ISCTE-IUL

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C Company: Time to wake up for safety.

An investigation into the influence of Virtual Reality safety training on the safety of its workers

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Resumo

A evolução dos programas e metodologias utilizadas nas formações em segurança têm permitido aos trabalhadores das Organizações uma melhoria na informação, nos conhecimentos e nos seus comportamentos de segurança. A atenção aos custos que os acidentes de trabalho acarretam para as Organizações ajudou-as a perceber a Segurança como uma questão central e a necessidade de reduzir os acidentes de trabalho. A presente investigação foi realizada em parceria com a Empresa C e visa determinar se a formação em segurança em Realidade Virtual tem uma influência positiva nos comportamentos, conhecimentos e atitudes de segurança, quando comparada com uma metodologia que utiliza narrativa escrita. Procurou-se perceber, também, se esta relação era moderada pelo clima de segurança dos trabalhadores da Empresa C. Para tal, realizou-se um estudo experimental, com 61 trabalhadores das lojas da Empresa C, em que o grupo experimental, de 30 participantes, experienciou uma sessão de formação em segurança em Realidade Virtual, enquanto que o grupo de controlo, com 31 participantes, teve a formação em narrativa escrita. Após a mesma, os participantes tiveram de responder a um questionário e a um teste de retenção com 8 perguntas aplicado em dois momentos, imediatamente a seguir à formação e duas semanas após a mesma. Os resultados não revelaram diferenças entre os dois grupos para as variáveis, não confirmando as hipóteses em estudo. O efeito moderador do clima de segurança também não foi evidenciado. Acreditando na possibilidade destes resultados serem distintos dos obtidos, são apresentadas sugestões para futuras investigações a fim de ultrapassar as limitações encontradas.

Palavras-chave: Formação em Segurança, Realidade Virtual, Comportamentos de Segurança, Atitudes de Segurança, Conhecimentos de Segurança, Clima de Segurança

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Abstract

The evolution of the programs and methodologies used in safety training has allowed Organization workers to improve their information, knowledge, and safety behaviours. Attention to the costs that work accidents entail for Organizations has helped them to perceive safety as a central issue and the need to reduce work accidents. The present investigation was carried out in partnership with the C Company and aims to determine whether safety training in Virtual Reality has a positive influence on safety behaviours, knowledge and attitudes, when compared to a methodology that uses written narrative. We also tried to understand if this relationship was moderated by the safety climate of C Company workers. To this end, an experimental study was carried out, with 61 workers from the stores, in which the experimental group, of 30 participants, experienced a safety training session in Virtual Reality, while the control group, with 31 participants, had safety training in written narrative. Afterwards, the participants had to answer a questionnaire and a retention test with 8 questions applied in two situations, immediately after the training and two weeks after the training. The results did not reveal differences between the two groups for the variables, not confirming the hypotheses under study. The moderating effect of the safety climate was not demonstrated. Believing in the possibility of these results being different from those obtained, suggestions are made for future investigations to overcome the limitations found.

Keywords: Safety Training, Virtual Reality, Safety Behaviours, Safety Attitudes, Safety Knowledge, Safety Climate

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Glossary of Abbreviations

ACT	Autoridade para as Condições do Trabalho
CPU	Central Processing Unit
GB	Gigabyte
GEP	Gabinete de Estratégia e Planeamento
GHz	Gigahertz
HMD	Head-Mounted Display
HP	Hewlett-Packard
ILO	International Labor Organization
IPQ	Igroup Presence Questionnaire
ISCTE	Instituto Superior de Ciências do Trabalho e da Empresa
PPE	Personal Protection Equipment
OSCI	Organizational and Safety Climate Inventory
OSH	Safety and Health at Work
RAM	Random Access Memory
USB	Universal Serial Bus
VE	Virtual Environment
VR	Virtual Reality

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Introduction

Historically, since the time of the introduction of machines in the daily work of the human being and the resulting need for the worker to be more productive, the number of work accidents and occupational diseases has increased dramatically (Reis & Ravara, 2013). These consequences, mostly felt at the time of the Industrial Revolution, meant that there was a constant need to control these accidents because of their economic impact and on worker productivity (Barling & Frone, 2004).

In the twentieth century, the notions related to the importance of safety in organizations and the safety behaviour of their workers was gaining ground as a concern of researchers. It was from the consequences of the two World Wars and their effects that the issue of worker safety was most debated, leading to the creation of first aid services and minimum hygiene conditions for them (White, 2009).

Over the last century, the intense search for improvement in working conditions, added to technological advances, changes in the design of work and the use of protective equipment, have made workplaces safer, resulting in a reduction in work accidents (Hofmann, Burke & Zohar, 2017).

Regarding the causes that lead to a work accident, some research has pointed to several factors as determinants for those events like the human error (Kirschenbaum, Oigenblick & Goldberg, 2000; White, 2009) among other contextual factors. In the first study, Kirschenbaum, Oigenblick and Goldberg (2000) pointed the human error and individual failure as the main causes of work accidents, highlighting the lack of safety attitudes, lack of control over context and environment and poor knowledge of procedures and safety rules. White (2009) is more specific and estimates an 80% of work accidents to be caused by human error. Here, the author adds that errors may be related to physiological and psychological (e.g. lack of concentration, tiredness, forgetfulness, distractions), organizational and personal issues (e.g. lack of knowledge, confusion, overwork, inaccurate risk perception), or even with deliberate actions of the worker, (e.g. behaviour with an intent to cause harm or disrespecting the norms deliberately). One of the biggest work-related disasters in the world associated with human error was precisely the 1986 Chernobyl Plant Accident, which, according to White (2019), was precisely due to workers' lack of rigor in complying with safety rules.

Initially, human error was studied as the main predictor of work accidents. In the first decades, they were analyzed as the main causes of accidents at work, the abilities, and skills of workers, as well as personality and emotional characteristics. It was only later that a more

holistic view of the integrated worker in a given environment began to be adopted with certain conditions, a moment from which the work hours, breaks and the worker's exposure to risks began to be studied, as enhancers of less safe behaviours and as risk factors for themselves (Hofmann, Burke & Zohar, 2017).

Although the first literature focused on human error as the main determinant of work accidents, the truth is that human beings can also build a safer work environment. Focusing Jorgensen's (2016) investigation, he acknowledged that the statistics of work accidents in companies, have been decreasing over time, in part because of the human being himself, which allowed the development of the legislation in this sense, making the employers responsible for the safety of their employees and holding employees accountable for their own safe behaviours.

The creation of safety training Programs has made employees more informed about how important it is to follow the rules and how to follow safety behaviours. It was also in this sense that attention began to be given to work accidents as being explained not only by human factors but also by other social and contextual factors (Jorgensen, 2016; Barkhordari, Malmir & Malakoutikhah, 2019). While Jorgensen's (2016) study highlight some contextual factors like the information given to the worker, which may be too general or extensive, the relationship of dependence of different actors for the accomplishment of the task and other factors such as the clients' demands, the need to increase productivity or time pressure, the investigation of Barkhordari, Malmir and Malakoutikhah (2019) points other factors as work-family conflicts or the effort-reward imbalance.

Worker's safety performance is not only related to worker safety behaviours, but also to the organization's own safety outcomes (Christian, Bradley, Wallace & Burke, 2009). This authors state that the main difference between these two concepts is that safety behaviours refer to less tangible aspects than safety outcomes because the outcomes can be considered as the reflection of the workers' behaviours and also because they are related to the official number of accidents, injuries or even deaths.

The growing concern of organizations with the safety indicators of the work and the activity began to gain greater expression in scientific research since the 1970s and 1980s, when the terms *safety culture* and *safety climate* were firstly used (Guldenmund, 2000), as a set of values shared by the organization and its members, regarding safety behaviours, knowledge and attitudes.

Nowadays, the management of major organizations has been more concerned with the safety indicators of its workers and with the outcomes of the organization in this field. Here,

organizations' safety policies and practices, such as the Safety Training Programs, are fundamental to the development of workers' knowledge and behaviour (Neal & Griffin, 2004).

The following investigation was proposed by a company whose real name won't be revealed to guarantee the confidentiality of its data, a well-known retailer, and intend to study how a work accident during safety training can influence safety behaviours, attitudes, and knowledge of those workers. For that reason, the company will be named with the fictitious name of "C Company".

Despite the fact that C Company don't have a high number of work accidents statistics (regarding other retail companies), they wanted to study more effective safety training methodologies in increasing the safety behaviours and procedures used and, consequently, reducing work accidents. The relationship between the work accident and the research to be conducted is precisely the use of the work accident as a result of a training session and because work accidents can be related with low safety behaviours, which is intended to be counteracted.

Given C Companys' goal of developing its Training methodologies, the research question that must be answered with this investigation is: Does safety training in Virtual Reality [VR] increase the safety knowledge, behaviours and attitudes in C Company workers, and is this relationship moderated by the safety climate?

Considering the results obtained in this investigation, the objective will be to study if a new safety training Model using VR can be implemented and if it would be more effective for the increase of employee safety behaviours, safety attitudes and safety knowledge than the conventional written narrative methodology. Therefore, it is intended to update the Training methodologies used by C Company, regarding its safety policies. The aim is to determine the influence of safety training in VR, through the experience of a work accident, on these variables and whether this relationship is moderated by the effects of the existing safety climate and shared by C Company employees.

Theoretical Background

Work Accidents

The high number of work accidents occurring annually in Portugal makes it one of the countries with the highest rate of work accidents in the European Union, when considering the percentage of active population. In 2017, as the most recent report indicates, this number reached 209 390, of which 140 were fatal. Detailing these numbers, 143 425 of those involved lost workdays, with an average number of 37.9 workdays lost (Gabinete de Estratégia e

Planeamento [GEP], 2018). This report also shows that the retail sector, was one of the sectors with the highest number of work accidents, totalling 33 247 evidences (GEP, 2019).

By 2019, up to July, the number of work accidents in Portugal that resulted in the death of the worker was already 46 (Autoridade para as Condições do Trabalho [ACT], 2019). The high number of work accidents show the urgency of taking preventive measures and taking on safety policies that reduce not only work accidents but also all the consequences that derive from them for the injured people and for the organization. It also reveals the need to modify work through the transformation of work processes, through the organization of work and its conditions, experienced by those who perform it (Valverde, 2007).

Despite knowing the data regarding the number of work accidents and the associated economic costs, these estimates still cannot explain the overall physical and psychological suffering, that results from the injuries (Barling & Frone, 2004). The authors state that, in addition to the injured worker, his or her family and caregivers also suffer, emotionally and psychologically.

Returning to the work accidents, they can be defined as a low frequency event that is typically triggered by unintentional errors (Neal & Griffin, 2006). It occurs during the worktime and in the work environment, meaning that an injury is work-related if an event during work causes an aggravation of a pre-existing health condition in the worker (Bureau of Labor Statistics, 2016). According to point a) of the 2nd of Article 8 of Decree-Law no. 98/2009 (Diário da República, 2009), on work accidents, "workplace" means any place where the employee is by virtue of his or her work and where he is directly or indirectly subject to control by the employer.

The definition in Article 8 of Decree-Law 98/2009 (Diário da República, 2009), argue that a work accident produces directly or indirectly an injury, disturbance, or disease in the worker, which is associated with loss of functionality and work ability. Following this definition, it is always associated with a loss for the worker in his ability to work, or in any body function. Some of these consequences are the loss of consciousness, days away from work, medical treatment or, in the worst scenario, death.

To deepen the consequences of work accidents, it is important to clarify the differences between the occupational illness and occupational injury, both as possible consequences of work accidents. This is important because both are often discussed together as the same thing, which is wrong. According to Bureau of Labor Statistics (2016), while the occupational injury is related to the wounds or damages in the workers body caused by a specific event in the work environment, the occupational illness represents any condition or disorder caused by the

continuous exposure to factors associated with employment, such as chronic illnesses or diseases induced by ingestion, absorption or direct contact with those factors.

In Barling and Frone (2004) perspective, the impacts of a work accident can be seen in two perspectives: the lack of productivity of the injured worker in the workplace, meaning that this worker will have his/her productivity decreased; and the impact on the living contexts of the injured people and their contribution to their families and communities.

As above mentioned, one of the causes of work accidents is the unsafe behaviour of workers as well as their lack of safety knowledge (Christian, et al., 2009). In their research, the authors demonstrated that motivation and safety knowledge have a positive influence in employees' behaviours and, in turn, the frequency and incidence of work accidents.

In the early beginning, as there was a serious deterioration in working conditions at the time of the Industrial Revolution, it was necessary to start considering the health of workers (Reis & Ravara, 2013). This historic milestone for humanity led to the creation of Entities and Commissions whose focus was precisely on safety indicators and outcomes. As an example, and addressing a topic which had become a top priority, it was because of the importance of preventing work-related accidents and illnesses, associated with costs for the worker, for organizations and for the economy itself of the countries, that the International Labor Organization [ILO] was established in 1919 (Reis & Ravara, 2013). The creation of this organization was very important, because it brought much more attention for the safety outcomes, and its mission is to set labour standards, and to develop policies promoting decent work conditions for all the people (ILO, 2020).

In Portugal, the evolution of the legislation on work accidents came from the Law No. 83 of July 24, in 1913, being the first to legislate specifically on liability for work accidents (ACT, 2020a). Later, with work accident prevention measures beginning to gain expression throughout the country, in 1959, the Occupational Health and Safety Commissions were created, whose work focused on the implementation of campaigns and the creation of the Hygiene and Safety at Work Office. The focus of this Body was the development of research and Programmes that would allow the dissemination of techniques for the prevention of work accidents and illnesses (ACT, 2020a).

With the historic events of April 25th in 1974, the Ministry of Labor emerged, which in turn gave rise to the Directorate-General for Labor, which is responsible for the development of a set of activities and actions for risk awareness and protection against work accidents (ACT, 2020a).

Only in 1978, through Decree-Law No. 47/78, the first specific measure to empower those entities emerges making the Labor Inspectorate independent of the political power, getting closer to the principles defended by the ILO (ACT, 2020a). Yet only in 1986 were made the first diplomas covering workers in a safety and health regulation (ACT, 2020a). It was in 1991 that the different Companies signed the first Occupational Safety, Hygiene and Health Agreement, which would give rise to the main foundations of Occupational Safety and Health legislation in Portugal, subsequently updated in 2001. The second half of the 1990s allowed occupational health and safety to begin to be seen as an important organizational function, with its own technical and human resources that began to demand new responses and the restructuring of workers' activities (Neto, 2011). Finally, the year of 2007 represents the beginning of ACT through Decree-Law No. 326-B/2007, replacing the General Labor Inspectorate. ACT, until now, is responsible for promoting health in working contexts, improving working conditions and supervising the standards and their compliance in terms of safety and health at work (ACT, 2020a).

The mission of the Ministry of Labor, Solidarity and Social Security is related to the planning, execution and evaluation of employment, vocational training and working conditions policies, as well as policies to support families, the inclusion of people with disabilities, to fighting poverty and to social inclusion (Governo da República Portuguesa, 2017).

The prevention of work accidents should start by the recognition of the employers of the need for their companies to comply with legal requirements, always taking into account the specificities and risks associated with each activity and, subsequently, implementing preventive measures and define good practices to prevent these accidents and illnesses arising from professional activities (Freitas & Cordeiro, 2013). As regards preventive measures and good practices, the following stand out: 1) information measures on the risks associated with the development of their activities; 2) training measures, related to training the workers on safety procedures to be followed and on good practices to be adopted in view of the risks of the activity; and 3) medical surveillance measures, which aim to preventively promote workers' health surveillance (Freitas & Cordeiro, 2013). As these authors say, countries have their workplace supervisory bodies that support workers in the event of a work accident. In Portugal, this entity is ACT, which, when there is a work accident, besides inspecting the site, conducts surveys to understand the causes that led to that accident. ACT's activity is not limited to the events when work accidents occur, but also to ensure control of compliance with the norms and the promotion of occupational safety and health when complaints are made by workers of

an organization or by Workers' Representatives for Safety and Health at Work [OSH] (ACT, 2020b).

Another reason that shows the importance of the prevention of work accidents is evidenced by the efforts made by the company's top management in which they try to follow the ergonomic principles in the design and use of the equipment and with a greater control orientation in the workers performance in order to reduce the number of accidents (Barling & Hutchinson, 2009). Following the study of these authors, the evidence has shown that the managers play an important role in the workers attitudes, behaviours, and commitment to the safety climate. From a safety management perspective, the workers' health is an important organizational goal, and it can be considered as important as productivity. This means that a positive attitude of the management towards safety policies will increase the probability of safety benefits and a decrease in work accidents (Neal & Griffin, 2004). Some examples of this positive attitudes are performance appraisal, positive reinforcements and training programs that provide the workers the knowledge and skill to follow the correct safety procedures. Summing up, leaders are determinant in the definition of the policies and procedures towards safety, helping to create a positive safety climate (Neal & Griffin, 2004).

Safety Behaviours

Making a brief definition of safety behaviours, they can be resumed as behaviours of employees belonging to an organization that promote or consider the safety and health of employees, customers and the general public (Burke, Sarpy, Tesluk & Smith-Crowe, 2002). In this definition safety behaviours help the workers' to be more conscientious of the importance of the performance of their activities in safe conditions.

Safety behaviours can be seen in two different ways, in a two-dimensional model of safety performance: The first, *compliance behaviours*, include the compliance of safety regulations, the following of the safety procedures, and the use of appropriate equipment. The second type of safety behaviour, defined as *participation behaviours,* does not directly influence the organizational safety, but supports safety in the wider organizational context. One example of this second type of safety behaviour is the voluntary attendance to safety meetings of training (Neal, Griffin & Hart, 2000; Neal & Griffin, 2004).

Another demonstration of safety participation behaviour by an organization is the promotion of safety through the Health and Safety Committees, where workers and managers act to reduce work accidents (Turner & Parker, 2004). These Programs have already proven to

reduce the number of work accidents and their resulting injuries. When specifically addressing safety training focused on workers' behaviours, these Programs can be critical for workers to learn to ask themselves about the safety of their behaviour, to define safe goals and to support co-workers, through feedbacks of each other's actions and behaviours, and this feedback must be temporal (Health and Safe Authority, 2013).

One of the most important and studied theories of human behaviour is Ajzen's Theory of Planned Behaviour (Ajzen, 1991). According to it, the behaviour is influenced by: attitudes towards the behaviour of the worker himself; the beliefs and norms imposed by society, such as the behaviour of co-workers and supervisors; and perceived behavioural control on the part of the worker, these three being associated with the individual's feeling of self-efficacy and the perceived difficulty of the task. According to Ajzen (1991), the relationship between these three variables and the person's behaviour is mediated by the behavioural intention, the latter being a motivational factor.

This theory has been used in different contexts to enhance the greater involvement of workers in safety behaviours (Loosemore & Malouf, 2018). An example is a study carried out in the context of aviation, where it has been shown that 50% of violations of safety procedures in an aircraft maintenance are explained by the combination of behavioural intentions, group norms and workers attitudes (Fogarty & Shaw, 2010).

The relationship between work situations, behaviours and experience with work accidents influences the workers' safety behaviours. When workers neglect the importance of complying with safety standards and therefore engaging in risky behaviours, they are more at risk of having work accidents, compared to those who follow the safety procedures. This is because, in many situations, the risks are underestimated by the workers (Rundmo, 1996). For a safer work environment that promotes the minimization of risk factors for workers and helps them engage in safer behaviours, Mullen, Kelloway and Teed (2017), argue that Safety Training Programs are important as well as other measures like the maintenance of work equipment. These authors also point to the establishment of rules regarding the promotion of safety behaviours.

In addition to the influence that individual experiences have on safety behaviours, there are several other factors that play an important role in the development of safety behaviours by employees. The literature has indicated as some of the main predictors of behaviour and safety performance, the safety climate (Griffin & Neal, 2000; Neal & Griffin, 2002), employee risk perception (Rundmo, 1996) and knowledge and motivation for safety behaviours (Neal, Griffin & Hart, 2000). In other sense, the study developed by Bronkhorst (2015), has indicated that the

demands of the job, such as the amount of work, the poor work-life balance and job insecurity lead to a decrease in physical and psychosocial behaviour of the employees.

One different investigation tried to assess the relationship between the tenure of workers in an organization and absenteeism due to occupational injuries. The results found that more inexperienced workers tend to engage more in risky behaviours and less in safe behaviours when compared to workers who have been there for over a year (Morassaei, Breslin, Shen & Smith, 2012).

Another investigation that sought to better understand the history of safety behaviours concluded that they are influenced and determined by the safety climate in the organization. In this sense, safety climate has found to be an antecedent of individual behaviour, as safety behaviours are mostly determined by the knowledge, skills and motivation to perform those behaviours (Neal, Griffin & Hart, 2000; Neal & Griffin, 2004). This set of behaviours focused on employee safety, when valued on a group and organizational level, strengthen the safety climate.

The use of individual Personal Protection Equipment (PPE) and the training for their use, when viewed as a priority, may be indicative of the importance that the organization attributes to the safety behaviours of its employees (Burke et. al, 2002). This study indicates that industry attaches great importance to the use of such equipment and believes that safety training is essential for the development of safety knowledge and procedures. Even so, it is advisable to use the equipment with care so that its action is preventive and does not harm the worker either in the conditions of execution of the work, as in the efficiency and comfort in the execution of tasks (Associação Portuguesa de Segurança, 2020).

Considering the importance that Safety Training Programs have in educating workers and changing their behaviours (Mullen, Kelloway & Teed, 2017), the first hypothesis (H1) to be tested in this research is that safety behaviours are higher in employees receiving VR Safety Training than those who receive Safety Training in a written narrative.

Safety Attitudes

The attitudes toward safety must be differentiated from perceptions of safety climate because attitudes can be influenced by individual differences and environmental factors. This means that it is most likely to be less agreement about attitudes than in relation to perceptions of safety climate (Neal & Griffin, 2004). About these individual differences, the authors say that there are some mechanisms that have been associated with a higher prevalence in

involvement in work accidents. Lapses, mistakes, and lack of motivation can reduce concentration and safety compliance.

The distinction of a positive or negative safety attitude can be given by the goal of that attitude. Attitudes toward promoting safety behaviours, complying with safety rules and the reduction of risky behaviours to reduce the work accidents are examples of positive safety attitudes. Conversely, attitudes toward the opposite, workers performing their jobs without any concerns about safety compliance, and the involvement in risky behaviours to get the work done, are examples of poor safety attitudes (Rundmo & Hale, 2003).

As the literature states, it is not only safety attitudes that can impact the number of work accidents in an organization, but also workers' previous experience in work accidents can play a major role in developing their own safety attitudes workers (Gharibi, Mortazavi, Jafari, Malakouti & Abadi, 2016).

Concerning attitudes within an organization, they are also related to the priorities set by its managers. If productivity overlaps and is a criteria of effectiveness for the organization rather than the existing safety indicators themselves, then safety attitudes will tend not to be positive, while if the worker safety is an organizational goal, the safety attitudes will tend to be more positive and in line with the preventive measures at work (Rundmo & Hale, 2003).

Efforts made by an organization to improve its safety climate can positively influence employees' perceptions of safety at work. Consequently, positive attitudes towards safety can lead employees to become more motivated in adopting safety behaviours and conforming with safety procedures (Lee, Huang, Cheung, Chen & Shaw, 2018).

The presence of a strong safety culture in an organization and the specification of certain measures to stimulate the safety of workers is crucial for the development of safety attitudes by the workers themselves. Some measures such as daily supervision of work, reinforcement for compliance with the rules or the use of safety equipment by an owner or a team leader are examples of actions that can stimulate an increase in the safety attitudes of the workers of a that Organization (Comissão Europeia, 2016).

Organizations' efforts to increase safety attitudes can be evidenced in some ways. One of them, according to Mullen, Kelloway and Teed (2017), may be through the establishment of safety rules for workers that must be complied, leading to an increase not only in safety attitudes, but also in the workers safety compliance and participation behaviours. However, in this study, the authors added the transformational leadership variable as a Moderator of this relationship, resulting in a positive moderation. Prior to that, Clarke (2012), in her meta-analysis, had described participation behaviours as being more related to a high-confidence,

transformational leadership style between leader and subordinates, and compliance behaviours as more associated with a transactional leadership with better monitoring of leaders to the work of subordinates.

Also, addressing the relationship that safety attitudes have with these variables, the research by Kao, Spitzmueller, Cigularov and Thomas (2019), used managers' safety attitudes as a Mediator variable between workers' knowledge and their safety behaviours. Here, the results revealed that, in the presence of positive safety attitudes of managers, workers' safety knowledge positively influences their behaviours. Once again, research has proven that are the attitudes of top managers that influences the most the workers' behaviours and the outcomes on the number of work accidents (Rundmo & Hale, 2003).

As stated, the mandatory use of Personal Protective Equipment (PPE) by workers, and its use by a manager or a team leader also shows a strong presence of safety attitudes in organizations. Arguing in this regard, a study in the agriculture sector, one of the sectors showing the highest number of work accidents, developed by Lekei, Ngowi and London (2014), showed that in Tanzania, the lack of training and safety knowledge of associated with the low use of Personal Protective Equipment lead to an increase in work accidents and the number of injuries to farmers. In fact, beyond this conclusion, the farmers themselves admitted that if they were engaged in more safety training sessions, they would have fewer work-related accidents and their own safety attitudes would increase. Even so, this idea is not shared throughout the literature, as, with a contrary argument, arises the research of Elkind (1993), also in the context of agriculture, which states that safety knowledge is not necessarily correlated with workers' safety attitudes or their behaviour. The author adds that if this knowledge is not related to work attitudes, then safety attitudes themselves cannot be associated with farmers' behaviours.

Although the relationship between people's attitudes and their behaviours has been recognized by most of the literature, a few examples were given, showing that safety attitudes don't have only an individual impact on the behaviours of each worker, but also in the group and in the leaders. They also affect managers' own decisions for their organization and even the explicit safety priorities and policies of those organizations (Rundmo & Hale, 2003).

One more time, safety training has demonstrated to be important not only in managers perspectives to reduce costs with work accidents, but also in the worker's perspectives too (Lekei, Ngowi & London, 2014). Bearing in mind the relationship between the safety programs, as exemplified by the training programs in these themes, described in the literature, and the impact that safety-promoting policies can have on the development of workers' safety

attitudes, the second hypothesis (H2) that it is intended to prove is that safety attitudes are higher in employees receiving VR safety training than those who receive safety training in a written narrative.

Safety Knowledge

The practical notion of following protocols and safety standards does not prevent injuries or accidents from occurring, although Christian, et al. (2009), point to safety knowledge as a direct determinant of safety behaviours, as safety enforcement is a precondition for the promulgation of safe behaviours.

The workers' knowledge of the work and the workplace are crucial for clarifying the risk factors inherent to the activity, helping this knowledge to improve safety and health management at work (Valverde, 2007). To know the work, a deeper analysis of the activity and all its conditions is required. Incidents, risk factors, workload, relationships with work teams are variables that contribute to the knowledge of the activity and these are conditions that change and influence workers' behaviour (de Keyser, 1988). In what concerns to risk factors, the typology of those has also changed in recent years, as the first studies focused on risk factors for the physical health of the worker while, at the present, investigators are approaching more to another risk factors that may bring consequences on the psychosocial functioning of the worker (Valverde, 2007).

To have a more detailed knowledge of the activity and its conditions, it is necessary to be practiced. It is this practice and the level of involvement that the individual has in the interaction with the working conditions, which leads to the knowledge of the risks of the activity and the specificities they have (Zhang, Suo, Chen, Liu & Gao, 2017). As evidence, the investigation of these authors, who used the simulation of a fire situation in a virtual environment as a methodology for safety training, helped to realize that the knowledge of safety increased, as well as the knowledge of behaviours to adopt in these situations.

Understanding the concept of knowledge associated with safety procedures is critical to develop a management orientation towards practices that promotes safety behaviours in workers and, consequently, reduces the negative outcomes of unsafe behaviours, with particular emphasis on companies that involve work situations that imply a greater number of risks to the worker (Burke & Sockbeson, 2016). Safety knowledge is therefore a key resource for workers to perform their duties while reducing the risks of their behaviours (Smith, Jordan & Wallace, 2016).

The safety climate in an organization should encourage safe practices and procedures, whether through reward mechanisms or social exchange principles (Christian, et al., 2009). In their turn, Fargnoli, De Minicis and Di Gravio (2010) underline that access to safety information and knowledge is relevant to decision making at any organizational level, with an effect on safety costs reduction and in the safety climate growth. These changes will have a positive impact on the prevention of work accidents.

Neal, Griffin and Hart (2000), demonstrate that a strong safety climate in an organization can have positive effects on workers' knowledge and motivation for safety and that both have a positive impact on one's attitudes and safety behaviours. Thus, according to the same authors, more effective interventions and training can be designed to improve workers' knowledge and attitudes.

Changes in safety knowledge, based on workers' experiences, is one of the essential processes in knowledge management, in which the organization must identify the processes and competencies needed to perform the activity. The existence of this knowledge is related to best practices in the workplace and compliance with safety procedures (Fargnoli, De Minicis & Di Gravio, 2010).

With regard to factors that may contribute to safety practices, Christian, et al. (2009), concluded in their meta-analysis that several measures can be considered to improve workplace safety, such as the selection of workers to be trained to maximize safety motivation and safety knowledge, which in turn leads to safer behaviours and fewer work accidents. Once again, managers' commitment to these measures tends to significantly increase safety performance and, in turn, to reduce work accidents.

The development of safety knowledge in an organization is due to the interaction between workers and workers with their own management. The fact that the workers are profoundly aware of their own activities, the constraints and difficulties they encounter in the development of their tasks, make them an active part in the construction of knowledge within the organization and in the decision-making that managers will have to make about priorities regarding the implementation of measures and training that promote occupational safety and health (European Commission, 2016).

Regarding to the relation between safety knowledge and leadership styles, the literature shows that there are some differences in the decisions and in what is valued the most in an organization, depending on the leadership style. In this sense, Jiang and Probst (2016), studied those leadership styles and their relationship with safety knowledge, safety motivation and safety participation. The authors demonstrated that safety knowledge and safety motivation are

positively related to safety participation, establishing a relationship between transformational leadership and safety participation. This type of leaders is useful to improve the safety participation behaviours. They also reinforce the safety knowledge-participation relationship in those leaders, whereas a passive and unfocused safety leadership weakens the safety knowledge-participation relationship (Jiang & Probst, 2016). This study has practical implications as leaders may act as role models to prioritize safety knowledge, encourage safety meetings and trainings, implement safety proceedings, and make suggestions to promote employees brainstorming sessions to help resolve safety issues.

In this sense, and specifically regarding the results of some literature (Neal, Griffin & Hart, 2000; Christian et al., 2009), the third hypothesis (H3) is that safety knowledge is greater in employees receiving VR safety training than those who receive safety training in a written narrative.

Organizational Climate

In what concerns to organizational climate, it is commonly defined as the overall meaning of the aggregation of individual perceptions about the work environment (James, 1982). Despite of that, it is important to understand that the term *climate* remains individual regardless of the agreement of other individuals' perceptions (James, et al., 2008). In what concerns to these individual perceptions it is possible to define Psychological Climate as well as the individual descriptions of organizational practices (Joyce & Slocum, 1982). In fact, the distinction between the psychological climate and the organizational climate has been well studied in the literature, as Silva (2008) points out. Still, something in which both constructs seem to coincide is in the idea that both are based on perceptions.

Moran and Volkwein (1992), in their work, said that the biggest differences between the constructs of organizational culture and organizational climate live in the fact that the second is more related to the workers perceptions, attitudes and behaviours, while the organizational culture is about the shared values and less tangible aspects of work. In other words, it is possible to state that the climate refers to a more superficial level than the culture.

The use of qualitative methodologies to study the organizational climate has not been very common contrary to what happens with the organizational culture. In contrast, the use of quantitative methodologies, such as the questionnaires, seems to be more adequate sources of data collection (Silva, 2008). The author says that the use of a greater diversity of

methodologies to study the organizational culture is related to the impossibility of the questionnaires to access some aspects of the organizational culture.

Regarding the characteristics of the organizational climate, the literature has indicated that there is an agreement that it is shared and multidimensional, distinguishing between different types of climate, such as "Creative Climate", "Safety Climate" or "Innovative Climate" and that the climate is relatively stable and works as a frame of reference for employee behaviour (Silva, 2008). For the purposes of the present investigation, the climate that will be further studied is the safety climate.

Safety culture and safety climate

Although the origin of the studies about safety culture and safety climate is similar, it is possible to associate the safety culture with an attempt to explain different work accidents throughout history (Silva, 2008). The existence of an organizational culture is fundamental for the survival of organizations, for the way it guarantees the behavioural regularity of its actors, a fundamental condition for the coordination and predictability of the organizational system. This predictability is also explained by the fact that organizational culture is relatively stable over time (Cunha, et al., 2014). Accordingly, to the authors, relatively to safety climate, this construct had its origin to explain different safety levels in the organizations through the comparison between organizations with a high rate of work accidents and organizations with a low rate of work accidents.

Another aspect that differs in the study of safety culture and safety climate, as early mentioned, is the methodology used. In safety culture studies, as stated before, researchers often use qualitative methodologies like semi-structured interviews or observation while in safety climate studies, the quantitative methodologies such as scales or questionnaires are more appropriate (Silva, 2008). Despite of being different, there are some authors that still use both as almost synonyms.

It may take longer to modify the safety culture than the safety climate, since for the safety culture it may be necessary to modify some mental processes of the members of the organization on safety issues that are at the subconscious level (Lee, et al., 2018).

In what concerns to safety climate, its definition is about two main aspects: a) individual perceptions about the safety in the organization and b) with influence on safety-oriented behaviours of the workers (Silva, 2008). Safety climate is the shared perceptions of the workers about the values, norms, procedures, and safety practices of a certain organization and is a

result of the manifestation of safety culture (Griffin & Neal, 2000; Zohar, 1980; Zohar, 2000; Silva, 2008).

Safety climate is an important construct because it is an antecedent of safety-related motivation of the employees which, in turn, influences safety behaviour and safety outcomes of the organization (Neal & Griffin, 2004). Measures taken to make the workplace safer may be the main objective of improving an organization's safety climate (Lee, et al., 2018).

In other investigations, evidence has emerged that a positive safety climate is significantly correlated with *participation* behaviours in safety-related issues (Neal, Griffin & Hart, 2000; Clarke, 2006). Further detailing this relationship, Christian, et al., (2009), demonstrated in their meta-analysis that it is the safety climate in an organization at the group level that has been evidenced more as a predictor of safety behaviours and performance than the individual climate itself and when perceptions are not shared among employees. This investigation also highlighted the positive consequences that safety training and the increased commitment of managers to safety issues can have on the organization's own safety outcomes.

Neal, Griffin and Hart (2000), have changed the status of the safety climate variable, using it as a mediator, and have proved that this mediates the relationship between organizational climate and safety practices in the organization. These authors also demonstrated that the safety climate has a direct effect on workers' participation in safety behaviours. Similarly, Clarke (2012), used the safety climate as a mediator variable in the relationship between the type of leadership, transactional or transformational and the safety behaviours of participation and compliance. The results of the study revealed that the safety climate partially mediates the relationship between transactional leadership style and safety behaviours, with a direct effect of this leadership style on compliance behaviours, but only an indirect effect between this leadership and the participation behaviours.

Although there are processes that are only verified in an individual or group level in the organization, the positive safety climate affects the work both individually and at the group level (Turner & Parker, 2004). This phenomenon can be explained as safety climate involves many dimensions that are related to a more general level, like the impact of the communication on safety, or to a specific level, the individual's safety attitudes.

The research argues that, while there is individual variability in perceptions about the safety climate and the interpretation of organizational rules, it is expected that individual employees as members of the organization will develop a consensus on what is most valued and the most desirable behaviours to have, acting accordingly to it (Zohar & Luria, 2005).

Although there may be variation between groups, this must be limited, since the company policies establish the limits of the interpretations that can be made at group level. For that, it can be affirmed that policies and procedures are formulated at an organizational level and implemented at the group level (Zohar & Luria, 2005). As the authors defend, as department heads are expected to execute these policies instead of redefining them according to their department, the organizational climate and the group climate will remain aligned without significant differences.

One of the most important empirical studies in the safety climate area is the one conducted by Zohar (1980) that, besides the instrument that resulted from this work, some of the main characteristics that define the organizations with a strong safety climate were also described: a) a strong management commitment with safety; b) safety-related training for the organization's recent employees; c) open communication channels between workers and managers on safety aspects; d) high levels of environmental and safety control; e) a more stable work force, less turnover and less older workers; and f) different ways of promoting safety such as guidance and counselling, rather than oversight and admonition.

Regarding the methodologies used to assess safety climate, there is a great consensus in using scales and questionnaires (Silva, 2008). Despite of being the first questionnaire developed to assess safety climate, Zohar's instrument had some limitations regarding the psychometric qualities, predictive validity and sample which was limited to industry (Silva, 2008).

Some of these investigations had some limitations, such as the fact that they were developed for organizations in each sector and, for that, the results could not be generalized to other organizations (Neal & Griffin, 2004).

Based on Zohar's (1980) work, Brown and Holmes (1986), in their model of safety climate, proposed a reduction from an 8-factor model to a three-factor model. These factors were: a) the employee perception of the managers concern with their well-being; b) the managers' action to maintain a safe working environment; and c) employee physical risk perception.

On the other hand, Neal, Griffin and Hart (2000) stresse the values of management, organizational and management practices, communication and employee involvement in health and safety behaviours, as dimensions to be considered.

Another example is the investigation conducted by Guldenmund (2000), who reviewed 15 studies and derived 6 dimensions from the literature: management, risk, safety arrangements, procedures, work pressure and training.

After further proposals for instruments from other researchers, Baptista, Silva and Lima (2003), developed the Organizational and Safety Climate Inventory (OSCI), a validated instrument for the Portuguese population that was constructed based on the definitions of organizational climate and safety climate. The dimensions here proposed were a) Safety as an organizational value; b) management actions towards safety; c) safety training; d) safety effectiveness; e) quality of safety communication; f) work pace effects; and g) safety organizational learning.

In fact, the lack of consensus regarding the dimensions that are part of the safety climate in different contexts is a documented reality. Coyle, Sleeman and Adams (1995) argued that although the dimensions of the safety climate vary from context to context, the factors identified in each organization can serve to create good Occupational Health and Safety Programs.

One of the most important factors that impact the safety climate in organizations is the management commitment to safety. The manager's behaviours towards safety affect the success of safety Programs in their organizations (Zohar, 1980). In this direction Cohen (1977), has argued that the success or failure in occupational health Programs is dependent on the personal variables. Neal and Griffin (2004) complement, stating that the individual's perceptions about safety should reflect the importance given to safety aspects in the workplace by the managers.

Organizations can enhance their safety climate by adopting more safety equipment/ systems and/or training programs (Lee, et al., 2018).

As said before, safety climate has found to be an antecedent of individual behaviour (Neal, Griffin & Hart, 2000; Neal & Griffin, 2004), but not the only one. As important as safety climate, safety training is another antecedent of safety behaviour (Neal & Griffin, 2004).

The importance of the Health and Safety Programs to the development of a positive safety climate and safer behaviours by the workers is well studied (Guldenmund, 2000; Neal & Griffin, 2004; Lee, et al., 2018). Recalling the experiments that have used safety climate as a mediator variable between the organizational climate or managers practices and safety outcomes such as safety participation behaviours, safety knowledge or safety attitudes, in the fourth hypothesis (H4), the main goal is to demonstrate that safety climate moderates the positive influence of Safety Training in VR on safety knowledge, behaviours and attitudes.

Virtual Reality and its potential for Training

Virtual Reality can be defined as a methodology used to make a person experience a given reality, even if not present in that reality, through interactions and stimuli present in that same virtual environment (Rebelo, Noriega, Duarte & Soares, 2012). It can also be understood as a representation of reality through digital means in which at least one of the senses is stimulated (Cunha, 2017). According to the researcher, the more senses are stimulated, the greater the immersion experienced and the greater the sense of reality of the experience.

Virtual environments [VE] differ from computer games and simulators in their ability to interact in a non-structured environment. In a VE, it is the use that creates its own interactions and interacts the way it wants (Merchant, Goetz, Cifuentes, Keeney-Kennicutt & Davis, 2014).

Historically, at the beginning of its use, participants had a lot of problems with their experiences reporting some feelings of sickness, dizziness, and disorientation (Stanney, Mourant & Kennedy, 1998; Merchant, et al., 2014). However, with the increase in computer processing power and graphics capabilities, VR experiences have become much more immersive and perceived as more like real-world experiences. In addition, one of the conditions that has exponentially increased the use of this technology is that the price of the device has steadily declined (Merchant, et al., 2014).

One of the main concerns in the use of this technology in research has been its consistency, and in this sense, the study of Ragan, et al. (2015), helped to realize the importance of three types of fidelity in VR systems: the reliability of interaction, which refers to the degree of accuracy with which real interactions are reproduced in an interactive system; the reliability of the display, which represents the immersion or the degree of accuracy with which a given sensorial stimulus is reproduced in the device; and the reliability of the scenario, linked to the degree of accuracy with which the behaviours, rules and properties of the objects presented in the device approximate with reality. According to the authors, it is the combination of these three factors that will determine the realism of experience.

As Rebelo et al. (2012) enumerate, some of the main potentialities of VR are related with availability, safety and data provision. Accordingly to the first one, VR allows access to all types of places with the respective environmental conditions in an easy and repeatable way, still allowing access to these realities by people with disabilities. The second advantage is related to the possibility of participants experiencing situations in extreme conditions and that would be dangerous if experienced in person. Finally, the last advantage is related to the high ecological validity of the data collected, using this type of methodology.

The investigation by Ragan, et al. (2015) also highlighted as a great advantage the low cost of this type of methodology and the possibility of being applied in training contexts.

Regarding one of the main advantages of using VR in safety training programs, it is possible to put people in dangerous situations and that, in the context of training in real environment, would not be possible. For ethical reasons, subjecting a participant directly to an experience that will inflict pain on him or life-threatening is not acceptable in any form of training. For this reason, VR is a very advantageous method for exposing participants to this type of situation, as it does not subject them directly to the danger (Cha, Han, Lee & Choi, 2012). This is precisely what these authors studied by using VR in a fire simulation, demonstrating that this methodology offers a possibility to train the most inexperienced firefighter behaviours in fire situations.

In fact, VR has been shown to have positive effects in what concerns to learning and its transfer in a number of areas and contexts, such as the training of medical staff (Gallagher, et al., 2013), in the firefighters personnel (Bliss, Tidwell & Guest, 1997), in sports training (Rauter, et al., 2013), as well as in mapping and instructional tasks (Bliss, Tidwell & Guest, 1997; Carlson, Peters, Gilbert, Vance & Luse, 2015). More recently, the use of VR in training has focused mainly on other aspects, such as cognitive training, motor training and decision-making training (Ragan, et al, 2015; Makransky, Borre-Gude & Mayer, 2019). The research conducted by Makransky, Borre-Gude and Mayer (2019), has shown that the use VR as methodology for training, have revealed some benefits related to the transfer of learning, in multiple contexts. In their investigation the authors, compared two groups, one experiencing a simulation in VR and another that had safety training through a conventional method like reading a written manual. The conclusion was that the first group had some advantages in what concerns to the transfer of the knowledge they achieved during the training. Likewise, Merchant et al. (2014), highlight the affordances that technology offers, namely regarding the training and refinement of certain cognitive skills.

Although the literature on the various contexts where VR is used for training purposes is rich, it becomes scarce when it comes to studying safety procedures. With this lack of literature in mind, the investigation of Buttussi and Chittaro (2018), pioneered the study of safety procedures by using different VR devices for training in safety procedures in the aviation industry. The authors used this context because it is a work in which professionals must follow a set of safety procedures in the event of an accident hazard. The effects of the experience in the three devices were then measured in terms of knowledge about safety procedures, self-efficacy, involvement in safety procedures and feeling of presence in the experiment, two

weeks after the procedure. The conclusion was that all the devices had a positive influence on involvement in safety procedures and the feeling of presence and that the training positively influenced the knowledge about the safety procedures and the self-efficacy reported by the participants.

The reason why the tests of training-related variables should be performed with a time interval rather than immediately after training is justified by the need to understand whether learning is consolidated and whether after some time the participants still recall the procedures learned in the training (Buttussi & Chittaro, 2018).

Another advantage of using VR in a training context is the easy access to certain contexts and materials that in real environment would be more complex or costly financially (Ragan, et al, 2015). In this way, using VR in training, guarantees a safer and potentially faster training scenario compared to the training that is given in the real environment (Carlson, et al., 2015). In their study, Carlson and colleagues (2015), sought to compare the retention of training information in a VE and in a real environment, and concluded that the retention of the training experience in VR is not inferior to that experienced in the environment within 2 weeks between the experiment and the retention test performed.

On the other hand, research participants cannot be subjected to exposure to risk factors for ethical reasons. This impossibility, according to Velosa, Cobo, Castillo and Castillo (2017), is due to the risk that, in a real environment, a work accident may occur due to the high exposure to multiple stimuli simultaneously with the risk factors. Regarding the results obtained with the use of these methodologies in safety training, it has been demonstrated that the use of VR or Augmented Reality leads to the participants having practices consistent with those of normal training, by the assessment of risk factors, the classification of this same risk and the action plans that are developed during the experiment for the different activities. In this sense, what this means is that it is as if the participants are interacting with the real environment.

Safety Training

Barling and Frone (2004) admit that the prevention of work accidents has been a public policy issue in the last years not only for the managers of a given organization but for many governments too. An example of these concerns is the legislation created in many countries that prescribes minimum safety standards for the organizations and direct penalties for those who do not meet these standards.

The high number of work-related accidents and their costs for the organizations mentioned above justify the existence of safety training programs and actions in these

organizations. These training programs, according to the literature, should focus on some dimensions, such as increasing safety attitudes on workers and increasing the participation and engagement of those workers on safety behaviours. One example of this concerns can be given by Loosemore and Malouf (2019), that developed a study to understand the importance of construction safety training in developing positive safety attitudes. They concluded there were a minor change in safety attitudes in the workers after the training that were mainly cognitive, e.g. increased knowledge of safety risks, and behavioural, e.g. better intention to behave safely, while the affective component of safety attitudes, e.g. caring about safety as an issue, remained unchanged. This authors also suggested that age, gender, and education could be potential mediators in safety attitudes training processes.

In another study, developed by Liu, et al. (2015), it has been shown that safety training is related to a reduction in work accidents, mainly due to the greater importance that workers themselves attach to the use of safety equipment and devices.

Management's safety actions and commitments within the organization, coupled with the existence of Safety Training Programs, positively influence workers' safety behaviours and their positive consequences in reducing work accidents, as previously mentioned (Cooper & Phillips, 2004).

In other sense, Ricci, Chiesi, Bisio, Panari and Pelosi (2016), showed that some modalities of safety training has positive effects on workers' safety attitudes and self-protection attitudes at work, as well as their knowledge related the hazard and risky factors in the workplace. For these authors, regarding these training modalities, the conventional classroom training methodology has been shown to be less effective in changing employees' behaviours and attitudes, while the practical and behavioural E-Learning Training has resulted in major changes in these same aspects.

Regarding the methodologies used for safety training, these can be differentiated in the way they allow and encourage trainees to actively interact with training materials (Leder, Horlitz, Puschmann, Wittstock & Schültz, 2018). These researchers say that a training given in the classroom, such as written instructions or narratives, as well as other merely expository methodologies, should be distinguished from sessions that allow participants to simulate work situations or interact directly with materials, by the simple level of involvement they have in each of these situations. This means that, while in situations where there is no participation of the trainee, the level of involvement is low, the same involvement becomes high when trainees can interact with the materials and have training sessions with more active methodologies. This idea is accompanied by other authors (Zhang, et al., 2017), who claim that the more traditional

training methods do not allow the participant to interact with the environment and the situation to be experienced and do not allow the practical exercise of behaviours for which that participants are being trained.

The methods used to communicate safety information in safety training can be distinguished according to the extent to which they require the learner to engage with the presented material and the mental effort that learners must exert to learn the material. Safety training conveying information through written descriptions can be considered to offer only low levels of engagement, whereas simulations should provide a high degree of engagement because learning in a simulation is based on interactive elements. Another investigation that deserves some attention due to the study of the effects of different levels of involvement of the participants in their own experience of safety training is the meta-analysis developed by Burke, Salvador, Smith-Crowe, Chan-Serafin, Smith and Sonesh (2011), which compared a set of studies developed in the context of safety training that have used different methodologies and in which the work accident also had different levels of severity. In this sense, the results obtained in this study, allowed to realize that the level of involvement of the participants in the experience, positively influence their safety performance, but only when the severity of the accident is greater.

In what concerns to the level of involvement of participants in training, the use of VR as a methodology has received some attention, given the high involvement of the participant in the situation and in the virtual environment, due to the experience of situations that are closer to reality and the control of environment and the task that allows the participant (Ragan, et al, 2015).

Regarding the use of VR devices in safety training, the literature has shown that the use of these devices can enhance the learning of the trainees, because the level of vigilance during the experience is higher, increasing the participants' attention (Sacks, Perlman & Barak, 2013). In addition, these authors further demonstrated that learning remained more stable over time in participants who had experienced VR safety training than those who had experienced "on-site" training.

Another study by Chittaro and Zangrando (2010), also sought to develop the potential of using VR as a methodology for safety training, where they compared two groups for which the same methodology was used, but with two different stimuli for the participant. In one of the groups, the participants were subjected to a dangerous situation with a stronger emotional content, such as the virtual environment being surrounded by a red shadow, while in the other the stimulus was not so emotionally strong, since there was no red shadow. surrounding the

viewed scenario. The results of this study demonstrated that the participants who experienced a virtual environment with the red shadow, not only increased the participants' anxiety levels, but also led them to want a greater change in their safety attitudes. In this sense, this study complements the literature, helping to realize that the emotional content that refers to a greater perception of risk, positively influences the change in people's safety attitudes.

Safety training using VR has shown clear advantages over other training methodologies, especially as regards: a) enabling trainees to experience real safety risks without compromising their own safety; b) maintenance of higher levels of attention than conventional training methodologies; c) allow learners greater control over the environment and more real interaction with the situation (Sacks, Perlman & Barak, 2013). Velosa et al. (2017) complement, although in an industrial context, demonstrating that the use of VR in a training context can increase the perception of risk and its assessment by the individual, leading to greater promotion of safety practices and behaviours.

In what concerns to the learning and training in safety procedures, the effectiveness of VR is high, as stated by the investigation of Buttussi and Chittaro (2018). Their conclusions highlight significantly increased safety knowledge in the study participants. It was found that regardless the display, using desktop VR setups can be enough for procedural safety training, underlying that the type of display in VR can affect users' sense of presence, but not self-efficacy and knowledge increase.

Finally, and related with the advantages of using VR in the training context, the fifth hypothesis (H5), intends to prove that the participants of the experimental group who receive VR safety training have a greater retention of the different moments of the training than the control group the participants who receive safety training in a written narrative.

In short, the hypotheses under investigation are: safety behaviors are higher in participants receiving VR Safety Training than those who receive Safety Training in a written narrative (H1); safety attitudes are higher in participants receiving VR safety training than those who receive safety training in a written narrative (H2); safety knowledge is greater in the experimental group, compared with the control group (H3); safety climate moderates the positive influence of Safety Training in VR on safety knowledge, behaviors and attitudes (H4); and participants of the experimental group have a greater retention of the different moments of the training than the control group participants (H5).

Method

Participants

Being this research developed in partnership with C Company, all participants of this research are the workers from the stores of this organization. Thus, 61 participants, aged 20 to 51, participated voluntarily and constitute our sample. The sample consists of 24 male and 37 females with different academic qualifications. Employees also vary in the time they work at C Company, with the minimum time at C COmpany being 1 month, while the maximum time is around 15 years. The sample was divided into two groups, corresponding to the two conditions under study. These groups are the experimental group and the control group. Participants were not randomized for the conditions, given the priority of collecting data from the experimental group first. The experimental group consists of 30 participants, in which 14 are men and 16 women, aged between 20 and 46 with an average of 31 years old (*SD* = 7). In turn, the control group consists of 31 participants, 10 men and 21 women, aged between 20 and 51 with an average of 31 (*SD* = 9).

It was determined prior to the experience that participants who did not complete the VR experience or their participation at all the moments of data collection, or who completed it without experiencing the work accident, would be excluded from the sample. The reason why the absence of experience of the work accident was used as an exclusion criterion is because the participants in the control group were all induced to that work accident and because the objective of the study includes precisely the experience of the work accident. Thus, after data collection, only one female participant was excluded because she was able to complete the experience without experiencing the work accident.

Procedure

Before defining the procedure to be adopted during the investigation, two meetings were held with a C Company representative to present the objectives and discuss the conditions for the application of the study. At these meetings, C Companys' commitment to the safety of its workers was highlighted as their ambition to implement innovative and effective training methodologies in safety at work for its employees.

For this research, an experimental design was conducted.

Regarding the variables used, the independent variable is the safety training methodology, which has two levels: VR methodology or written narrative. In turn, the

dependent variables are safety behaviours, safety attitudes, and safety knowledge. Finally, the safety climate will be tested as a moderating variable following the rationale of Neal, Griffin and Hart (2000), who did not use this variable in a direct relationship, but rather as a Mediator of the relationship between organizational climate and workers' safety behaviours.

The sample was divided into 2 distinct groups: the experimental group and the control group, both with a similar size. In the experimental group, safety training was given using VR, while for the control group was used a Written Narrative with a semantic content textually identical to the verbal content expressed in VR.

The sample was not randomized by the conditions as the experiment was firstly performed on the experimental group and only after reaching 30 participants in this group, in the control group. The reason why the sample was not randomized by the conditions was that the experimental group was more time consuming, required a much more complex logistics in the transport and assembly of the whole VR device in each store and, for the small number of C Company's employees available to participate, this was the safest way to guarantee the desired number of participants in the experimental group and then in the control group.

The investigation was divided into two distinct stages with a 2-week interval between each part. In the first part, participants experienced the safety training experience and then answered a Questionnaire on their perceptions on some indicators related to the behaviours, attitudes, knowledge and safety climate experienced by C Company employees and, finally, a retention test with 8 open questions related to the experience itself. Subsequently, in the second part, 2 weeks after the first part, participants would again respond to the same retention test, applied after the Questionnaire, two weeks before. The objective was to understand if there were differences between the two groups in memory and recall of the facts that occurred during the experience.

Data collection was done late at the end of June, which made it very difficult to randomize participants by the conditions, as mentioned above. The late schedule for data collection was due to the delay in obtaining permits from the C Company Human Resources and the deadlock over where data collection would take place. This difficulty was overcome when it was decided that such data would be physically collected in their stores. Data collection was carried out at C Company headquarters, with three employees from the North stores and then Alfragide, Colombo, Vasco da Gama, Sintra, António Augusto Aguiar, Chiado, Dolce Vita, Almada, Cascais and Oeiras stores.

The collection procedure for the experimental group prior to the actual data collection contemplated the entire construction of the VR device in the space provided by C Company

and only then it was possible to collect data and conduct the experiment with the participants. For the control group, it was not necessary to assemble the device as the application was through a sheet with a written narrative.

The results and all statistical analyzes presented were obtained using IBM SPSS Statistics Software Version 24.

Materials

Virtual Reality. The VR experiment presented to the experimental group was C Company experience, version 1.02, "Experiment 1". Developed through the Unity Development Platform, used for 3D Experiments (Unity Technologies, 2019), this experiment was fully built and implemented by the Universidade de Lisboa, ErgoVR a unity of ergoUX Laboratory.

During the experiment, the participants remained standing and could move in a rectangular space of varying dimensions, depending on the store size, of at least 1.5m X 2m. These dimensions corresponded to the signal reception limit of the motion sensors. Virtual images were viewed through a head-mounted display (HMD): HTC VIVE headset powered by Stream® VR, including Steam VR Tracking 1.0 technology and Chaperon Guidance System. A motion-sensing wireless controller was used by two pre-synchronized sensing bases before the experiment started, and a front camera headset, integrated microphone, 3.5mm headset jack and USB 2.0 port.

For the presentation of the VE images, an HP Desktop Z440 computer with an Intel® Xeon® CPU E5-1650 v4 processor, 3.60GHz, 16GB of RAM and a resolution of 1920x1080 was used. The operating system used was Windows 10 Pro, version 1709.

For this investigation, as previously mentioned, a VR device was used. The VE scenario was previously pre-tested by 5 people, with different qualifications and jobs, ranging from a student in the 1st year of the Degree, to a computer technician, in order to test the sense of presence in the scenario and to check if the instructions and events were understood.

The VE includes 3 different physical spaces and a transition scenario between two of these spaces:

- Initially, the participant is in a tutorial and training space where he learns and practices the controls for moving in the VE, pressing switches / commands and also approaching, grasping and dropping objects;

- In the first space of the experience, the C Company Lounge, the participant is set in a store setting with sofas, TV, windows and a service desk. Here participants listen to the store manager's instructions and perform three tasks: turn off the alarm, open the window blinds and turn on the television;
- Next, the participant goes to the elevator, which corresponds to the transition scenario between the Lounge and the last space of the experience, Warehouse 1;
- In the last space, Warehouse 1, participants are asked to store the boxes on the table in the corresponding shelf. It is in that moment, when the last box is being stowed, that the work accident occurs, with the boxes on the highest shelf falling on top of the participant.

Written Narrative. For the control group, the procedure was different in that safety training was given on a sheet of paper with a Written Narrative (see Appendix A). This narrative was replicated and transcribed from what was verbally expressed in the VR experience, except for the Tutorial moment, when the experimental group participants got used to the controls. The written narrative, similar to what happened with the VR device, was also pre-tested by 5 volunteer people of different ages and occupations, from a 25-year-old girl with a Master's degree and unemployed to a 57-year-old human resources director with the 12th year. Once again, the intention was to check if the narrative was objective in its instructions and if it was well linked in its events. After pre-test, the written narrative did not change.

Questionnaire. The questionnaire was applied to both the experimental group and the control group (see Appendix B), with some differences in their composition. Demographic questions were used in both groups to identify some characteristics of the sample, such as age, academic qualifications, working time at C Company, and participation in safety training. After these questions, the experimental group answered a questionnaire with 59 items, arranged in a totally random order, while the control group answered a questionnaire with 45 questions, 14 fewer than the experimental group, corresponding those to the Perception of Presence in the VE questions. Since the control group did not use the VR equipment, these questions did not apply to the latter. The items in both versions of the questionnaires sought to assess safety behaviours, safety attitudes, safety knowledge and safety climate. For this purpose a 6-point Likert Scale was used, where 1 represents "Strongly Disagree", 2 "Disagree", 3 "Slightly Disagree", 4 "Slightly Agree", 5 "Agree" and lastly 6 which stands for "Strongly Agree". The choice of the 6-point scale was justified by the need to minimize social desirability in the responses and overuse of the midpoint of the scale if it had 5 or 7 points. The questionnaire consisted of some inverted items to check if the participants answered the questions coherently

and to verify if they were attentive in completing the instrument. A questionnaire code was requested on all sheets of the questionnaire to match the first data collection moment, consisting of a Questionnaire and a Retention Test, and the second data collection moment, a replication of the same Retention Test. The questionnaire was pre-tested and was applied to 4 people of different age groups, all with higher education. No changes were made to the items.

Retention Test. A retention test was also administered immediately after the safety training experience and 2 weeks after each participation. The application of this Test was intended to ascertain whether there were differences between the experimental group and the control group regarding the memory of the events experienced during safety training. This instrument has 8 questions related to the safety training experience. The quotation of the answers was "Right" or "Wrong", with no intermediate classification. The retention test also had on each page the Questionnaire Code. Prior to its use in the experiment, this instrument was pre-tested (see Appendix C) by the 10 people who have voluntarily pre-tested both VR device and the written narrative, and their suggestions for changes were followed and made (see Appendix D). It is also important to clarify that the questions of the retention test were presented individually, with one on each page, so that the following questions did not influence the previous answers.

Informed Consent. Prior to the start of the experiment, in order to ensure that participation was completely free and that the participant's rights were safeguarded and known, the Original and Duplicate Informed Consent Terms (see Appendix E) were distributed to the participants and were guaranteed to be signed by all participants prior to start of the experiment. This document expresses the anonymity of the participants and their responses to contribute to responses free of social desirability and the voluntary nature of participation, allowing the participant to withdraw at any time of the experiment, without need for justification.

Debriefing. At the end of the experiment a Debriefing was given to each participant (see Appendix F) with some literature that helped in the construction of the research. Relations between some variables with safety training and safety climate are discussed here.

Measures

Sense of presence. The scale of perception of presence in the VE was used as a manipulation check to verify the extent to which people had the perception of being experiencing VR. The sense of presence was measured using the Igroup Presence Questionnaire (IPQ), developed by Schubert, Friedmann and Regnbrecht (2001), and later translated and validated for the Portuguese population by Vasconcelos-Raposo et al. (2016).

For this purpose, two of the authors of the instrument validation were contacted (see Appendix G), José Vasconcelos-Raposo and Miguel Melo, from whom authorization was obtained for the use of the instrument items. This questionnaire consists of 14 items that measure three dimensions of the feeling of global presence of the subject who is experiencing a VE (see Appendix H). The first dimension, *Spatial Presence*, corresponding to the feeling of being physically present in the VE, was evaluated on 6 items (e.g. "I felt present in the virtual space"). The second dimension, *Involvement*, which is related to the attention given to the VE and the experienced involvement, has been evaluated in 4 items (e.g. "I concentrated only on the virtual space"). Finally, the third dimension evaluated, *Experienced Realism*, which represents the subjective experience of realism in the VE, was assessed through 4 items (e.g. "I did not feel present in the virtual space"). Participants should answer the questions using a 5-point Likert scale, with 1 corresponding to "Strongly Disagree" and 5 to "Strongly Agree" (Vasconcelos-Raposo, 2016). IPQ has good psychometric qualities in all its variables, when analysed individually and globally. Regarding the internal consistency, the Spatial Presence has a good consistency ($\alpha = 0,57$), as well as the Involvement ($\alpha = 0,55$) and Experienced Realism ($\alpha = 0,67$). Overall, the Portuguese version of IPQ has a good internal consistency ($\alpha = 0,62$).

Safety behaviours. Safety behaviours were assessed using the scale proposed by Neal, Griffin and Hart (2000). This scale was not validated for the portuguese population, so the translation and retroversion method were used, so that the meaning of each item was as reliable as possible to the original version. The translation was done by the research team.

The scale used is composed of 8 items, 4 related to compliance behaviours (e.g. "I use the correct safety procedures to develop my work") and 4 other items related to participation behaviours (e.g. "I voluntarily develop tasks or activities that help improve workplace safety"). The 4 items of compliance behaviours have good internal consistency ($\alpha = 0,86$). In turn, items related to participation behaviours also have a good internal consistency ($\alpha = 0,76$).

Safety Attitudes. Regarding safety attitudes, they will be evaluated using the items belonging to the safety attitudes scale of the questionnaire developed by Rundmo (1996). This scale is part of a 250-item questionnaire, although safety attitudes are only 11 questions (e.g. "When I see that safety instructions are not being followed, I immediately get the person's attention"). Participants should answer the questions using a 5-point Likert scale, with 1 corresponding to "Strongly Agree" and 5 to "Strongly Disagree". The referred 11 items mentioned have a good internal consistency ($\alpha = 0,78$).

Safety Knowledge. To assess safety knowledge, a scale developed in the study by Griffin and Neal (2000) was used. This scale was not validated for the Portuguese population

either, so the translation and retroversion method was used. The translation was again done by the research team. The scale used is composed of 4 items (e.g. "I know how to use the safety equipment and working procedures required of me"). The 4 safety knowledge items have a good internal consistency (α = 0,80).

Safety Climate. The Safety Climate assessment was made using a questionnaire validated for the Portuguese population, the OSCI by Baptista, Silva & Lima (2003). Also, for the use of OSCI' items, a meeting was held with one of the authors Sílvia Silva and authorization was obtained for its use. In this questionnaire, the scale of safety-related organizational practices was evaluated, comprising a total of 6 dimensions and 22 items in total. The dimensions evaluated here are: Safety Management Actions, consisting of 3 items, with good internal consistency (α = 0,71); Safety Training, consisting of 3 items, (α = 0,81); Safety Effectiveness, with 4 items, (α = 0,59); Quality of Safety Communication, 4 items, (α = 0,61); the Effects of the Work Rhythm, 4 items, (α = 0,87); and also organizational Safety Learning, 4 items, (α = 0,62).

Results

In the first instance, the responses to the questionnaires in both groups and the participants' responses to the Retention Test were analyzed. This first phase aims to verify if there are differences between the groups for each of the dependent variables, namely, safety behaviours, safety attitudes and safety knowledge. The moderating effect of the safety climate variable on the relationship between the variables was also tested. Finally, it was verified whether the Retention Test results were different between groups in its first application.

In a second phase, the aim was to check if there were differences between both groups in the results obtained in the second application of the Retention Test, applied at least two weeks after the first application of this Test.

Finally, in a third phase, intra-group analyzes were performed, as it is analyzed if there were differences between the first and second moments of data collection, in both groups and, if so, in what direction.

The significance level used in all statistical analyzes is $p < .05$.

First Part

As stated in the method, the sample participating in this investigation is 61 C Company employees. The experimental group is more gender balanced, with 16 female participants and

14 male participants, compared to the control group, with 21 female participants and 10 male participants.

With respect to the ages of the employees, as mentioned above, the ages are similar in both groups as the average age of the experimental group is 31 years (*SD* = 7) and the average age of the control group is also 31 years old (*SD* = 9).

Still, one of the major differences in both groups to note is the average tenure that participants in both groups have as C Company employees, as shown in Table 1. Here, the difference in average is approximately one year, with the control group having one more year in average of tenure at C Company, compared with the experimental group. As participants in the experimental group have an average working time at C Company of 2.80 years (*SD* = 3.19), the control group participants have an average tenure at C Company of 3.86 years (*SD* = 3.99).

Table 1
Gender, Age and Working time in C Company in the experimental and control groups.

			Gender			How long do you work
			Female	Male	Age	in C Company (years)
Group	Experimental Group	Count (n)	16	14		
		Mean			31	2,80
		Standard Deviation			7	3,19
	Control Group	Count (n)	21	10		
		Mean			31	3,86
		Standard Deviation			9	3,99

Regarding the results on the perception of global presence in the LV, the participants in the experimental group revealed an average of 3.90 (SD = 0.48). For each of the IPQ Scales, the participants revealed an average of 4.75 (SD = 0.62) in Spatial Presence, an average of 3.03 (SD = 0.94) for Engagement and an average of 3.48 (SD = 0.73).

Safety Behaviours

In order to analyze safety behaviours between the two experimental conditions, the first hypothesis is to test and prove that safety behaviours were superior in the experimental group that received safety training in VR, when compared to the control group that received safety training in Written Narrative. Table 2 shows the average scores for both groups.

An independent t-test was performed to evaluate the difference between means of the experimental group and the control group. From the analysis, the mean of the two groups is relatively similar, so there are no significant differences regarding safety behaviours between the experimental group and the control group (t (59) = -.14, p = .89, d = .04). As the experimental group showed an average safety behaviour of 4,81 (SD = .75) on a scale of 1 to 6, the control group had score of 4,83 (SD = .47). Therefore the first hypothesis was refuted.

Table 2
Average Scores of Safety Behaviours in the experimental and control groups.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Safety Behaviours Average	Experimental Group	30	4,81	,75	,14
	Control Group	31	4,83	,47	,08

Safety Attitudes

Regarding the second hypothesis, it sought to demonstrate that participants who received VR safety training report more positive safety attitudes than those who received written narrative safety training. The mean scores for both groups are described in Table 3.

An independent t-test was used as a resource for these analyzes, in order to understand whether hypothesis 2 was confirmed or not. The results do not show any difference between groups (t (59) = .54, p = .59, d = .14). with respect to reported safety attitudes. Here, the experimental group mean score for safety attitudes was 4.62 (SD = .72), slightly higher than the score that was found in the control group, with an average of 4.53 (SD = .66). These results also reveal that the second hypothesis was not verified.

Table 3
Average Scores of Safety Attitudes in the experimental and control groups.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Safety Attitudes Average	Experimental Group	30	4,62	,72	,13
	Control Group	31	4,53	,66	,12

Safety Knowledge

The third hypothesis sought to prove that safety knowledge is greater in the experimental group than in the control group. The results are shown in Table 4.

Once again, the independent t-test was used to prove this third hypothesis. The analysis shows that, although there is a difference between the safety knowledge mean scores between the experimental and control groups, this difference is not statistically significant (t (59) = -1,85, p = .07, d = .47). The experimental group showed an average of 5,15 (SD = .52), while the control group showed a slightly higher average of 5,40 (SD = .52). This absence of difference between the means allows us to state that hypothesis 3 was not confirmed.

Table 4
Average Scores of Safety Knowledge in the experimental and control groups.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Safety Knowledge Average	Experimental Group	30	5,15	,51	,09
	Control Group	31	5,39	,52	,09

Safety Climate

For safety climate, the existence of differences between the group that experienced VR training and the one that only had access to a written narrative was also tested. The results are shown in Table 5. The same independent t-test was used to show if there are any differences in the average of safety climate of those groups. The analysis shows that the safety climate mean scores for both experimental and control groups, are not statistically different (t (59) = -.21, p = .84, d = .05). Concerning safety knowledge, the experimental group showed an average of 4.48 (SD = .62), while the control group showed a slightly higher average of 4.51 (SD = .43).

Table 5
Average Scores of Safety Climate in the experimental and control groups.

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Safety Climate Average	Experimental Group	30	4,48	,62	,11
	Control Group	31	4,51	,43	,08

Since none of the dependent variables reveals significant differences either in the experimental group or in the control group, it is interesting to check, within the variables, which items differ significantly in the two groups. For this analysis, the 45 items that are common to the two questionnaires are compared, except for the 14 items that relate to the measurement of the Perception of the participants of their Presence in the VE. To perform this analysis, a comparison between means was used, to verify which items the groups differ from.

After the comparison test between means of the two groups, it was possible to verify that the only item that has differences in the two groups, is "I know how to reduce the risk of accidents at work and incidents in the workplace" (*t (59) = -2.33, p = .02, d = .61*). This item concerns the safety knowledge scale. Here, the experimental group (mean = 4.83, SD = .70) has a lower average in the score, compared with the control group (mean = 5.23, SD = .62).

When testing the moderating effect of the safety climate on the relationship between the variables under study, it was initially sought to understand whether the safety climate of C Company's employees influences the relationship between the safety training methodology of the groups and their safety behaviours, attitudes and knowledge.

Regarding the moderating effect of the safety climate on the relationship between the training methodology and safety behaviours, as shown in Table 6, the model explains 37.1% (R^2 = .37) of the total variation in safety behaviours (F (3, 57) = 11.22, p <.001). The results also demonstrate that the safety climate does not moderate the relationship between the variables (*t = -1.74, p = .09, d = .04*).

Table 6

Moderation Effect of the Safety Climate in the relation between safety training methodologies and safety behaviours

Predictors	Safety Behaviours B (SD)
Constant	-1.02 (1.69)
Safety Training Methodologies	2.07* (1.20)
Safety Climate	1.30** (.37)
Interaction Effect	-.46* (.26)
R^2_a= .37***	
$F_{(3, 57)}$ = 11.22	

p<.1 p<.01** p* < 0.001***

Then, the moderating effect of the safety climate was tested in the relationship between the training methodology and safety attitudes. As shown in Table 7, the model explains 51.5% (R^2 = .52) of the total variation in safety attitudes (F (3, 57) = 20,20, p <.001). The results also demonstrate that safety climate does not moderate this relationship (*t = .26, p = .80, d = .14*).

Table 7
Moderation Effect of the Safety Climate in the relation between safety training methodologies and safety attitudes

Predictors	Safety Attitudes B (SD)
Constant	.99 (1.67)
Safety Training Methodologies	-.42 (1.15)
Safety Climate	.84* (.36)
Interaction Effect	.07 (.26)
R^2_a= .52***	
$F_{(3, 57)}$ = 20.20	

p<.1 p<.01** p* < 0.001***

Finally, it was necessary to test the moderating effect of the safety climate on the relationship between the training methodology and safety knowledge. As can be seen from Table 9, the model explains 34.3% (R^2 = .03) of the total variation in employee safety knowledge (F (3, 57) = 9,92, p <.001). The results also demonstrate that the safety climate does not moderate the referred relation (*t = -.59, p = .56, d = .47*).

Table 8
Moderation Effect of the Safety Climate in the relation between safety training methodologies and safety knowledge

Predictors	Safety Knowledge B (SD)
Constant	1.71 (1.46)
Safety Training Methodology	.84 (1.04)
Safety Climate	.72* (.32)
Interaction Effect	-.14 (.23)
R^2_a= .34***	

$F_{(3, 57)} = 9.92$

$p<.1^{*}$ $p<.01^{**}$ $p < 0.001^{***}$

With regard to the results of the two moments of the retention test carried out for both groups, the analyzes will be: a) the test of the differences of inter-group means, in order to understand if there are differences between the groups in the number of the correct answers at the first moment and, later, if there are differences in the number of correct answers between the groups, at the second moment of application of the retention test; and b) the test of differences of means within the group, comparing the means of correct answers in the first moment and in the second moment of the retention test, for the experimental group and for the control group.

Concerning the averages presented in the total of correct answers for both groups at the first moment of the retention test, the experimental group, presented an average of 6.57 (SD = 1.04) correct answers, while the control group showed an average of 5.97 (SD = 1.68) correct answers. Analyzing whether these averages are different between the two groups at the first moment of application of the retention test, immediately after the experience and the application of the questionnaire, the two groups did not reveal any differences in the averages of correct answers (*t (59) = 1.67, p = .10, d = .43*).

Furthermore, regarding the items in which there were differences between the means of correct answers in the two groups, the following items stand out: "Indicating the name of the last space, what tasks were here performed?" in which in the experimental group 93% of the people answered correctly while, in the control group, only 74% of the participants gave the correct answer (*t (59) = 2.06, p = .04, d = .52*); and the item "What should have been done to prevent this occurrence?" in which, in the experimental group 87% of the people answered correctly and only 61% of the participants in the control group also got the answer to this question (*t (59) = 2.31, p = .02, d = .61*).

Second Part

While in the first moment of application of the retention test, there all the 61 responses were valid, which can be justified by the fact that its application was immediately after the training experience. In this sense, it was expected that there would be some mortality in the sample, considering the fact that the second moment of application of the retention test, would be two weeks after the experiment and the data collected remotely, via email. Confirming this expectation, and slightly exceeding what was thought, there was a mortality of 44.3% of the

participants in the second moment of collecting data. This means that only 34 valid responses out of 61 were obtained in the second moment of the Retention Test, representing a total of 55.7% of valid responses.

Of these 34 participants who answered the Retention Test in the second moment, 12 are part of the experimental group, representing a total of 40% of valid responses, of the 30 participants. The remaining 22 participants who responded to this moment of data collection, are part of the control group, totaling 71% of valid responses, out of 31 participants. This discrepancy between the number of participants with valid answers in both groups, makes it difficult to compare both and to investigate possible differences in the average of correct answers per group.

Still, as for the averages presented in the total of correct answers for the two groups in the second moment of the Retention Test, although the time interval for collecting this second moment for the first was not exactly two weeks for all participants, the experimental group, presented an average of 5.92 (SD = 1.56) correct answers, while the control group showed an average of 5.77 (SD = 1.48) correct answers. Regarding the second moment of data collection of the retention test, there was also no difference in the mean of correct responses between the experimental group and the control group ($t\ (32) = 0.27$, $p = .79$, $d = 0.10$).

Contrary to what happened in the first moment of the retention test, immediately after the safety training experience, in which differences in the average of correct answers were revealed between the two groups in two items, in the second moment of the retention test there was no item in which participants' average correct answers differed from one group to the other.

Third Part

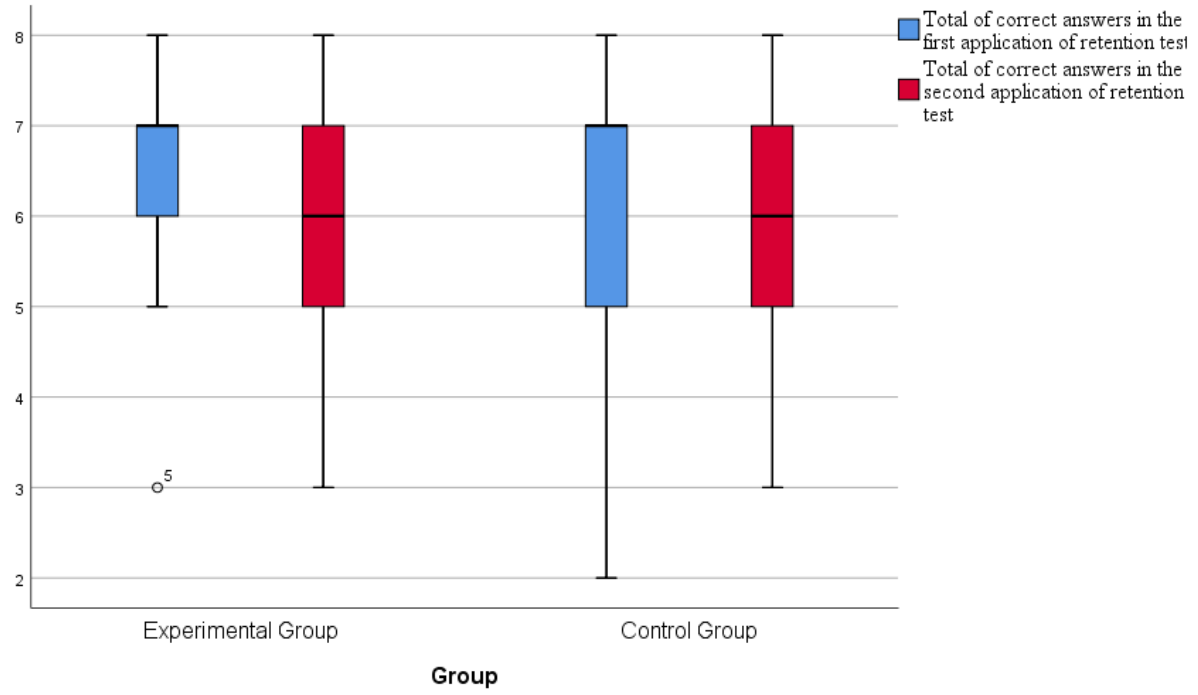
To assess whether there are differences in the means of correct responses between the two moments for each group, intragroup differences were tested in both experimental and control groups, as shown in Figure 1.

Of the participants who were part of the experimental group, only 12 participants out of 30 completed the first and second moments of the retention test. The same is to say that, of this group, only 12 participants completed the investigation. Recalling the average of correct answers in the first moment of the retention test for this group, it was 6.57 (SD = 1.04), whereas in the second moment of the retention test, the average of correct answers was 5.92 (SD = 1.56). In this group, analyzing the intragroup differences between the average number of correct answers in the first and second moments of the retention test, it is possible to verify that there are no significant differences between the two moments ($t\ (11) = 1.29$, $p = .22$, $d = .37$).

Comparing both groups, the control group had a greater number of people completing the different moments of data collection in this investigation, more precisely 22. As stated above, the average of correct answers in the two moments of application of the retention test for the control group, it was found that in the first moment, the average of correct answers was 5.97 (SD = 1.68) as in the second moment was 5.77 (SD = 1.48). When comparing the average number of correct responses from the first moment of the retention test to the second, it is noticed that there are also no significant differences between the two moments (*t (21) = .60, p = .55, d = .13*).

Figure 1

Comparison for each group of the number of correct answers in the two moments of application of the retention test



Discussion

The original question that this investigation aims to answer is precisely to understand whether the methodology used for safety training positively influences safety behaviours (Hypothesis 1), safety attitudes (Hypothesis 2) and safety knowledge (Hypothesis 3) in C Company workers. We also tried to understand if this relationship was moderated by the safety climate existing at C Company (Hypothesis 4).

With respect to the first hypothesis, from the results obtained, it was noticed that there were no differences between the participants of the experimental group and the control group,

about safety behaviours of compliance and participation. This result leads to a rejection of the first hypothesis. After the analyzes carried out, it was noticed that the average safety behaviour is slightly higher in the control group, when compared with the experimental group, although this is not a significant difference.

Addressing this relationship and these results in the light of the literature, Loosemore and Malouf (2019), starts to reveal in their research in the Australian construction sector, that safety training is important not only for an increase in the perception of risk by workers, but also for an increase in workers' intentions to engage in safety behaviours.

In what concerns to training and the methodologies used for this purpose, research has shown that the use of methodologies based on immersion in VR, have revealed motivational and cognitive benefits with regard to the transfer of learning, in multiple contexts (Makransky, Borre-Gude & Mayer, 2019). In the investigation of these authors, the methodology used was similar to that used in the present investigation, having been compared two groups, one that experienced a simulation in VR and another that had safety training through a written manual, having, after the experience, a retention test. The conclusions were that the group that experienced VR training showed better results in a real behaviour transfer situation than the second group, although they did not show better results in the retention test performed.

As in the previous study, the expectation in this investigation was precisely that the results would reveal superior safety behaviours in the participants of the experimental group when compared to the control group, which did not happen. It should be emphasized, however, that research on the relationship between the use of methodologies such as VR in contexts of safety training and the positive results obtained in learning, behavioural change and increased safety knowledge has obtained inconsistent results (Makransky, Borre-Gude & Mayer, 2019).

The inconsistency in the results can be explained by the multiple factors that can influence people's behaviour in these situations, such as the different contexts in which the investigations are made, the different methodologies used in the investigations and the type of work accidents described and simulated in the investigations (Burke et al., 2011; Makransky, Borre-Gude & Mayer, 2019). Another example of the variability obtained in the results of some investigations that use immersion in VR as a methodology is given by the research performed by Shi, Du, Ragan, Choi and Ma (2018), who sought to understand whether the safety behaviours of construction workers could be influenced by phenomena of social influence and by the observation of unsafe behaviour on the part of figurant actors who were present in the VE. The conclusion helped to realize that the unsafe behaviours of those figurant actors, have influenced the participants to move faster and, for this reason, increased the probability of them

also being involved in risky behaviours. This study helps to realize that, as in a real context, also in the VE, there may be other phenomena like social influence, such as, for example, from the actions of other actors present in the VE and that can lead people to get involved also in more or less safe behaviours. Although, in the present investigation, the VE is not composed by any other figurant actors, the study by Shi et al. (2018), is useful in that it helps to realize that, although experiments can be done in a VE, this methodology does not completely eliminates certain external factors that can influence participants' behaviours.

The results of the present investigation are not consistent with what the literature has indicated, as there were no significant differences between the two groups, about safety behaviours. The conclusions of the meta-analysis developed by Burke et al. (2011) point to an association between higher levels of involvement in training experiences and better safety performance, when compared to methodologies with less involvement in experience, but only in situations where the severity of the work accident is high. These conclusions can help to understand the results obtained, since in this investigation, despite the level of participation and involvement of the participants being different in the two groups, the severity of the work accident is low, since there are only a few boxes falling on top of the participant, which leads to no observable physical consequences from the accident itself. This absence of observable physical consequences may have influenced the results obtained and the absence of differences between the groups. Additionally, the existence of a single moment when it was necessary for participants to adopt safety behaviours, meant that the participants themselves hadn't had other opportunities to resort to and practice other safety behaviours, in order to check if there would be differences between the groups.

In terms of safety attitudes, there was also no significant difference between the results obtained by the participants of the experimental and control group, which also leads to a rejection of Hypothesis 2, which does not confirm the idea that different methodologies used for safety training, lead to an increase in safety attitudes, as expected. Although the average of the results of the items related to safety attitudes is slightly higher in the experimental group than in the control group, this is not significant.

Like the meta-analysis developed by Burke et al (2011), the level of involvement of participants in training experiences has also served to assess other variables, such as safety attitudes. In this regard, the research by Ricci, et al. (2016), which demonstrated that more practical and behavioural methodologies of safety training have more positive effects on workers' safety attitudes, as well as on their own self-protection attitudes, when compared to more conventional training methodologies, like the ones used in a classroom.

More recently, another study developed by Chittaro, Sioni, Crescentini and Fabbro (2017), sought to investigate whether the perception of risk and attitudes towards risk were superior in participants who experienced a VE that evokes danger and death, as the presence in cemeteries, than in the participants who experienced a VE that does not evoke death, such as circulation through a park with people. The conclusions of this study were precisely that the participants who experienced the VE that evokes situations of death have more safety attitudes when compared to the participants who experienced an environment in which death was not perceived as being present. Contrary to what the results of the present investigation demonstrate, the investigation by Chittaro et al. (2017) also reinforces that the presence of situations that evoke negative consequences for the subjects or for third parties in a VE, when used for training purposes, can also help the participants to change safety attitudes. In the case of the present investigation, the participants who experienced VR had the opportunity to see the stimulus that represented a dangerous situation, such as the box badly placed on the shelf, unlike those who read the written narrative, who did not have this opportunity and who did not. he was told that the box was incorrectly placed before the work accident occurred.

Approaching once again the research by Makransky, Borre-Gude and Mayer (2019), it was demonstrated that the use of VR for the purposes of safety training also leads to people reporting higher levels of self-efficacy and greater intrinsic motivation to act in line with safety procedures, compared to people who have safety training, using more conventional methodologies.

Although the literature indicates a positive direction in the relationship between the use of methodologies such as VR in safety training and the increase in safety attitudes, once again, the results of the present investigation do not match the evidence shown in the literature. Here, the experimental group did not reveal more safety attitudes than the group that had their training in a written narrative. In this sense, the results obtained are convergent with the investigation by Elkind (1993), as the author argues that greater knowledge of the risk factors and safety conditions of the activity, are not necessarily related to an increase in attitudes of safety. Although this study was carried out in the context of agriculture, for the author, the safety attitudes of workers' are more related to other variables such as the economic well-being of families or, conversely, with the costs that preventive measures can represent to farmers, and can also influence their own productivity. In the specific case of the training that the participants experienced in this investigation, the fact that an instruction was given to perform certain tasks, before the store opened, may have led them to think that their safety would not be a priority, but rather the execution of tasks before the store opens.

The same was verified for safety knowledge, since, again, there was no difference in the results obtained by the participants who received VR safety training, when compared with those who received safety training in written narrative. These results also lead to the rejection of Hypothesis 3. For this reason, they do not meet the investigation by Buttussi and Chittaro (2018), who revealed that the methodology and the device used for safety training, influence not only the involvement in safety procedures, as well as the participants' own knowledge of safe behaviours to adopt. These results are also not in line with what was expected, since the immersion of participants in the VR experience, according to the literature (Merchant, et al., 2014; Cunha, 2017), leads the participants to a greater sense of reality and a consequent increase in knowledge about safety procedures, when compared to other methods used, less close to what is the reality experienced, as is the case of a written narrative.

The literature has indicated that methodologies that use VR for the purposes of safety training have increased not only safety knowledge, but also the transfer of that knowledge to real situations, helping adaptation and behavioural change in workers from different contexts such as that of nursing (Rossler, Sankaranarayanan & Duvall, 2018), in the mining sector (Liang, Zhou & Gao, 2019) or in the industrial sector (Avveduto, Tanca, Lorenzini, Tecchia, Carrozzino & Bergamasco, 2017).

Specifically approaching the relationship between knowledge of the activity and the perception of present risks studied by Liang, Zhou and Gao (2019), in the mining sector, the authors sought to understand whether risk factors, such as the danger of falling stones within the mine is most effectively detected in a group that is subject to safety training through VR, when compared to a group of workers who in their training only watch a video. The results of the investigation by Liang, Zhou and Gao (2019), turned out to be positive in this relationship, as the participants in the experimental group, which interacted with the VE, acquired safety knowledge more quickly, more memorized the experiences and better understood the procedures to be adopted in this type of situations, when compared to the participants of the second group who only watched a video. In this investigation, the greater knowledge of safety of the participants in the experimental group led them to have greater capacity to avoid situations of falling stones and, thus, to be involved in less dangerous situations, in comparison with the second group that was more involved in dangerous situations.

Recalling also the investigation by De Keyser (1988), the perception of risk factors, the workload and the relationship between working conditions, are essential for the knowledge of the activity, its risk factors and, consequently, for the development of safer behaviours. From what has been described and demonstrated in the literature, what was expected in the present

investigation is that the participants who experienced VR training, as they had contact with the VE, should reveal a more detailed knowledge of the activity and risk factors, by comparison with the group of participants who read the written narrative, which did not happen, with no differences between groups. The results can also be explained by the safety training being composed of only one moment when there was an accident at work. In this sense, it would be interesting to see if there would be differences in these results, in other situations and with other risk factors present.

An explanatory factor for this reality may be due precisely to the fact that greater knowledge of the activity in a VE is not necessarily related to greater knowledge and perception of the risk factors present, when compared to the written narrative. This relationship was studied by Eiris, Gheisari and Esmaeili (2020), who wanted to compare the use of VR and a 360-degree simulation as methodologies for safety training and its benefits in increasing safety knowledge. The results of this study demonstrate that, although there is a greater ability to identify risk factors for those who experienced the condition of VR, the scenarios built for VE are simplified and often do not allow the perception of the true risks and conditions present in the real work environment. In the present investigation, the risk factor to be identified and which leads to the occurrence of a work accident, is not easily identifiable, as the box that is incorrectly placed on the shelf is not at eye level, being on the highest shelf. For this reason, there may have been a considerable number of participants in the experimental group who were unable to identify the risk factor itself, before the accident occurred, leading the experimental group and the control group, for which it was presented a written narrative, have obtained similar results with regard to safety knowledge.

The fact that the reported safety behaviours were not greater in the experimental group, as happened with safety knowledge, does not respect the principle defended in De Keyser's investigation (1988), that the deeper knowledge of the activity and its conditions it is more related to the increase in knowledge and safety behaviours.

The expectation that the relationship between the methodology used in safety training and the dependent variables under study was moderated by the safety climate was not verified, which leads to the rejection of Hypothesis 4. Although the relationship between these variables is rarely addressed in the literature, the moderating effect of the safety climate was tested in the relationship between the methodology used in safety training and each of the dependent variables, safety behaviours, safety attitudes and safety knowledge, individually, with the result being similar for each of them, proving the absence of a moderating effect.

The use of the safety climate as a moderating variable in the present investigation was defined by the results that have been obtained in the literature (Neal, Griffin & Hart, 2000; Mullen, Kelloway & Teed, 2017) of its influence on safety indicators.

Initially, the investigation by Neal, Griffin and Hart (2000), was one of the first to test the safety climate by mediating a relationship between two other variables, specifically the organizational climate in the organization's safety practices. The results were positive for the mediation of this relationship. Subsequently, the investigation by Clarke (2012), also demonstrated that the perceived safety climate also partially mediated the relation between the type of leadership and participation in safety behaviours. In both studies, the safety climate influences workers' safety behaviours. Another study used the leadership style related to compliance with safety rules as a moderating variable in the relationship between the employees' perception of the employer's safety obligations and the employees' own safety behaviours and attitudes (Mullen, Kelloway & Teed, 2017). The results precisely indicated this moderating effect, as the existence of a leadership focused on safety and compliance with safety rules has a positive influence on the attitudes and behaviours of employees.

The importance of safety training programs in the development of safety indicators by workers has been studied by Christian, et al. (2009), who demonstrated that this relationship is positive, complementing with the idea that the managers of these organizations have a fundamental role in this awareness and education for safe behaviours. They also demonstrated that the leaderships' commitment to safety is associated with an increase in the safety performance of the workers themselves.

Complementary to the study previously presented, Barling and Hutchinson (2009), also address that the implementation of training programs is important for an improvement in the safety indicators of organizations, a relationship that is enhanced by the safety climate and the importance attributed by the organization to the development of safety policies.

Analyzing the average results obtained for each of the four variables under study, safety behaviours, safety attitudes, safety knowledge and safety climate, the latter was the variable where the lowest average value was obtained in the responses of the participants in the experimental group ($M = 4{,}48$; $SD = .62$) and in the control group ($M = 4{,}51$; $SD = .43$), compared to the other variables. These results can also contribute to the short tenure that employees in each group have, on average, at C Company 2.80 years ($SD = 3.19$) for the experimental group and 3.86 years ($SD = 3.99$) for the control group. These results help to clarify that the perception of the safety climate of C Company by its employees is not superior, on average, to the attitudes, behaviours and knowledge that they themselves report having.

Given the ambitions of C Company, revealed in the preparatory meetings for the investigation, these results do not match the evidence of the investigation developed by Barling and Hutchinson (2009), as the implementation of safety training did not enhance the safety behaviours, attitudes and knowledge of employees, having no moderation effect of the safety climate in this relationship. In this sense, the results obtained could be different, if there were not only a more regular investment in these actions and training methodologies by C Company, as well as a greater awareness of managers for the participation of employees in those training programs, being those integrated in their own workflow.

Finally, in what respects to the retention test carried out two weeks after the safety training, it was expected that the experimental group would have a greater retention of the experience and its events translated by a higher average of correct responses, when compared with the group of control. These were not the results obtained, so Hypothesis 5 also rejected in the same way. The expectation that the experimental group would obtain better results than the control group is mainly due to the fact that in both experimental and control groups, the narrative has always been in the sense that safety would be a priority factor, although in the experimental group, this indication was given verbally in the virtual environment, whereas in the group of control it was present in a written sentence. Also, the conclusions that have been obtained in the literature in recent years helped to have this expectation.

Following the results of the research by Carlson and colleagues (2015), mentioned above, who in their study also used a two-week interval between training and retention testing to compare a group that had received VR and another group that had received training on the spot, physically, it was concluded that the retention of information in the experimental group was not less than the retention of information in the control group, which received training on the physical site. In addition, the study by Buttussi and Chittaro (2018) also used a two-week interval to test the retention of safety knowledge and the conclusion was that the use of VR devices allows the retention of knowledge during this period. Finally, the expectation of confirming Hypothesis 5 in the present investigation was linked to the results previously mentioned, as well as the conclusions obtained by Sacks, Perlman and Barak (2013) who, in their investigation, although in the construction sector, demonstrated that learning remains more stable over time in participants who have experienced VR safety training, when compared to participants who have received training in the classroom, with photos, images and texts.

Although it was initially planned to apply the second part of the retention test exactly two weeks after the experiment, there was a great variability in the response time to it, with participants who responded two weeks after the experiment, and others who took about a month

to respond, or others who ended up not responding. The fact that the retention test was carried out remotely contributed to the fact that the data had not all been collected at this stage of the procedure.

Another explanation for the fact that there were no differences between the two groups, either in the first application of the retention test, or in the second, two weeks later, may be due to the participants' prior knowledge of the tasks usually performed in a warehouse of C Company or the type of care to be taken when storing the shelves, which would lead to easier and more predictable responses by the participants. This phenomenon, also known as *ceiling effect*, concerns a set of items that are easy to answer by the participants, which leads them to get it right in most situations, thus reducing the variance in the answers obtained (American Psychological Association, 2020). Similarly, in another study about safety training in the aviation context, this phenomenon was also discussed as explaining the absence of differences in the perceptions of behaviours to be adopted by two groups in the pre and post-test (Chittaro & Buttussi, 2018). The same result was obtained by Makransky, Borre-Gude & Mayer (2019), who explain that the absence of differences in retention tests between two groups, subject to different training methodologies, may be due to the existence of few items that measure the behaviours to be adopted or adopted by themselves. In the case of the present investigation, this is what happened, given that in the retention test, only one of the questions sought to explore the behaviour of the participants, asking them about what should have been done to avoid an accident at work. Precisely, this question "What should have been done to prevent this occurrence?" was one of the two questions of which differences were found, with better results to the experimental group, probably due to the fact that it is easier to understand the safety behaviors to be adopted in a risky situation, when we are in the VE dealing with its stimuli, than when we are reading a written narrative that can make it difficult to perceive the behaviors to adopt.

Overall, the general results do not meet the defined hypotheses, with some constraints arising not only in the operationalization of the experience, but also in the different moments of data collection. The fact that the experiment was carried out during the working hours of C Company's employees and at their workplace, may have negatively influenced the response time and the participants' own responses. In some specific cases, the fact that the data is collected during hours of greater flow of customers in the stores, may have precipitated the responses of the participants a little. Furthermore, in the second application of the retention test, two weeks after the experiment, the fact that it was delivered via email, did not allow the

control of the time and place of the participants' response, their spontaneity, nor the control for avoid possible sharing of information between participants.

Limitations

To talk about the limitations of this research is to talk about some constraints that somehow had a negative impact not only on the results, but also on the data collection methodology itself and on the development of all stages of the research itself. Considering the limitations that will be presented below, the purpose of their presentation is also related to a deeper analysis and a more distant view of what could have gone better and, consequently, to influence our findings. Subsequently, appropriate suggestions will be made for future investigations that can be used to control these limitations.

The present investigation having been carried out in partnership with C Company, the context in which the results must be interpreted is in the retail sector. Due to the scarce existing literature on the use of these methodologies for safety training in the retail sector, the justifications for the results obtained were made by comparison with other studies, with methodologies that were similar to those used in this investigation, even though the contexts in which these investigations were carried, were different. This was the case in the present investigation, so the interpretations of the results obtained, and their conclusions must be viewed with caution.

The realization of this study in real context and with all its idiosyncrasies made many of the conditions for conducting research and logistics itself different from a controlled laboratory study. Conducting a study in real context, as it indicates, contemplates a constant adaptation of the procedures to unpredictable situations that are not totally controlled by either the actors of the situations or the researchers. This constant need for adaptation of the research plan is a limitation because any temporal planning, procedures to follow, necessary materials or contingency plans make it impossible to control all scenarios that may occur. In the case of C Company, a constant articulation and frequent dialogue was necessary, not only to clarify the research objectives and the establishment of goals and expectations for both the organization and the research, but also to set deadlines and goals to be achieved.

Difficulties in planning and meeting deadlines for real-time investigations are precisely the second limitation to the fact that adjustments are made according to the emerging priorities. In the specific case of C Company, the first meeting of the Research Plan presentation was held at the end of october in 2018, so that not only the intended plan and objectives could be

discussed, but also the terms of acceptance for C Company. Following this meeting, project approval was dependent on certain details such as the establishment and signing of a Collaboration Protocol by the Parties concerned, the researcher, ISCTE, through the Project Advisor and C Company, the formal authorization of C Company for data collection, as well as the authorization to use C Company data VR equipment. The use of C Company equipment was considered because they had the entire VR device and their own VR experience to be used for this research. With several delays in scheduling and data collection, data were collection only started in june.

The existence of these delays in the timings and the consequent delayed data collection was a very negative point to highlight because it reflected the difference in the expectations of the parties involved, especially regarding priorities. While on one hand, it was in the best interest of this investigation that data had started to be collected well in advance, on the other hand, meetings with C Company provided a better understanding that data collection, apparently, was not as a priority for the organization. At that time, there were other tighter deadlines that the organization itself had to meet and prioritized. Again, and recalling the research by Rundmo and Hale (2003), the priorities of organizations are essential in defining their practices and therefore safety practices will also be considered a priority if safety is one of the main criteria for C Company's organizational effectiveness. Clearly, setting expectations and deadlines for each stage of research development is always important to ensure that both researchers and organization leaders themselves understand the importance and share the same goal in conducting the research. In this situation, it could have resulted in a stricter compliance with the deadlines and the sequence of research steps, from presenting the instrument to obtaining and discussing the results.

Another type of constraints and limitations encountered were related to the methodology used on this investigation.

The first limitation in this sense is that although the translation and retroversion method was used in this investigation, the items were not constructed for the Portuguese population, meaning that they did not consider cultural issues and the idiosyncratic characteristics of its people.

The fact that data collection was done with C Company's employees meant that their own willingness to participate in the experiment was conditioned not only on their interest, but also on the working hours and the peak customer turnout on C Company's stores. The data was collected during the summer, when more people are on vacation, which turned the work rate faster and therefore the availability of participants more limited. Speaking of the availability of

the participants themselves, and considering that the data was not collected in one single moment but in two different, there were two participants who stated that they could not respond to the second moment of participation because they would be on vacation and for that reason they would not answer.

As stated before in the discussion, talking about another aspect of the methodology that limited the construction of the VE itself and the addition of more stimuli that could differentiate the results of this investigation, it concerns the fact that the whole experience was previously built before the beginning investigation, which was used for the subsequent collection of data. The use of an experience in a VE that tests safety behaviours, presenting as the only stimulus, the need to store a badly packed box on a shelf to avoid a work accident, can greatly limit the self-assessment of participants, regarding their safety behaviours, insofar as it is only at that moment that the participants are tested. Additionally, and since the written narrative had to be replicated from the VE to the paper, this caused the narrative used for the control group to be quite short and somewhat poor in terms of the presented stimuli.

The division of the methodology into two distinct moments was thought to distance the first moment from the second in 2 weeks. Because the literature (Buttussi & Chittaro, 2018; Carlson et al., 2015) indicates 2 weeks apart between a first moment and a second moment in data collection, this was also the time interval used in the investigation, during which some people had lost contact with the research themselves and may have lost the sense of the importance of completing that second moment. Although the importance of participants also performing the second part of the data collection was reinforced, only 56% of participants completed this second phase. The two-week spacing between data collection moments caused significant mortality in the sample, especially in the experimental group, as only 12 out of 30 participants have completed the investigation, while in the 31 participants in the control group, 22 have completed the two moments.

For the mortality of the sample at the second moment of data collection, it was also contributed the fact that data were collected remotely via email. As such, the distance did not allow the researcher to isolate each participant from distracting factors and place them in the most controlled environment possible. Even at distance, if the data had been collected via phone calls, this would allow a greater control over the time taken to respond and would help to understand whether participants have responded by their own memory.

The disadvantage of collecting data remotely is precisely to prevent any contagion effects that may cause some participants to respond depending on peers' memories and work, or even to do the second moment together. In the research by Andrews and Rapp (2015), where

the benefits of performing memory tasks in group are discussed, the authors demonstrate that interactions between participants and the group not only help to more easily evoke events and details, as well as a debate of ideas and opinions, helping to discriminate critically the information. In this sense, participants' responses may not be related to the results of their own retention, but rather to colleagues' memories. Only on-site data collection could eliminate the risks of contagion effects and response transfers between participants. This limitation was so much felt in this investigation, since there were participants who, in the second moment of the retention test, two weeks after the first part, with the same questions, achieved a better performance than in the first moment that was immediately after the experience. While in the experimental group 2 out 12 participants have improved their performance in the second part, in the control group a total of 6 out of 22 participants also improved their performance on the retention test, two weeks after the experience. This number of people who improved their performance in both groups represent a percentage of 17% and 27%, respectively. These results ask for an explanation, as it is not normal, that a person can outperform a memory test two weeks after the experiment, compared to the moment immediately after the experiment. In this sense, remote data collection has not allowed to control the absence of contagion effects or to prevent the transfer of information.

The remote data collection itself led to greater variability in response interval time as some participants have responded to the second retention test application after two weeks as expected, but some others didn't, as they responded to the second application only one month after the first part of the experiment and after successive emails stressing its importance for research. This lack of uniformity of interval time between the two moments of the experiment makes it difficult to compare participants' results, as the methodology was not similar for all. Once again, the remote collection and constant emailing reinforcing the importance of responding to the second part of the experiment did not result in the participants' greater compliance with the timings.

Going further with the limitations, the participants' lack of knowledge and beliefs about the importance and objectives of the study may have caused C Company's own employees and research participants to have felt less involved and perhaps perceived importance of this research as being less important for their duties and the consequent results of the organization. In this sense, the limitation was not the low importance perceived by the participants in the fulfillment of all research data collection moments, but rather the lack of strategies and articulation between the researcher and the team managers, in order to raise awareness from the early beginning of the experiment to the importance that the research results could have for

C Company and the safety training methodologies used. With this lack of clarity, participants themselves may not have felt that the second retention test application was relevant, leading to a mortality of nearly 50% of the sample in both groups at the second retention test application.

In what concerns to the space used for data collection and participation in the experiment, it had to be done in C Company facilities, such as its own warehouses, its meal rooms, or even the offices. In the latter case, as they were tighter, the offices were only used to collect data in the control group as the entire VR device did not have to be assembled. The experimental group that had to use this device had to have a larger space for mounting the circuit of motion sensors needing a minimum distance from each other. Here, the measures previously referred as necessary to construct the virtual space where participants would have to move, in a rectangle with minimum dimensions of 2m x 1.5m, made quite difficult to establish these virtual boundaries to construct the walking zone of the participants themselves. Through the confined spaces, there were participants who frequently reported seeing the walls, which represents the virtual limits of the scenario, from which the participants must move away. This constant visualization of boundaries that cannot be crossed, in a grid of blue squares, in the participant's field of view, can also take some sense of realism out of the experience as regards the participant's sense of presence in the VE and possibly distract them even from the true focus of the experience. As well as not being very spacious, these places were also circulation areas for employees who were changing shifts, as well as dining areas for those on break. This limitation is related to the fact that these people act as distractors for the participants, even if they themselves were using a VR device.

Finally, there was also a difference in expectations created between the two groups, as managers informed employees that they were going to participate in an innovative VR device experience. This setting of expectations by the employees was confirmed by those who were part of the experimental group, as opposed to the control group that only read a written narrative. This break of expectations was noted in the motivation of the control group employees themselves who, when they realized that they would not have the experience in VR, were somehow disappointed. For this reason, in order for the effects of VR to be felt by the control group as well, the solution would be to apply the same methodological conditions later to that group, so that they could also experience VR, albeit with a neutral stimulus.

Future Research

Considering the limitations that this research had, there are some suggestions that should be made to ensure precisely that future investigations can control the largest number of

external variables and influencers of the results. The proposals, in this sense, are not to improve safety at C Company directly, but to build, from scratch, a proposal to validate an instrument and training methodologies that promote more attitudes and a greater number of behaviours in its employees, consequently, reducing the number of work accidents to the minimum.

For future investigations, the first suggestion is precisely the concern that there should be with the consistency of each instrument used. The use and validation of all instruments for the Portuguese population is an important factor in ensuring the consistency of the items of each instrument and what they are measuring.

Secondly, and arguing perhaps one of the most critical factors that may have contributed to the results of this research, it is necessary to underline and ensure before starting the research that researchers and the managers that allow it, share the same objectives and expectations as regards research and its possible outcomes. To warn organizations to reinforce with their employees the importance of research for the positive results of safety in the organization is also to guarantee evidence provided by the organization that shares the priority for the development or change of safety internal practices. Early meetings with managers are very important to clarify precisely the importance that research can have on organizational policies. In addition, making managers aware of the issues involved in research can help employees to be more motivated, not only to participate in it, but also to change their attitudes and behaviours. Here, as already mentioned, the adhesion to the research will be higher, the higher is the importance perceived by the employees about the theme and the influence that it can have in aspects related to their work or even in their performance. As noted by Neal and Griffin (2004), management's actions and the creation of safety training Programs will make a difference in the importance attached by employees to the compliance with safety procedures and for them to assume that safety is directly related to their productivity. In future investigations, the high commitment to their objectives and goals must be ensured and monitored, so that focus is not lost, and timings are met.

Addressing some of the limitations that were pointed out previously and that may have contributed to not obtaining the expected results, there are some suggestions to make and that may be important for future investigations.

The definition of the material to be used in an investigation, gains an additional importance, when comparing two groups, in an experimental study. When defining the material to be used in the present study, it was defined that an experience that had been previously built for the purposes of training in safety culture would be used, even though the experience itself was not built with this specific study in mind, since it was already built in a VE, prior to

defining the objectives of the study itself. As mentioned, given that the experience in the VE itself consisted only of a single moment in which the participants would have to adopt a safety behaviour, this reality may have made it difficult to obtain different results between the two groups. It is therefore suggested that, in future occasions, the experience in a VE be constructed with a greater multiplicity of stimuli that require specific safety behaviours from the participants to avoid accidents at work in order to check if there are still no differences in the tested groups.

Looking also at some of the conditions of this research and the methodology itself, future studies may consider experimentation and data collection in a more isolated context of external distractors, as well as a wider space that allows the participant greater capacity for walking through the VR zone.

As stated before, the use of written narrative was due to the inexistence of a VE scenario with a neutral stimulus. In future investigations a second scenario should be constructed for the control group or, if it is not possible to construct a scenario with the same conditions as the experimental group in which the stimulus is neutral, greater care should be taken at the communication of the goals, so that won't crate false expectations about the investigation. The motivational differences that resulted in the present investigation resulting from non-compliance with these expectations should be controlled in order that both groups are in the same conditions and even for the control group not to feel deprived when compared to the experimental group.

Comparative studies can be carried out between groups in order to verify whether people who have already suffered work accidents have different outcomes regarding safety behaviours, as Rundmo (1996) did in his study, or in safety attitudes, as Gharibi et al. (2016) proved in their research, but in a context of safety training in VR. From a cross-group point of view, the comparison between two groups with different years of experience in C Company may also be relevant to compare the results, as it is expected that those who have been in the organization for a longer time already have a deeper knowledge about the existence of a strong safety culture or not and, consequently, its practices. This idea was well documented in the literature that defined *Safety Culture* as the set of values shared by the members of an organization (Guldenmund, 2000; Lee, et al., 2018), that may take longer to modify because it would be necessary to modify some mental processes of those members who are already well acquainted with the values of the organization and have a deeper knowledge of the rules and their own internal organizational culture, when compared to new members in the organization. In fact, another investigation of Morassaei, et al. (2012), was precisely at the heart of this issue,

having studied over 10-year period the relationship between job tenure and working time lost due to occupational injuries. The first conclusion of this study was that workers newly joined to an organization with less than one year in the organization had longer periods of absenteeism when compared to employees who had been in the same company for more than one year. year. In the same vein, Breslin and Smith (2006) investigation, also indicated that new workers in the organization tend to engage more in risky behaviours when compared to more experienced workers in the same organization. The guidelines are that these workers should not only be placed at less risk of injury jobs but should also attend safety training programs earlier.

From the point of view of the work accident that is experienced in VE, it can be studied whether the type and severity of work accident suffered can impact on the development of safer attitudes and behaviours, as well as a better memory of the events that occur in the VR experience. The study by Burke et al. (2006), reveals that a greater immersion in the VR experience and an experience that culminates in a work accident with visible consequences for the participant itself is more impactful in changing one's own safety behaviours. Here, work accidents with different levels of severity may have a different impact on these variables, and it would be interesting to study to what extent these differences exist and, if they exist, whether they are larger or smaller in accidents with greater consequences for the participant.

Finally, another adaptation that can be made in the investigation is the inclusion of figurants and other actors in the VE, in order to verify the influence of other phenomena like the social influence in the participants behaviours and if the observation of certain actors behaviours' by the participants can influence their own behaviours, as suggested by Shi et al. (2018).

The suggestions made here for future research should, of course, be adapted according to the objectives and variables under study, as well as the type of population to be tested. For this reason, all the suggestions presented, must be understood, and contextualized for the C Company reality and not for other contexts.

Conclusion

The present investigation aimed to evaluate the influence of the methodology used for safety training on safety behaviours, attitudes and knowledge, aiming to test also if this relationship was moderated by the safety climate. The differentiation of the two groups was done using VR as a methodology for the experimental group or, in contrast, for the control group, a written narrative. To guarantee that this narrative would be reliable to the speech

present in the VE, each instruction and word present in the VE was transcribed. In addition, to ensure the quality of immersion of participants in the VE, prior to development, the IPQ instrument (Vasconcelos-Raposo, et al., 2016) was applied to pre-test the extent to which people feel present and immersed in the VE. The collection of data was divided into two different moments separated in two weeks, precisely so that they allowed to perceive the stability of the learning of safety behaviours, attitudes and knowledge, showing the differences between the two groups.

The results of the investigation revealed an absence of differences between the two groups in the variables under study and an absence of a moderating effect of the safety climate on the results. Despite this, the literature has indicated that safety training, using methodologies such as VR is a good alternative to more conventional methodologies, as it allows the person to have an experience closer to reality (Sacks, Perlman & Barak, 2013; Ragan , et al., 2015) and with positive results in the safety procedures adopted by workers (Buttussi & Chittaro, 2018). Although the results have not proven the influence of the VR training methodology on safety indicators, and given the limitations and respective suggestions for future research, this investigation may motivate further studies on the influence of using these methodologies in changing employee behaviours of a given organization, also giving some clues of contextual factors to control, if the investigation is done in a real context. In fact, as previously discussed in the limitations of the investigation, some contextual factors such as data collection having been done during full working hours, in hours with a greater flow of customers, or the limited space for data collection in the experimental group, may have contributed so that the results obtained have not been as expected. Although the results were not the expected, considering the limitations found in the study, the research team emphasizes that it continues to believe in the hypotheses defined and in their direction, having those derived from the results obtained in previous investigations. In this sense, with a more controlled sample and for which participation in research is perceived as a priority, as well as the modification of some aspects in the procedure, such as all moments of data collection being in person, can lead to other results, so it would be interesting to study these hypotheses, controlling as much as possible all these contextual variables.

Although the results obtained are not conclusive on the advantages that these methodologies offer C Company's employees in their safety training, they can motivate their management to understand the importance of safety training and its methodologies. For this, the use of scenarios that are as close as possible to the realities lived by employees in their day-to-day lives are essential so that they can remember which are the correct procedures to provide

in the different situations they encounter and that may represent a danger to them. It can also help C Company management to measure the impact that these training programs can have, when carried out regularly, on the behaviour, attitudes and knowledge about the safety of its workers. Finally, holding these sessions on a regular basis will lead their employees to understand the importance of engaging in and seek safety behaviours and, consequently, fight against risky behaviours.

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Appendix A. Safety Training in Written Narrative used for Control Group

De seguida, será apresentado um breve excerto, o qual deve ser **lido com a máxima atenção.**

Hoje é o teu primeiro dia de trabalho na [redacted]. Faltam 10 minutos para a loja abrir e o gerente de loja vai ter uma reunião. Por isso, ainda que seja o teu primeiro dia, terás de ser tu a abrir a loja. Antes disso, não te podes esquecer de algumas tarefas. Por ser o teu primeiro dia, o gerente de loja dá-te algumas indicações e pede a tua atenção para as tarefas que tens de fazer. Pede que o oiças com atenção e reforça:

- "A Segurança está sempre em primeiro lugar".

Inicialmente, é preciso desligar o alarme da loja, que está entre a televisão e a janela. De seguida, tens de abrir as cortinas, carregando no botão eletrónico junto à janela. Por fim, deves ligar a televisão com o comando que se encontra em cima da mesa. Quando acabas, tens as tarefas do Lounge concluídas. Posteriormente, tens de ir ao armazém para fazer outras tarefas. Apanhas o elevador para ires ao armazém 1.

No armazém 1, tens de verificar sempre se existem ou não caixas desarrumadas em cima da mesa. Observas, e, como existem, arruma-las na estante que estiver mais próxima da mesa. Mas atenção, sabes que deves verificar o tipo de caixa que está em cima da mesa, e se está de acordo com a prateleira onde estás a arrumar as caixas. No momento em que estás a arrumar as caixas nas respetivas prateleiras, sofres um acidente de trabalho.

O que aconteceu?

Caíram caixas em cima da tua cabeça. Existiam objetos nas estantes. Ao colocar as caixas nas prateleiras, as que estavam mal arrumadas, caíram.

Em situação real, as tuas ações poderiam ter danos irreversíveis para ti e para a Nespresso. Na [redacted], um acidente, é um acidente a mais... Por isso, todos os acidentes devem ser evitados. Para tal, é fundamental o compromisso de todos.

Appendix B. Questionnaire

Segurança na [redacted] Código do Questionário_____

Olá. Uma vez mais, muito obrigado por ter aceitado participar neste estudo. O meu nome é João Pedro Robalo Teixeira e sou aluno do Mestrado em Psicologia Social e das Organizações do ISCTE-IUL. Estou a estudar alguns indicadores de segurança na [redacted] e venho por este meio pedir a sua colaboração no preenchimento deste questionário para a obtenção de dados para a minha Dissertação. A duração estimada não excede os 15 minutos.

Este estudo é composto por duas partes distintas:

Parte 1: Esta parte é composta por uma experiência inicial, resposta a um questionário e resposta a um conjunto de questões adicionais. As respostas serão dadas em papel;

Parte 2: Esta segunda parte é composta por um conjunto de questões de resposta rápida que serão enviadas via email, 2 semanas após a parte 1. Para tal deve indicar o seu email.

Nota Importante: Para que os seus dados sejam válidos e considerados para este estudo é necessário que responda às duas partes do estudo.

Para a correspondência de ambas as partes do estudo solicito que, no canto superior direito de cada folha (no "Código do Questionário"), indique em todos os instrumentos de resposta: 1. A letra inicial do seu nome; 2. A letra inicial do seu apelido; 3. A letra inicial do seu local de residência; 4. A letra inicial do nome da sua mãe. Exemplo: **Código do Questionário:** JTAM

De seguida, peço que leia com a máxima atenção cada uma das questões e que responda da forma mais sincera possível pois, só assim, poderá contribuir para esta investigação. Para tal, solicito que seja breve a responder a cada questão por forma a garantir a sua opinião livre.

O questionário é totalmente anónimo e a informação obtida confidencial, sendo utilizada exclusivamente para fins académicos. A sua participação nesta investigação é livre e voluntária pelo que pode desistir em qualquer momento, se assim o desejar.

Dados Biográficos

1. Sexo/Género: _____

2. Idade: _____

3. Habilitações Académicas: Ensino Básico ☐ Ensino Secundário ☐ Ensino Superior ☐

Outro ☐ Qual? _____

4. Há quanto tempo trabalha na [redacted]? _____

5. Desde que trabalha na [redacted] já recebeu Formação em Segurança? Sim ☐ Não ☐

6. Email: _____

Segurança na [redacted] Código do Questionário_____

Discordo Completamente	Discordo	Discordo Ligeiramente	Concordo Ligeiramente	Concordo	Concordo Completamente
1	2	3	4	5	6

De acordo com a escala anteriormente apresentada, responda às seguintes questões:

1- Muitos acidentes e lesões de pequenas dimensões podem revelar a forte possibilidade da ocorrência de acidentes de trabalho graves;	1	2	3	4	5	6
2- As pessoas estão dispostas a fazer um grande esforço para que o trabalho possa ser desempenhado de uma forma segura;	1	2	3	4	5	6
3- Às vezes, é necessário afastar-me dos requisitos de segurança, em prol da produtividade;	1	2	3	4	5	6
4- Estive consciente do mundo real enquanto navegava no ambiente virtual;	1	2	3	4	5	6
5- A cadeia de comando faz com que não nos sintamos à vontade para falar sobre as preocupações relativamente à segurança;	1	2	3	4	5	6
6- Tive a sensação de estar a atuar num espaço virtual;	1	2	3	4	5	6
7- Os meus chefes estão dispostos a aprender com os acidentes;	1	2	3	4	5	6
8- Invisto um esforço extra na melhoria da segurança no local de trabalho;	1	2	3	4	5	6
9- Desenvolvo voluntariamente tarefas ou atividades que ajudam a melhorar a segurança no local de trabalho;	1	2	3	4	5	6
10- As pessoas do departamento de segurança são muito influentes dentro da [redacted];	1	2	3	4	5	6
11- As pessoas estão bem preparadas para as emergências, e todos sabem como responder em caso de emergência;	1	2	3	4	5	6
12- O ambiente virtual pareceu-me completamente real;	1	2	3	4	5	6
13- A formação em segurança é feita regularmente;	1	2	3	4	5	6
14- Senti-me presente no ambiente virtual;	1	2	3	4	5	6
15- O equipamento de segurança está sempre disponível;	1	2	3	4	5	6
16- Eu entendo as regras de segurança e saúde relacionadas com o meu trabalho;	1	2	3	4	5	6
17- Existe uma adequada formação em segurança;	1	2	3	4	5	6
18- A experiência no ambiente virtual pareceu-me tão real como as minhas vivências do dia-a-dia;	1	2	3	4	5	6
19- Quando ocorre um acidente reajustam-se as normas de segurança existentes;	1	2	3	4	5	6
20- Utilizo os procedimentos de segurança corretos para desenvolver o meu trabalho;	1	2	3	4	5	6

Discordo Completamente	Discordo	Discordo Ligeiramente	Concordo Ligeiramente	Concordo	Concordo Completamente
1	2	3	4	5	6

21- Eu tive a sensação de "estar" no ambiente virtual;	1	2	3	4	5	6
22- As estatísticas de segurança raramente são estudadas e discutidas;	1	2	3	4	5	6
23- As medidas de segurança apenas mudam os perigos de uma área para outra;	1	2	3	4	5	6
24- Se eu me estivesse sempre a preocupar com a segurança, o meu trabalho não ficaria feito;	1	2	3	4	5	6
25- Os acidentes de trabalho são resultado de um mau planeamento e de uma má gestão;	1	2	3	4	5	6
26- Habitualmente, os lucros económicos estão em conflitos com as medidas de melhoria da segurança pessoal;	1	2	3	4	5	6
27- Eu não estava consciente do mundo real que me rodeava;	1	2	3	4	5	6
28- Não nos é fornecida informação adequada sobre o que se passa em termos de segurança na [redacted];	1	2	3	4	5	6
29- Chamar a atenção para violações de segurança pode ser facilmente sentido como um aborrecimento desnecessário;	1	2	3	4	5	6
30- Eu tenho o conhecimento que preciso para usar os equipamentos do meu trabalho de forma segura;	1	2	3	4	5	6
31- O ambiente virtual pareceu-me mais realista do que o mundo real;	1	2	3	4	5	6
32- Existe alguma confusão sobre quem devemos contactar quando se trata das questões de segurança;	1	2	3	4	5	6
33- Muitos acidentes acontecem porque as pessoas simplesmente não os podem evitar;	1	2	3	4	5	6
34- As chefias não têm muita formação para identificar e tratar de problemas com a segurança;	1	2	3	4	5	6
35- Corrijo os meus colegas quando eles estão a trabalhar em condições perigosas ou arriscadas;	1	2	3	4	5	6
36- A cadeia de comando dá atenção ao que o departamento de segurança diz;	1	2	3	4	5	6
37- Durante a experiência continuei a prestar atenção ao local onde estava a ter a experiência;	1	2	3	4	5	6
38- Nas vezes em que trabalhei sem segurança foi porque tinha de realizar rapidamente a tarefa;	1	2	3	4	5	6
39- As regras e as instruções de segurança pessoal, por vezes, dificultam o acompanhamento das metas de produção;	1	2	3	4	5	6

Discordo Completamente	Discordo	Discordo Ligeiramente	Concordo Ligeiramente	Concordo	Concordo Completamente
1	2	3	4	5	6

40- O ambiente virtual pareceu-me tão real como o mundo que conheço;	1	2	3	4	5	6
41- Desenvolvo o meu trabalho de forma segura;	1	2	3	4	5	6
42- De alguma forma eu senti que o mundo virtual me envolveu;	1	2	3	4	5	6
43- Quando há muito trabalho não é possível seguir as normas de segurança;	1	2	3	4	5	6
44- A cadeia de comando não demonstra grande preocupação com a segurança, até existir um acidente;	1	2	3	4	5	6
45- Os acidentes têm servido para aumentar as condições de segurança da [redacted];	1	2	3	4	5	6
46- Senti-me completamente atraído pelo ambiente virtual;	1	2	3	4	5	6
47- Senti-me como se estivesse apenas a visualizar imagens;	1	2	3	4	5	6
48- Às vezes, é necessário correr riscos para garantir que o trabalho é feito;	1	2	3	4	5	6
49- Boas propostas para melhorias na segurança são muitas vezes ignoradas porque custam muito à [redacted];	1	2	3	4	5	6
50- Promovo o programa de segurança dentro da [redacted];	1	2	3	4	5	6
51- Quando vejo que as instruções de segurança não estão a ser cumpridas, eu chamo imediatamente a atenção da pessoa;	1	2	3	4	5	6
52- Não me senti presente no ambiente virtual;	1	2	3	4	5	6
53- Eu sei como desempenhar o meu trabalho de forma segura;	1	2	3	4	5	6
54- Eu sei como reduzir o risco de acidentes de trabalho e incidentes no local de trabalho;	1	2	3	4	5	6
55- Utilizo todo o equipamento de segurança necessário para desenvolver o meu trabalho;	1	2	3	4	5	6
56- Quando ocorre um acidente ele é discutido e aprende-se com ele;	1	2	3	4	5	6
57- Às vezes é preciso correr algum risco para acabar o trabalho mais depressa;	1	2	3	4	5	6
58- É dada atenção à manutenção de boas condições de segurança nas nossas instalações;	1	2	3	4	5	6
59- Asseguro a existência dos níveis mais elevados de segurança quando desenvolvo o meu trabalho;	1	2	3	4	5	6

Appendix C. Retention Test before Pre-test

Leia com atenção as seguintes questões e **responda sucintamente ao que lhe é pedido**, utilizando, para o efeito, **apenas o espaço designado para cada questão**, sem saltar questões.

- Quais os espaços onde se desenrolou a experiência?

- Indicando o nome do primeiro espaço, que tarefas aqui foram realizadas?

- Indicando o nome do segundo espaço, que tarefas aqui foram realizadas?

- O que é que, segundo o Gerente de Loja, vem em primeiro lugar?

- O que acontece durante a sua última tarefa?

- Que tarefa estava a ser realizada quando se deu a ocorrência?

- Qual o perigo que provocou a ocorrência?

- O que deveria ter sido feito para evitar esta ocorrência?

Appendix D. Retention Test after Pre-test

Segurança na [redacted] Código de Questionário_____

Leia com atenção as seguintes questões e **responda sucintamente ao que lhe é pedido**, utilizando, para o efeito, **apenas o espaço designado para cada questão**, sem saltar questões. Estou interessado em saber as suas respostas espontâneas e, por esse motivo, peço-lhe que não leve muito tempo a responder a cada questão.

Recordo que, para a correspondência de ambas as partes do estudo, deve preencher o "Código do Questionário", indicando: 1. A letra inicial do seu nome; 2. A letra inicial do seu apelido; 3. A letra inicial do seu local de residência; 4. A letra inicial do nome da sua mãe. Exemplo: **Código do Questionário:** JTAM

- Não considerando o tutorial/treino, indique quais os espaços onde se desenrolou a experiência?

- Indicando o nome do primeiro espaço, que tarefas aqui foram realizadas?

- Indicando o nome do último espaço, que tarefas aqui foram realizadas?

- O que é que, segundo o Gerente de Loja, vem em primeiro lugar?

- O que acontece durante a sua última tarefa?

Segurança na [redacted] Código de Questionário_____

- Que tarefa estava a ser realizada quando se deu a ocorrência?

- Porque é que as caixas caíram?

- O que deveria ter sido feito para evitar esta ocorrência?

Appendix E. Informed Consent of the Study

Termo de Consentimento Informado

A presente investigação decorre no âmbito do Mestrado em Psicologia Social e das Organizações e preconiza estudar as opiniões pessoais dos colaboradores sobre questões relacionadas com a Segurança na [redacted].

Pretende-se, desta forma, contribuir para o conhecimento sobre esta temática nas organizações sendo, para tal, necessário contar com a participação dos colaboradores da [redacted]. Reforçamos, assim, a importância da sua participação, não só para a obtenção dos dados, mas também para um contributo ativo na investigação sobre a Segurança nas Organizações.

Apesar da recolha de dados demográficos dos participantes, importa referir que o anonimato dos mesmos é mantido, contribuindo assim para a expressão de opiniões sinceras, com a ressalva de que não existem respostas certas ou erradas, apenas opiniões pessoais. Os dados serão alvo de tratamento estatístico, mas não de avaliação qualitativa.

A sua participação nesta investigação é totalmente voluntária, pelo que lhe é permitida a desistência em qualquer momento, se assim o pretender, sem necessidade de justificação.

Pela necessidade de recolher dados com outros participantes, pedimos que não partilhe informações sobre a experiência com ninguém, a não ser com o investigador.

Investigador: João Pedro Robalo Teixeira – joaoteixeira_msn@hotmail.com

Orientadora: Professora Doutora Sara Ramos

Co-Orientador: Professor Doutor Paulo Noriega

Declaro ter lido e compreendido as condições de participação nesta investigação, aceitando participar na mesma de forma voluntária,

Nome: _____

Assinatura: _____

Data: ___/___/___

Appendix F. Debriefing

Debriefing

Portugal é um dos países da União Europeia com maior número de acidentes de trabalho. Em 2016, esse número ultrapassou os 205 000 acidentes de trabalho (Gabinete de Estratégia e Planejamento, 2018). Estes dados revelam a urgência de se apostar em políticas de segurança para uma redução dos comportamentos de risco, bem como das suas consequências para o trabalhador e para as Organizações (Barling & Frone, 2004).

Atitudes positivas face a políticas de segurança estão associadas a maiores benefícios de segurança e à diminuição nos acidentes de trabalho (Neal & Griffin, 2004). Exemplo dessas atitudes positivas são os programas de Formação de Segurança que visam aumentar os conhecimentos e as capacidades dos colaboradores para seguirem os procedimentos de segurança. A literatura (Burke et al., 2002; Neal & Griffin, 2004), tem demonstrado que a Formação em Segurança influencia positivamente os conhecimentos de segurança dos colaboradores, bem como os próprios procedimentos de segurança. No mesmo sentido, o clima de Segurança existente nas Organizações tem efeitos nos conhecimentos, atitudes e comportamentos de segurança (Neal, Griffin & Hart, 2000).

Para mais questões, contacte: joaoteixeira_msn@hotmail.com

Appendix G. Email requesting access to the IPQ instrument validated for the portuguese population

Boa tarde,

O meu nome é João Teixeira e sou estudante do Mestrado em Psicologia Social e das Organizações do ISCTE-IUL. Estando no meu último ano de Mestrado, encontro-me a desenvolver a minha Dissertação sobre a Utilização da Realidade Virtual no estudo do Clima de Segurança dos trabalhadores da [redacted]

Neste sentido, gostaria de lhe solicitar o acesso à versão portuguesa do iGroup Presence Questionnaire (IPQ), validada no estudo de Vasconcelos-Raposo et al, (2016)[1], para poder avaliar, nos meus participantes, o sentido de presença na experiência em RV.

1 - Vasconcelos-Raposo, J., Bessa, M., Melo, M., Barbosa, L., Rodrigues, R., Teixeira, C. M., Cabral, L. & Augusto Sousa, A. (2016). (IPQ) Adaptation and Validation of the Igroup Presence Questionnaire in a Portuguese sample. Presence: Teleoperators & Virtual Environments, 25(3).

Aguardo a sua resposta,

Com os melhores cumprimentos,

João Teixeira.

Appendix H. Virtual Environment Sense of Presence Questionnaire

QUESTIONÁRIO 1

Por favor indica o QUANTO CONCORDAS OU DISCORDAS com cada uma das seguintes afirmações fazendo um círculo em apenas UM dos números utilizando a escala de 5 pontos

Discordo totalmente	Discordo	Não concordo nem discordo	Concordo	Concordo totalmente
1	**2**	**3**	**4**	**5**

1.	Estive consciente do mundo real enquanto navegava no ambiente virtual	1 2 3 4 5
2.	O ambiente virtual pareceu-me completamente real	1 2 3 4 5
3.	Tive a sensação de estar a atuar num espaço virtual	1 2 3 4 5
4.	A experiência no ambiente virtual pareceu-me tão real como as minhas vivências do dia-a-dia	1 2 3 4 5
5.	O ambiente virtual pareceu-me tão real como o mundo que conheço	1 2 3 4 5
6.	Não me senti presente no ambiente virtual	1 2 3 4 5
7.	Eu não estava consciente do mundo real que me rodeava	1 2 3 4 5
8.	Eu tive a sensação de "estar" no ambiente virtual	1 2 3 4 5
9.	De alguma forma eu senti que o mundo virtual me envolveu	1 2 3 4 5
10.	Senti-me presente no ambiente virtual	1 2 3 4 5
11.	Durante a experiência continuei a prestar atenção ao local onde estava a ter a experiência	1 2 3 4 5
12.	O ambiente virtual pareceu-me mais realista do que o mundo real	1 2 3 4 5
13.	Senti-me como se estivesse apenas a visualizar imagens	1 2 3 4 5
14.	Senti-me completamente atraído pelo ambiente virtual	1 2 3 4 5