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Stop Work: Serious Games as Intervention Method to Enhance Safety Behavior

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Abstract. Organizations will go through great lengths to prevent accidents from occurring. This is shown in the implementation of safety management systems in which all procedures are captured describing how work can be done safely. Stopping the work is seen as one of the last barriers in risk management. Our theoretical analyses and conducted interviews have shown that no interactive, innovative and analogue tools exist that effectively enable the use of the Stop Work Policy in a safe space. Serious games and the associated provision of a safe environment make it possible to let personnel speak up about perceived unsafe situations, as there are no consequences to fear. The present paper describes and discusses the development of the two serious games Dare to Repair and Danger Dialogue that aim to support the implementation of the Stop Work Policy effectively and thus enhancing the dialogue on working safely.

Keywords: Human Errors · Intervention · Learning · Safety · Serious Games · Stop Work Policy

1 Introduction

According to the National Institute for Public Health and the Environment [1], 230.000 of the 7 million employees in the Netherlands have an accident every year. This means 600 injured people per day who can no longer work - temporarily or for life. Organizations, such as companies within high-risk industries in the maritime sector, will go through great lengths to prevent accidents from occurring. This is shown, amongst others, in the implementation of safety management systems in which all procedures are captured describing how work can be done safely. Furthermore, organizations will most often have implemented a risk management system - whether or not as part of the safety management system - which guides the organization in identifying, assessing, and mitigating the risks related to the operations. However, not all hazards can always be foreseen and therefore organizations working in high-risk environments have implemented a so-called ‘Stop Work Policy’ for which all personnel have the mandate to stop the work in case of an unsafe situation.

Stopping the work is seen as one of the last barriers in risk management. Workers are trusted to judge the situation and be able to identify whether a situation is deemed safe or unsafe, and to act accordingly. Hazardous situations should be resolved prior to continuing the job. To recognize the stopping of work as a last defense, it can therefore be considered an important factor in safe working environments. The right to stop work in case of hazardous situations by employees is often part of the law (for example; Article 29 in the Dutch Working Conditions Act). However, implementing a Stop Work Policy as such is not required by law, but is today more or less common knowledge within high-risk organizations [2].

Supporting the implementation of the Stop Work Policy effectively and thus enhancing the dialogue on working safely, is one of the goals of the Safety Deal project. To practice the application of a Stop Work Policy in a safe environment, two innovative and interactive serious games, Dare to Repair and Danger Dialogue, have been developed that motivate personnel in high-risk environments to speak out and to communicate risks. The present paper focuses on the design and development phase of both games as intervention methods to strengthen safety behavior.

2 Safety-Related Concepts

In the following, concepts in the field of safety that are relevant to the understanding of this publication are further elaborated.

2.1 Safety Knowledge and Skills

Knowledge on what is safe and what is unsafe is rather important as this is necessary to make a judgement and stop the work. Effective safety training improves knowledge and helps to make accidents more predictable [3]. Lack of training is a contributing factor to high incident rates [4]. Employees new to the job or organization should obtain sufficient training to learn about the risks associated with the work, as otherwise they would not be able to stop the work as they do not recognize the risks [5].

Not only knowledge and training of individuals is important, however, also the perceived knowledge of others is of importance to increase safety. The 'Perceived Colleagues Safety Knowledge / Behavior' (PCSK/B) is positively related to safety compliance and safety participation [6]. If employees perceive that their colleagues have knowledge and skills, and do act accordingly, they will do so as well.

Safety performance is influenced by safety culture [4], meaning that safety culture is an important aspect in the prediction of accidents [7]. This is also shown in relation with the PCSK/B. With a lower safety climate, the effects of PCSK/B were found weaker - meaning that with a higher safety climate, employees will follow and copy their colleagues' behavior regarding safety [6]. In addition, the safety culture within an organization is of importance, as this reflects the willingness to reflect on the situation.

2.2 Safety Culture

There is no consensus on the definition of safety culture. Safety culture and safety climate are often used interchangeably. See Guldenmund [8] for an elaborate review on

the distinction made and definitions used. Safety culture often involves the attitudes [9–11]), beliefs as well as perceptions [9, 12–14], and values [9, 15] that employees share in relation to safety. It is the frame of reference through which interaction, symbols and behavior are interpreted [16], and is dynamic and constantly and continuously adjusted and (re)created [17]. Once new in the group, one will be taught all norms and values [18] by socialization, meaning that individuals learn from others or the group [19]. According to Pidgeon [10], a good safety culture is characterized by three attributes: (1) Norms and rules for handling hazards, (2) attitudes towards safety, and (3) reflexivity on safety practice.

Culture is the frame of reference for people to rely on to act. They do so as they have limited capacity to process information, and base thereupon what information they can ignore, or should, creating certain blind spots [16]. Furthermore, the frames of reference, through which information is interpreted, influence whether hazards are seen, judged, or overlooked, but also how they are evaluated [20]. Training adds to knowledge about safety [21], and to discuss safety issues [4]. The Stop Work Policy being the last safety barrier for incidents to happen, is therefore only to be found effective as this is part of the norms of the safety culture.

2.3 Stop Work Policy

Due to its nature, it is difficult to implement a Stop Work Policy effectively. Weber et al. [2] conducted research towards the hampering factors in implementing a Stop Work Policy. They found that the decision to stop the work is influenced by procedural, social, technical and non-technical / personal aspects. Furthermore, it is stated that though the Stop Work Policy is a behavioral approach, it is limited for that matter as it leaves out the context the person is in. Havinga et al. [22] have further pursued the research of Weber et al. [2] and draw different conclusions as it was seen in their research that the decision to stop the work was made all the time, and workers found stopping the work a suitable way for them to completing their work, instead of linking this to safety reasons. Therefore, they conclude that it should be more useful for organizations to focus on alternative methods to complete a job instead of focusing on training to support workers in stopping the job for safety reasons. It should be noted that the conclusions refer to research conducted by one organization.

Although having a Stop Work Policy is common in high-risk industries, it is not easy to implement it well and to ensure that all employees are indeed making use of this policy and stop the work when deemed necessary. Some state that Stop Work Policy programs empower the employees to be more pro-active, and that workers are expected to speak up in an unsafe situation [23]. Workers are to be encouraged to speak up without fear of retribution [24]. Weber et al. [2] refer to Johnson [25] who stated that Stop Work policies are mostly built upon unrealistic assumptions such as that people will always stop work when an unsafe situation occurs, that all warning signs are clearly visible, that safety can always be the first priority and stopping colleagues is always possible.

Though not supported by the findings of Havinga et al. [22], van Vliet [5] did find various factors that were hampering the use of the Stop Work Policy within different organizations. These findings, together with the findings of Weber et al. (2018), show

that Stop Work Policies cannot be taken ‘for granted’, and require much more attention in implementation that is currently done.

3 Intervention Tools

According to Wilkins [26, p. 1017], “[...] *it is apparent that non-compliance with safety procedures and inadequately delivered training are among the key factors resulting in such a high rate of injury and fatality in this sector* [construction industry].” In addition, Tezel et al. [27] summarized success factors for safety training and concluded that, among other factors, the absence of training can affect safety practices in organizations and thus, represents a critical factor.

3.1 State of the Art

According to Burke et al. [28], there are different traditional tools for safety training which can be distinguished from each other based on their level of engagement, such as toolbox talks (low level of engagement) or hands-on training (high level of engagement).

Dyreborg et al. [29] have conducted a review towards the effectiveness of various behavior change safety interventions and have found that the effectiveness is still rather unclear. Mullan et al. [30] have found similar results, as for the studies reviewed, the methodologies lacked a scientific foundation - meaning that control groups were missing, or the conditions of test groups were not equal - resulting in it being difficult to draw the conclusion that the interventions had a positive effect.

In the Netherlands, research has been conducted by van Kampen et al. [31] on the safety interventions safety professionals most often use to train workers in their organization, and which interventions were considered most useful. Their results show that mainly very traditional tools are used, such as general risk inventory and assessments, reporting and investigating (near) misses, and emergency preparedness exercises.

Gao et al. [32] have performed a literature review and conclude that traditional tools about the safety domain ignore the real on-site physical environments, fail to take care of workers who have low English proficiency and low literacy, fail in attracting trainees’ attention and are less engaging, are limited in developing workers’ spatial awareness ability, and have an unsatisfied knowledge retention.

To conclude, traditional intervention tools are not sufficient enough to provide effective and efficient training in order to initiate a change in behavior. Thus, a different type of intervention is needed to enhance safety knowledge and skills of operational personnel in high-risk environments. This is supported by Zuidema et al. [33] who concluded that the development of and implementation of behavioral training is a must-have.

3.2 Use of Serious Games as Intervention Methods in Safety Domains

Having people change their behavior on this rather complex phenomenon and to get the Stop Work Policy implemented effectively, a traditional tool would not be deemed effective. It is important that people have the appropriate knowledge to react in the best possible way to the demands of a potentially dangerous situation, but it is also about the

reaction itself, i.e., the behavior of the people. In addition, other contextual factors [2], but also socio-economic aspects [34, 35], play a role that make the phenomenon of a Stop Work Policy a complex system.

Serious games are a suitable method for presenting these complex phenomena in a more simplified version and thus, making it possible for people to experience them and (interactively) participate in a safe environment [36]. Regarding the safety domain and according to Gao et al. [32], serious games are seen as a suitable and promising tool for training. With regard to safety in general, a number of serious games exist [see 37–38 for an overview of examples]. In the area of construction safety, Kazar and Comu [38] conducted a study with students and tested different safety trainings. Their results show that the participants who received safety training based on a serious game significantly improved their knowledge of occupational safety compared to participants who received traditional training. This was not influenced by the participants' game experience. Furthermore, their results (p. 04021091–1) “[...] *show that serious game-based training provides effective training that ensures the maintenance of safety knowledge acquired over time.*” Also, Martínez et al. [37] see serious games as an adequate alternative to traditional training formats, as during a serious gaming session the participants can make experiences that they most likely could not make in real life due to safety-critical, financial aspects and time.

Weber et al. [2] found that training is a factor that supports stopping work and recommend offering training to train less experienced employees in particular. Training is not described further at this point. To the best of the authors' knowledge and based on the discussed literature, (longer-term) interventions that address the Stop Work Policy and make it possible to physically interact with the subject and colleagues without fearing any consequences are not present. Based on the theoretical background information discussed in this publication, it became visible that an innovative and interactive tool is needed with the aim to address and discuss the use of the Stop Work Policy in a safe space and according to Martínez et al. [37, p. 107], “*serious games provide an opportunity to emphasize safe behaviors in the workplace.*”

In order to develop such an intervention method that makes it possible to let personnel experience the Stop Work Policy in an interactive and safe space, interviews have been conducted with experts to (a) gain more insight in the factors that hamper and motivate stopping the work, and (b) to gain an understanding of the context the game should fit in.

4 Development and Design of an Intervention Method

To get a more thorough understanding of why the Stop Work Policy is such a difficult policy to be implemented effectively, and therefore to know what a proper intervention should do, interviews were held with various managerial and operational personnel in different organizations operating in high-risk environments. In total, 48 people from 7 different companies were interviewed: a steel manufacturer, a logistic services provider, a crew and shipping management company, a yachts builder, a shipyard, a construction company, and an offshore construction company. All companies were based in the Netherlands, except for the crew management company that has offices worldwide and

employs international crews with their international clients. Almost all other companies work with multiple nationalities and cultures amongst their operational personnel.

The interviews took place both online and offline – this varied due to location and COVID19 restrictions, and were ranging from 30 min to 1 h. The goal for the interviews with the managerial personnel was to understand how their perspective was on the Stop Work Policy, what their role was in implementing, and whether they saw the same hampering and motivating factors as operational personnel. Amongst the questions asked were ‘to what extend do people use the Stop Work Policy according to you?’, ‘what hampers operational personnel to use the Stop Work Policy?’, and ‘how do you motivate your employees to use the Stop Work Policy?’. The goal for the interviews with the operational personnel was to understand whether they knew what the Stop Work Policy was, whether them or colleagues have ever stopped the work, and whether they or others have encountered situations in which the work should have been stopped for safety reasons but was not done. A more fundamental analysis can be found in van Vliet [5].

4.1 Target Group and Working Environment

The people designing and implementing the Stop Work Policy in organizations are most often not those that will use them. The difference is in the type of role and the physical work environment. Staff in the ‘Quality, Health, Environment and Safety’ (QHES) department will design the Stop Work Policy, but those in the line of fire most will be in the need of using it in a hazardous situation. The intervention developed is therefore targeted at operational personnel; those who are in the line of fire, and can be physically injured in case of an accident happening. As high-risk organizations can be very different from each other, the context also varies from company to company, however, workers often work in teams managed by a supervisor in hazardous environments characterized by noise, different materials, machines, and tools. The game should take this into account.

4.2 Conclusions for Intervention Design Based on Interviews

The interviews provided 13 different factors that hamper the effective implementation of a Stop Work Policy. An overview of the most important factors can be found in Table 1.

4.3 Designing the Intervention Method

Duration of the Intervention Method.

The intervention to be developed should consist of several units, as it has already been concluded by Mullan et al. [30] that a single intervention is less successful compared to a longer lasting intervention measure. To support this, the intervention method to be developed consists of one central unit, the main game, followed by so-called refresher moments, the building blocks.

Table 1. Description of relevant factors that hamper stop work.

Factor	Description	To what extent does this factor hamper stop work
Knowledge and risk perception	Stopping work in an unsafe situation, sufficient knowledge about the hazards are necessary to be able to judge the situation Perceiving the situation as safer than it actually is	Not having the right knowledge in order to judge the situation will lead to not stopping the situation Perceiving the situation as safer than it actually is, one will not stop the work
Complacency	Complacency is a type of risk perception in which one has a lack of awareness and a feeling of uncritical satisfaction	Especially when people have experienced a situation many times, their risk perception might change to the task of being of lower risk. This interpretation results in the frequency of stopping the work to decline
Hierarchy (Power distance; Social hierarchy)	Power distance refers to the relationship between higher-ranking and lower ranking individuals [40]. Social hierarchy refers to the relationship between individuals based not on a formal hierarchy but on the unofficial hierarchy, related to e.g. popularity, experience, or length of employment	People new in an organization have shown to have difficulties speaking up to people who are employed for the organization much longer. They might have newer, more complete or updated knowledge than those already working in the organization, the newly employed personnel find it hard to speak as they still need to find their place in the group and do not want to thorn on the legitimacy of others
Time pressure	Time pressure is the perception of people of having too much to do in too little time	Time pressure results in risk perception to change. Where situations might be stopped if there is sufficient time to conduct the activity; they will pursue in case of time pressure

(continued)

Table 1. (*continued*)

Factor	Description	To what extent does this factor hamper stop work
Being afraid to use Stop Work / how one has been treated before when using Stop Work	Not willing to stop work in case of an unsafe situation as one is afraid for the reaction of others, either because of a negative reaction that one got in the past, or one is just being afraid for the reactions of others without having a negative experience earlier	Having experienced a negative reaction when stopping the work, one will be less likely to do so again. Also, the feeling of potentially getting a negative reaction might result in people not speaking up

The Most Important Game Mechanic.

The task of the players in the game is focused on finding the right balance between three main elements. First, the players need to ensure that they can do the job safely. Second, they must be able to use Stop Work accordingly. Third, it is the task of the players to solve in-game challenges.

Use of Metaphor.

To take into account, as much as possible, the needs of different companies and to develop the game as generically as possible, it was decided to work with metaphors. A metaphor can help to reduce the complexity of a specific subject and can be beneficial for the relation between game and player(s) [39]. The use of metaphors often has the aim to reduce the complexity (abstract) of the implemented model of reality, which should make it possible to enter the gaming world more quickly.

Analogue Versus Digital.

As we aim to design an interactive and innovative game, we want to develop a physical game which makes this possible. In addition to this, we strongly believe that the idea of speaking up to someone is way easier to realize in a face-to-face situation than in a digital setting. Last but not least, we want to give the players the space to touch and thus, play with the game materials ('look and feel') in order for the game to be appealing for the players.

Number of Players.

Since an exact number of players per session cannot be determined in advance, it is decided to keep both games open for up to 3 to 6 players and make them adjustable according to the number of players.

Theoretical Frame.

According to Mullan et al. [30], it is important to have a theoretical basis for designing an effective intervention that aims to change behavior. The intervention presented in this paper is based on Kirkpatrick's model, which, however, is not the subject of further consideration as part of this publication.

Duration of Game Play.

To make the game still playable for personnel in high-risk environments, it was decided to target a maximum playing time (excluding briefing and debriefing) of 60 min for Dare to Repair and 30 min for Danger Dialogue.

Not all the factors listed in Table 1 have been explicitly implemented in the serious games. Some of them were implicitly incorporated (see Table 2). Based on the requirements described above, the following intervention method has been developed.

Table 2. Factors that hamper stop work and their implementation in the serious games.

Factor	Implemented in	Implicit / explicit	Description
Knowledge and risk perception	Dare to Repair	Explicit	Finding the right balance between risky and safe decisions
	Danger Dialogue	Explicit	Explaining the correct answer from one's perception
Complacency	Danger Dialogue	Implicit	Hearing out other's perceptions, challenging yours
Hierarchy (Power distance; Social hierarchy)	Dare to Repair / Danger Dialogue	Implicit	The game does not work with different in-game roles, but can certainly be played with different people from different hierarchy levels
Time pressure	Dare to Repair	Explicit	The implementation of time pressure plays an important role. The tasks to be solved have to be completed within 45 min
	Danger Dialogue	Explicit	Per round, players have approximately 7 min time to work on their tasks
Being afraid to use Stop Work / how one has been treated before when using Stop Work	Dare to Repair	Implicit → Explicit	In the course of playing Dare to Repair, the implicitly implemented benefits of stopping work are made explicit by taking too many risks

5 Description of Intervention Method

The intervention method presented in this publication consists of two parts: Dare to Repair and Danger Dialogue. Whereas the learning objective of Dare to Repair is mainly to make people more aware of the importance of safety in the workplace and in particular the Stop Work Authority, the idea of Danger Dialogue is to make safety-specific topics discussable.

5.1 Dare to Repair

Goal of the Game.

Dare to Repair is a cooperative board game for 3 to 6 players. The goal of this game is to learn how to use the Stop Work Policy and thus, speak up accordingly. The game was developed by Raccoon Serious Games and Quattor P and is available both in English and Dutch.

Goal in the Game.

The goal in the game is to repair a number of machines in a factory within a given time limit. This can only be achieved by the players playing and discussing together. While repairing these machines, all players face different challenges. The challenges are characterized by the fact that the players need to make decisions related to the trade-off between safety and risks for each machine. Through the conscious decisions made by the players, they experience the advantages of the Stop Work Policy based on the results of their decisions, which may result in a machine being repaired, not being repaired due to an accident, or having the work stopped early. Risk taking, time pressure and budgeting are three central key performance indicators that were implemented in the game, whereas the general idea is to have as few accidents as possible while focusing on costs and time. Each of the decisions made by the players is associated with the key performance indicators. In Fig. 1, the serious Dare to Repair game is depicted.



Fig. 1. Dare to Repair (left side) and Danger Dialogue (right side) game set-up (Quattor P & Raccoon Serious Games, 2022).

Role of the Facilitator.

The game is facilitated by a facilitator. His / her task is to make sure the game runs smoothly, meaning that he / she is responsible for setting up the game, explaining it (briefing), observing the game play carefully, and conducting the debriefing. It is extremely

important throughout the course of the game that the facilitator does not actively intervene in the game, but only answers questions that have to do with understanding the game.

Debriefing.

In order to let participants exchange their thoughts, reflect on the game play and make connections with their real working environments, a structured debriefing guideline has been developed. This is based on the 4 E's [41]. The 4 E's, a short description of each of them, and an exemplary debriefing question is shown in Table 3.

Table 3. Overview of some exemplary debriefing questions.

E	Explanation	Example
Emotion	How did you feel?	What are the first three words that come to your mind when you think of 'Dare to Repair'? Why?
Events	What happened?	Are you satisfied with the outcome of the game? Why (not)? What would you do differently?
Everyday life (translation game to reality)	What did you learn?	What elements or experiences from the game do you encounter in day-to-day life at work?
Experiences	How would you translate it to real life?	Has this game brought you any insights?
Every day application (future)	How can this game support you in future day to day life?	Did you learn or experience anything today that might help you to do things differently?

5.2 Danger Dialogue

Goal of the Game.

Danger Dialogue¹ is a card game playable with 3 to 6 players. The goal of the game is to let players discuss the risks that may affect different situations in their workplace.

Goal in the Game.

The game itself consists of several question and risk cards that are played in three different rounds. Each round consists of the following phases: (1) Randomly select a question card that describes a specific scenario, (2) select and explain a risk card that fits the question card, and (3) vote for the risk card that best fits the described scenario. At the end of the game, a fourth round is followed. In this phase, the players look at the chosen combinations of three question cards and risk cards and discuss them on a meta

¹ The illustrations are made by de Visuele Verbinders.

level with the goal to identify the most important one for the corresponding organization and to derive measures. A photo of the game is depicted in Fig. 1. This game can be played several times as new combinations can be drawn at each session, giving new input for discussions.

Role of the Facilitator.

There is no facilitator needed for this game, as this short game is meant to be self-learnable. A player is designated to be a facilitator, but only to make sure each card has sufficient reasoning behind it.

Debriefing.

There is room for discussion during the game. The results of the discussions during playing Danger Dialogue are documented in a book, which can be further used in follow-up sessions.

6 Discussion

The present paper focused on the development of an interactive and innovative intervention method to enhance safety behavior of personnel in high-risk environments. Therefore, a conscious decision was made to make use of serious gaming. Serious games and the associated provision of a safe environment make it possible to let personnel speak up about perceived unsafe situations, as there are no consequences to fear. Interviews with the target group of the intervention method were conducted to consider appropriate requirements of the interventions based not only on theoretical considerations from literature, but also potential end-users (user-centered design approach). The results of the interviews can be read in detail in van Vliet [5]. In summary, several factors resulted that should be considered in the development of the intervention method. In addition, other requirements with the design of the intervention method were defined. The results of all these analyses resulted in the development of Dare to Repair and Danger Dialogue. Dare to Repair - defined as the main game - follows the idea of a one-time intervention which should be used to give personnel the opportunity to speak up about perceived unsafe situations. In addition to Dare to Repair, the aim of Danger Dialogue - defined as a building block - is to function as a regular refresher making it possible to make personnel in high-risk environments more aware of the importance of safety (measures) in their workplace.

The theoretical analyses and conducted interviews have - to the best of the authors' knowledge - shown that no interactive, innovative and analogue tools exist that effectively enable the use of the Stop Work Policy in a safe space. During the playtests and in exchange with the players, it became visible that experiencing a serious game for personnel in these environments can also mean leaving one's own comfort zone. Associated with this, the acceptance of the target group towards serious games plays a major role. For many, this approach of using a game for serious purposes was completely new. On the other hand, it became apparent that some people also saw it as an opportunity to finally be able to talk about safety-related problems in a safe environment.

Furthermore, the interventions developed within the Safety Deal project aim to be used in diverse high-risk environments. As described earlier, the safety culture can also play a role in the experience of such an intervention and its subsequent implementation.

Future research should address this issue and explore the extent to which culture influences the active experience of these interventions. It is particularly interesting to see to what extent the discussion of risk-related topics is experienced in different cultural settings.

7 Outlook

Due to the fact that the Safety Deal Project mainly deals with Dutch organizations, future research activities should look at what forms of training tools are used in other countries. The authors of this publication are strongly convinced that these are similar tools, however, this should be elaborated scientifically.

To answer the research question of whether and to what extent the intervention (playing the serious games Dare to Repair and Danger Dialogue) have an effect on the safety behavior of personnel in high-risk environments, workshops are currently being organized at different organizations in the heavy industry sector (with high-risk environments). Groups of 3 to 5 employees are tested per workshop. In order to measure the effectiveness of the intervention, various conditions were defined: (1) One group that plays 1x Dare to Repair and 4x Danger Dialogue, (2) one group that plays 1x Dare to Repair and 2x Danger Dialogue, and (3) one control group that plays neither Dare to Repair nor Danger Dialogue. Fortunately, the sessions are not only planned in Europe, but also in Asia, which makes it possible to analyze cultural differences as well. In addition, the influence of the attitude towards serious games and a possible influence on the learning success remains a subject for future research.

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