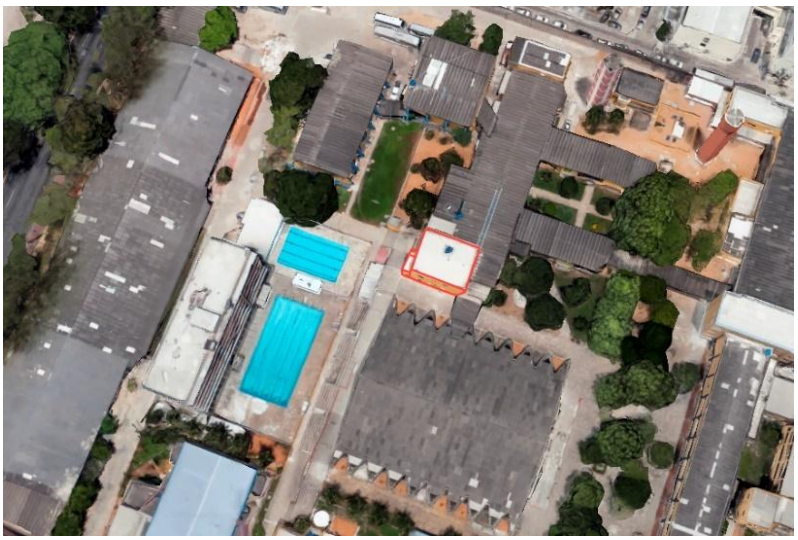

Figure 6: Satellite image of the IFRN health sector

The structural modeling took place by replicating the 2D floor plan on the Mooble platform, and then designing the walls at a height of 2.75m (right foot of the building). After that, the doors and windows of the room were inserted.

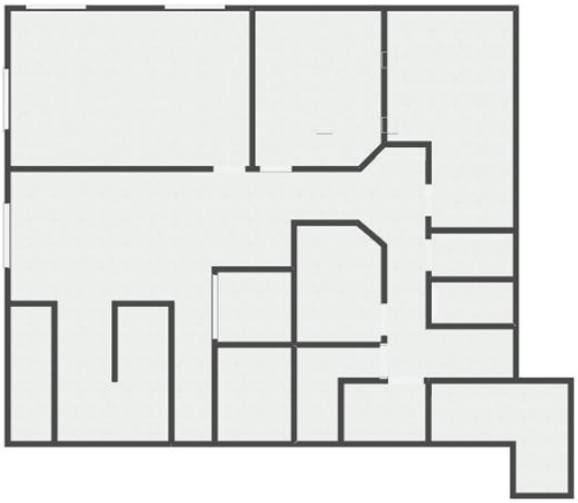

Figure 7: Floor plan of the IFRN health sector modeled on the three-dimensional platform

To carry out spatial modeling, it was necessary to visit the site accompanied by the SESMT team and a member of CIPA, photographs of the site were then recorded and subsequently the furniture and equipment were inserted.

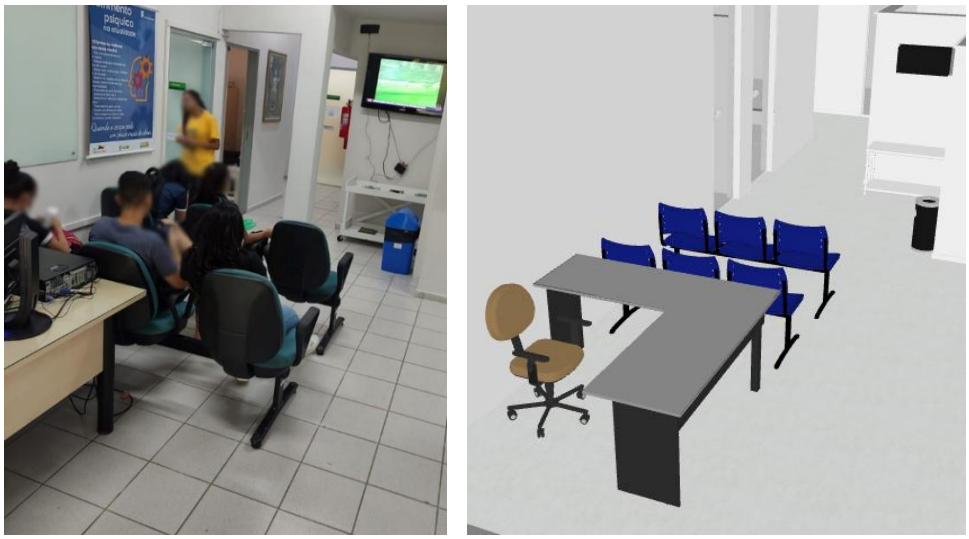

Figure 8: Modeling the reception of the IFRN health sector

V. DISCUSSION AND CONCLUSION

Based on the case study, the current risk map prepared by CIPA with the assistance of SESMT was adapted. The reception and screening clinic represented regions where there was a greater risk to workers, with possible ergonomic, chemical and biological risk agents, but most with a small impact factor. As discussed, the risk groups were represented through a sphere as close as possible to their original location, without compromising visualization.

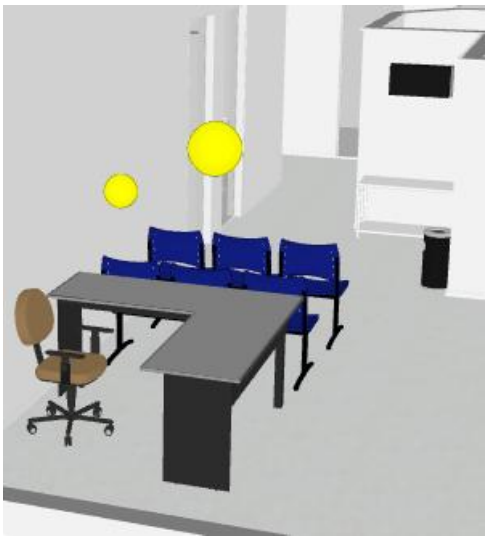

Figure 9: Three-dimensional risk map of the reception.

The three-dimensional modeling method for subsequent mapping proved to be a popular format among students on the technical occupational safety course who sought to replicate the methodology for application in course completion work. The innovative format and its simplified elaboration through new three-dimensional modeling tools allow for greater dissemination for future projects.

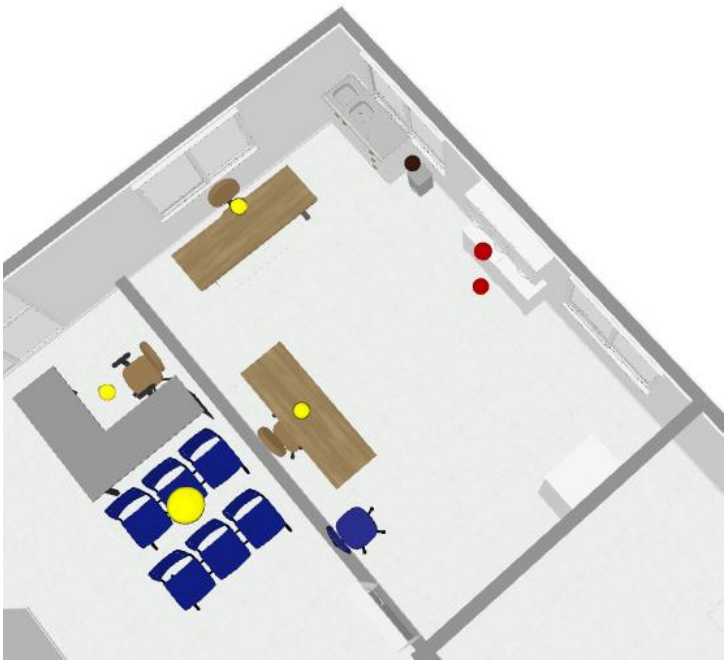

Figure 10: Three-dimensional risk map of the screening clinic..

The risk map generated for the facilities was attached alongside the existing one in the traditional format. It remains fixed next to the main entrance door, an easy-to-view location and is available for consultation by workers, students and other visitors the building may have. The implementation of the global risk map model, based on three-dimensional modeling, was on the agenda at CIPA meetings to be applied to all buildings and other work spaces on the Natal-Central campus.

The risk map system was defined as a mandatory element in regulatory standard number five and established as the responsibility of CIPA with advice from SESMT. Ordinance number 25 of December 29, 1994 defines the methods and standards for preparing the risk map, which functions as a document for the use and protection of workers, as well as serving as the basis for several other documents.

The current model for preparing a risk map is based on the building's floor plan, presenting the risk groups in each environment through circles with the respective colors, however this system brings difficulties in reading, understanding and preparing reviews, as in In certain situations, it is not possible to clearly read the position of the risk group, just as there are complications when the same environment has two sources of the same risk group.

Therefore, a complement to the current model was proposed, with the addition of three-dimensional views of the work environment, so that risk groups can be identified clearly and precisely through modeling in graphical interfaces. In this way, these locations receive a new layer of risk map, making their understanding more tangible for the worker. The global risk map is a document that would maintain the traditional risk map, but would be enhanced with these new views, bringing greater protection and understanding.

REFERENCES

[1]. HUBBARD, D. The failure of risk management: Why it's broken and how I'm fix it . 1 ed. New Jersey: John Wiley & Sons, 2009.

[2]. MATTOS, U. FREITAS, N. Mapa de risco no Brasil: as limitações da aplicabilidade de um modelo operário. Cad. Saúde Pública. Rio de Janeiro, 1994. P. 251 – 258..

[3]. BRASIL. Ministério do Trabalho e Previdência. NR 05 – Comissão interna de prevenção de acidentes. Brasília: Ministério do Trabalho e Previdência, 2021. Disponível em: https://www.gov.br/trabalho-e-previdencia/pt-br/composicao/orgaos-especificos/secretaria-de-trabalho/inspecao/seguranca-e-saude-no-trabalho/ctpp-nrs/norma-regulamentadora-no-5-nr-5. Acesso em: 6 jan. 2023.

[4]. SANTOS, J. Introdução à engenharia de segurança: Mapa de risco. Centro Universitário Fundação Santo André. Santo André, 2017

[5]. BRASIL. Portaria nº 25, de 29 de dezembro de 1994. Dispões sobre modificações na NR 9 - Riscos Ambientais. Brasília, 1994.

[6]. SECCHIN, L. F. Aprendizagem baseada em problemas no ensino de segurança do trabalho. Trabalho de conclusão de curso – Práticas Pedagógicas, Instituto Federal do Espírito Santo. Espírito Santo, p. 27. 2022.

[7]. ZOCCHIO, A. Do cumprimento da legislação ao mapa de riscos ambientais. CIPA, 159:28-29. 1993.

[8]. CASTRO, R. SANTOS, F. FONSECA, I. TAVARES, T. Ambiente computacional baseado em realidade virtual e interação natural para treinamento no setor elétrico. In: Nuevas Ideas en Informática Educativa TISE 2014. Anais. 2014

[9]. VENDIMIATI, C. Inovando na identificação de riscos. Disponível em: http://www.cis.sesims.com.br/inovando-na-identificacao-de-riscos. Acesso em: 06 de jan. 2023.