# Reducing Near Miss Incidents: A Shikake Approach to Safety Awareness in Manufacturing Plant

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**Abstract:** Safety in the workplace is one of the key factors for the successful development of a company, as it is closely tied to productivity and efficiency. This is why safety issues require immediate action to prevent and preclude potential accidents. Not all unsafe actions result in employee injuries. Such incidents are known as "near misses," and by evaluating them, it is possible to identify problematic areas in the production process or deficiencies in equipment and training. In this study, we examined a company in Russia that manufactures crane components. The company maintains a detailed record of near misses, which revealed a prevalent issue: most of these incidents occurred due to a disregard for safety rules, particularly concerning hands and fingers. An experimental "shikake" implementation was introduced to increase employees' awareness of safety rules. As a result of the experiment, a reduction in near miss incidents, especially those related to hands, is expected.

## 1 Introduction

With the rapid changes in industrial production, it is always necessary to ensure a safe working environment for the company's employees. The effective management of workplace safety not only safeguards the workforce but also contributes significantly to the overall efficiency and productivity of the manufacturing process and is directly linked to a company's reputation. Moreover, it is connected to the amount of insurance payment that can compensate for losses or injuries, so the fewer incidents happen, the better.

This imperative holds true for a Russian-based company specializing in crane production, where the pursuit of excellence in safety practices is both a moral obligation and a strategic necessity.

Safety in manufacturing environments is traditionally assessed through various metrics, and one key indicator often employed is the accident ratio triangle. This method is based on Heinrich's theory, which indicates the link between near miss incidents and injuries and involves tracking incidents that come close to causing harm or injury, serving as a valuable precursor to identifying potential hazards. While the overall safety record of the company under study is commendable, a noteworthy issue emerges: the incidence of near misses is relatively high.

This paper proposes a new way to address this challenge by introducing the concept of "shikake," a term derived from Japanese culture, which translates to 'trigger' or 'catalyst.' The shikake method involves employing subtle yet influential interventions to encourage desired behaviors or outcomes. In this case, the aim is to enhance safety awareness among workers in the manufacturing plant.

The proposed intervention consists of a simple but potentially transformative strategy: the distribution of pens of different colors, each inscribed with one of eight unique safety messages, and the placement of corresponding cups for their return. Each day, workers select a pen that resonates with them, read the safety message, and return the pen to the cup bearing the same message at the end of their shift. The underlying hypothesis is that this shikake method will reinforce safety awareness and foster a culture of vigilant adherence to safety protocols.

The central research question guiding this study is straightforward yet pivotal: Can the implementation of the shikake method effectively reduce the number of near misses within the manufacturing plant?

To address this question, this research paper draws upon the shikake concept developed by Matsumura Naohiro, a framework rooted in behavioral psychology and design thinking that aims to influence human

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behavior through subtle environmental cues. Additionally, it delves into the theory of near misses, recognizing their significance as early warning signals in safety management.

By investigating the potential impact of the shikake method on safety awareness and near miss reduction within the context of a crane manufacturing company, this study not only contributes to the growing body of literature on safety management but also offers practical insights and recommendations that can enhance workplace safety in similar manufacturing settings.

In the following sections, we will explore the research background, methodology, results, and implications of this novel approach, shedding light on the transformative power of subtle interventions in fostering a culture of safety within the workplace.

# 2 Research Background

## 2.1 Focus Company

First of all, it is essential to know the background of the focus company to conduct case study research. The focus company is a manufacturing company that provides cranes and other lifting solutions and has five manufacturing plants in different parts of Russia. The research is focused on one of the plants (hereinafter – Plant A) that has undergone some core changes in the last four years.

At first, Plant A was lossmaking for the company, and, to make it profitable again, it was downsized greatly (both in size and number of employees), and all the processes and production lines were deeply revised and cut to make it easier and more efficient to manage. Part of manufacturing was moved to another plant of the company. As a result of this downsizing project, the plant improved its performance a lot and became one of the most productive plants in the area.

Plant A has a foundry and metal processing. To be specific, the plant receives raw materials in metal charge, then the materials undergo a smelting process with the addition of chemicals, after which the liquid metal is cast into supports and covered with a non-stick solution. Then, the metal cools down, and the casting is hammered out. The metal is ready to be formed into the product shape. Metal processing is divided into two stages of turning operations: teeth miling and heat treatment. The final production steps relate to finish metal cutting and quality control procedures.

As the whole production process is connected to metal smelting, cutting, and chemicals, it is considered to be a hazardous work, work of high risk for the plant workers.

Therefore, Plant A faced some difficulties with safety: the company continuously records all the accidents and near misses of all the plants, and it is clear that even if the number of accidents resulted in injuries is quite low, the statistics of near misses are concerning. The reason for choosing plant A among the other four is that near misses happen more frequently than on other plants (See Table 1). As the number of employees in plant A is the smallest compared to other plants, every worker ends up making more mistakes that lead to near miss incidents. It is important to improve the safety awareness of the plant workers to make their work conditions better and avoid any injuries.

What is a near miss in the present can potentially turn into an accident in the future, especially in situations where almost all the processes can lead to a cutting or burning injury. That is why it is a problem that is clearly addressed and should be resolved.

## 2.2 Definition of shikake and differences with similar concepts

The term “shikake” (trigger) was first described in 2013 by N. Matsumura, a professor at Osaka University, who defined it as “an embodied trigger for behavior change to solve social or personal problems” [17]. In other words, using shikake can help to change people’s behavior to solve various kinds of issues, and occupational safety issues are one of them.

Often, shikake interacts with human curiosity and playfulness, giving a person a choice of an action that is more exciting than the ordinary one, and by choosing this particular action, people change their behavior, solving some issues. For example, to make people want to take the stairs instead of the elevator or escalator, the stairs were painted black and white like a piano and made a similar sound when being stepped on. As a result of using this shikake, significantly more people chose to take the stairs because it was interesting to interact with. By this experiment, the problem of low mobility of healthy people was partially solved.

Shikake can be used in various situations because the concept of it is simple and easy to implement. Also, it does not have any particular form, so, again,

Table 1: The number of personnel per plant and the average number of near misses per worker for each plant over the 21-month period of 2022-2023.

| | Number of personnel | | Near misses per worker | |
|---|---|---|---|---|
| | direct worker | employee | direct worker | employee |
| Plant A | 42 | 75 | 10.12 | 5.67 |
| Plant B | 166 | 266 | 4.75 | 2.97 |
| Plant C | 292 | 482 | 1.68 | 1.02 |
| Plant D | 368 | 617 | 1.46 | 0.87 |
| Plant E | 111 | 149 | 4.19 | 3.12 |

it does not have any limitations as long as it meets the three FAD requirements defined by N. Matsumura: fairness (the shikake should not discriminate its users and be equally used by different groups of people), attractiveness (it should attract the attention of potential users and make them want to interact) and duality of purpose (it should fulfill two purposes: one of the people who interacts with shikake and the other of the person who set the shikake) [16].

Shikake is divided into two categories by the triggers used: psychological and physical [18]. Psychological triggers refer to the triggers that "directly arouse a positive or negative impulse" or the triggers that show the influence of social structures, such as social proof, for example. Physical triggers, as the name implies, show the influence of physical objects. Each category should be wisely chosen for every particular case to increase efficiency.

There is a similar concept called nudge, which was presented by R.H. Thaler and C.R. Sunstein [20]. However, there are some key differences between shikake and nudge, which should be clarified. Despite the same purpose of implementing both concepts – behavioral change, shikake encourages this through consciousness, so the target group is fully aware of the choice of actions and consciously changes behavior. When using a nudge, the main goal is to change people's behavior unconsciously, engaging in the process of the so-called Automatic System, by which a person makes decisions immediately and without thinking [20]. Also, as it was mentioned above, shikake takes advantage of curiosity and playfulness, while nudge is based mostly on people's systematic biases that simplify decision-making greatly. As a result, unlike nudge, shikake can be implicated more widely to solve issues in different academic fields.

J.J. Gibson also formulated a theory close to shikake called "The theory of Affordance."[6] He defined "affordances" as the possibilities and opportunities for action that are inherent in the environment and can be perceived by an observer. In other words, objects and environments are meant to provide some possible actions to the user; for example, a chair affords sitting, a pen affords writing, etc. However, depending on the user, the perception of the environment might vary because it values context, so the observer cannot expect one or two distinguishing choices of action, unlike setting shikake. That is why shikake might be more effective in terms of problem solving.

Although shikake can be implemented in many forms and in various situations, as this concept is quite new, there is not much evidence of whether it is effective in terms of solving occupational safety problems or not. This study will provide analysis and add more applications of shikake.

## 2.3 Near misses and occupational safety

Another concept that is used in this study is 'near miss'. Near miss refers to a situation that had the potential to become an accident but was narrowly avoided without any damage to the equipment or injury to a person. Near misses first emerged as a concept around the first half of the twentieth century. This is when the rudiments of occupational safety theories began to develop, actively incorporating this concept to explain the relationship between near misses and accidents.

## 2.4 Accident Ratio Triangles

The first such theory is the theory of Herbert W. Heinrich. Heinrich's theory, which emerged in the 1930s.

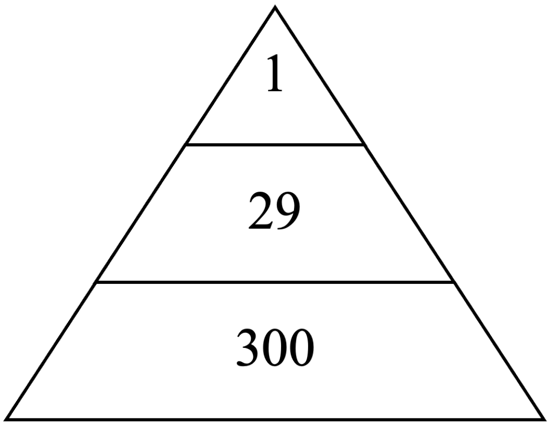



Fig. 1: Heinrich's accident ratio triangle.

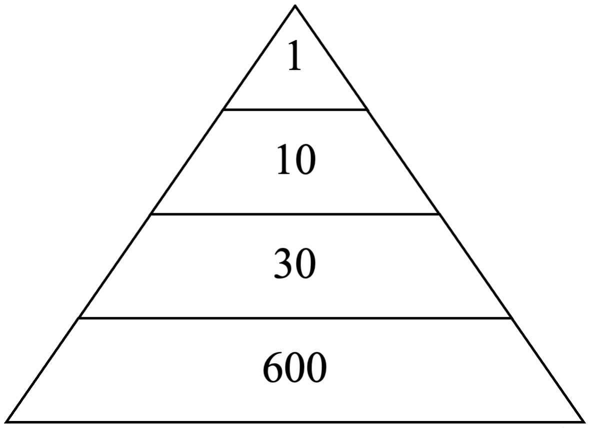



Fig. 2: Bird's accident ratio triangle.

In his work, Industrial Accident Prevention: A Scientific Approach, he argued that there is a hierarchical relationship between minor incidents and near misses, mild injuries, and fatalities in the workplace. Although this work was first published in the first half of the 20th century, it is not outdated, and Heinrich's theory is still widely applied by many organizations and cited by researchers. Of course, this theory has been criticized several times because of the insufficient statistical basis in its basics and simplicity, but it is impossible to deny its importance for controlling risks in production even now [3, 23, 4].

Specifically, Heinrich's theory presents a triangle divided into three parts, which is illustrated in Fig. 1. The top of the triangle represents major injuries, the part below is minor injuries, and the base of the triangle, respectively, is a number of near misses. The ratios for all the parts are 1-29-300, which means that in 330 similar accidents occurring to the same person, 300 will cause no harm, 29 will end in mild injury, and 1 will be the cause of serious injury (Heinrich et al., 1980). Heinrich's theory posits that by reducing the number of near misses and minor incidents, organizations can respectively reduce the number of serious injuries and fatalities.

Heinrich's theory was then further refined by Frank E. Bird ten years later (Fig. 2). Bird conducted a large-scale study in which he analyzed about 1.75 million accidents that occurred in the workplace and identified the following ratio: 1-10-30-600 [2]. Thus, another division in the triangle was added, denoting damage to equipment. Therefore, for every 641 incidents, there are 600 near misses, i.e., incidents with no visible disruption of equipment and no injury to the worker, 30 equipment damages, 10 minor injuries, and 1 serious injury. Unlike Heinrich's triangle, the structure of Bird's triangle is more complex and makes it clear that if an organization focuses all its efforts only on preventing serious injuries, there will be equipment losses and, consequently, costs [23]. This can presumably result in more near misses as workers would attempt to find an easier way to complete the task by replacing faulty equipment with homemade tools or even working on the same equipment.

## 2.5 Domino Models

Later, in 1959, Heinrich developed another theory that linked the cause of the near miss to the injury afterward, building it up like dominoes. There are five pieces in total, each representing a stage that theoretically leads to injury . Heinrich identified the following factors in accidents:

1. Ancestry and social environment. This factor is related to a process of inheritance of undesirable traits such as recklessness, stubbornness, etc., in a workplace. The occupational environment may develop these traits.

2. Fault of person. Inherited personal shortcomings are immediate causes for engaging in unsafe behaviors.

3. Unsafe act and/or mechanical or physical hazard. The unsafe actions of individuals lead directly to accidents.

4. Accident. Incidents that are caused by unsafe acts and result in injuries of any kind.

5. Injury. Bruising, fractures, etc. that are the result of accidents.

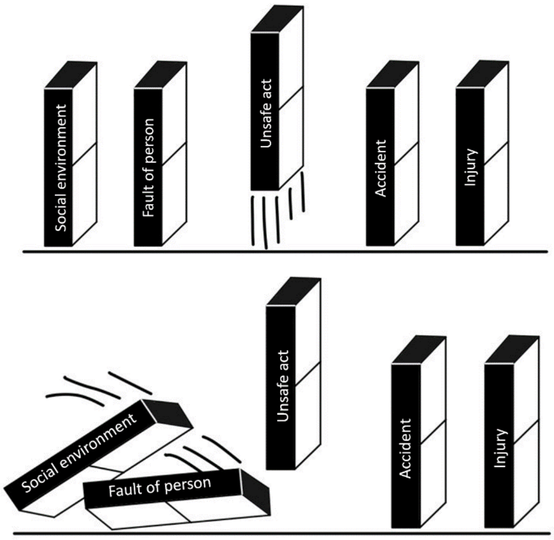


Fig. 3: Accidents can be prevented by removing the central piece.

Dominoes are arranged one after another so that the "falling" of one piece inevitably leads to the falling of the next. Therefore, if you remove any of the central pieces, a near miss will not turn into an accident, which is represented in Fig. 3 [10].

The domino model was updated by Bird in 1974 . He presented the same five dominoes but emphasized that the occurrence of accidents and injuries is also influenced by insufficient control on the part of the company management. The new names assigned to these five dominoes are as follows:

1. Lack of control – Management. Insufficient control, lack of training, and regulations.
2. Basic cause – Origins. If a highly dependable loss control system is absent, it allows for the presence of personal and job-related factors, which are commonly known as the fundamental or root causes of accidents or incidents leading to reduced safety. Personal factors include lack of knowledge, skills needed to accomplish tasks, lack of motivation, etc. Job-related factors include, for example, inadequate work standards and abnormal usage.
3. Immediate causes – Symptoms. Unsafe acts or conditions.
4. Accident – Contact.
5. Injury – Damage – Loss. This factor includes loss or damage of property, as well as injuries to persons.

Thus, there are some major differences between Heinrich's and Bird's models. Firstly, in Heinrich's model, the greatest attention is paid to the human factor of the enterprise worker: he/she observes other workers who perform unsafe actions and repeats them, consciously or not, and this sooner or later leads to consequences in the form of a near miss or, in a bad case, injury. Secondly, the role of organization and management in the fact that this or that accident happened is not defined. Third, the model oversimplifies the links leading to an incident.

Bird's model is more complex and comprehensive, emphasizing the role of the organization in causing accidents, i.e., Bird says that it is wrong to blame one worker for the incident [10]. It is also the fault of the company as a whole, which failed to explain safety rules to employees in a sufficiently accessible way and to provide working conditions in which the influence of the human factor on the processes will not be increased. Unlike Heinrich's model, this model has more complex relationships. However, in many modern industries, they are even more complex, so they are not applicable to all cases. The applicability of these models in practice is better considered in the context of a particular industry and the complexity of the links between employees within an organization.

This study utilizes both of these theories because it is important not only to count the number of near misses but also to determine what actions should be taken to reduce them. To do this, a domino model is essential because it tells us exactly how near misses result in injury at some point.

## 2.6 Human factor and organization influence on near misses emerging

By many researchers besides Heinrich, [11, 21], near misses are seen as an important indicator that something works wrong in the system. However, many organizations focus on the accidents that actually happened rather than on nearly safe incidents. This attitude towards near misses should be reconsidered because they give valuable information about flaws of different kinds that can be analyzed. Such analysis gives the opportunity to search for the problem and fix it before it leads to an accident, not after it has already happened [5, 22]. Incidents that end in injury do not provide enough information on how to prevent such accidents from happening. It is important to focus on the moments that almost caused the injury, and then the cause can be identified [1].

So, there is a need to record and analyze near misses to prevent their repetition and detect weak zones in the system.

There are several fundamental causes of near misses. Heinrich stated that there are three main categories of near misses: behavioral, technical, and organizational [10]. Behavioral near misses mostly include human factors of workers: fatigue, unsafe behavior, task omissions, pressure, stress, lack of motivation, the distraction of attention, task miscomprehension, etc. Technical near misses are strongly related to the failure of the equipment, defective tools, and lack of proper instructions for using the equipment, as well as the difficulty of its usage. Finally, organizational near misses are connected to organizational failures, such as managerial and supervisory miscommunication with workers, especially lack of proper instructions, directions, and motivation [10]. All three categories might be presented in every company to some extent, as near misses and accidents happen for a variety of reasons. Moreover, they can be mixed because sometimes it is not easy to determine which specific category an error belongs to.

The human factor is considered to play a factor of great role in near misses as it becomes a reason for the majority of behavioral near misses [9, 7, 14, 19]. Thus, the importance of employee training that can improve safety awareness and proficient management in accident prevention should not be overlooked [15].

The importance of human factors in occupational safety has also been researched widely. Karanikas, N., Melis, D. J., & Kourousis, K. I., in their study on safety and productivity in aircraft manufacturing, stress that human factors such as workers' fatigue, training, and experience influence much on overall productivity and on safety. Also, they argue that communication between managerial and worker staff can also influence both productivity and safety. So, in order to be profitable and productive, an organization should provide adequate training, set safety rules suitable for the industry, and communicate with their workers as well. Other scientists have come to the same conclusion. Although the circumstances of the study are completely different, as it is a work that analyzes near misses on a tanker ship, Hasanspahić N, Vujičić S, Kristić M, Mandušić M. stress that the combination of safety engineering and communication is the best to reduce the number of accidents [8].

However, it is worth noting that even if work is done to improve the environment in terms of safety technologies, there is still a risk of near misses because the human factor is defined as something that can lead to consequences even if the system is working properly [12]. Therefore, the problem should be addressed in a holistic manner: improving the security of the work environment from a technological point of view and improving communication between managerial staff and subordinates will help to significantly reduce the impact of human error on work processes. And thus reduce the number of near misses.

This paper will explore the solution of reducing near misses by increasing employee safety awareness through messages that clarify managers' instructions and thereby help deliver information accurately.

# 3 Research Details

This study will provide information on the practical use of shikake in the occupational safety sphere. As the shikake method has not been widely researched, it is not certain that it can be implemented in such areas, although it is believed to be effective in different academic fields. The effectiveness of shikake in various social spheres was studied but not detailed. Thus, this study will be helpful for those who are willing to practically use shikake for safety improvement.

Both quantitative and qualitative research methods were used in this study to provide a more detailed analysis based on statistics data and observations of people's behavior, as using just one approach may result in a lack of understanding of the influence of shikake on the focus group.

For collecting data, experimental research was applied as shikake must be implemented to analyze its effect on human behavior. The experiment preparation was divided into several stages.

Firstly, a meeting with the managerial staff of the plant was held to formulate the main goals that were expected to be achieved after the experiment. This helped to gain an understanding of the problems that the plant is facing and what shikake will be the most suitable solution. As the plant processes are quite hazardous and connected to various kinds of risks, hand injuries were selected as the most frequent type of injury in the plant.

In the second stage, a shikake idea was created. As the majority of injuries are related to hands and fingers, it was considered that the best way to change behavior is to create a strong association of this topic with shikake. Thus, pens were selected as the best choice for the subject of the research. There were two reasons for that. Firstly, pens are the most frequently used objects on the plant because the workers must fill up their individual checklists after completing each task. Secondly, in the Russian language, the word 'pen' has a similar pronunciation and spelling as 'hand,' so this object can possibly remind users of hands.

The main idea of the experiment is to improve workers' safety awareness by using pens every day. To do that, a message was printed on the body of each pen, eight different messages altogether. The messages are as follows:

1. I'm working safely.
2. I'm always careful.
3. I wash my hands before eating.
4. I'm working with proper equipment.
5. I'm cutting with a knife away from myself.
6. I'm protecting my fingers.
7. I'm using PPE (Personal Protective Equipment).
8. I'm aware of sharp edges.

These pens are of eight colors, and the messages are randomly printed on them; therefore, people can choose their favorite color every day and still get different messages (See Fig. 4).

Also, two cups were placed near the plant's locker room. At the beginning of the working shift, each worker should get dressed in the uniform and take a pen. It is supposed that they would read the message right away, but it is not necessary. After the shift ends, they must return pens in the most suitable cup. There are a pair of cups: one cup is for messages concerning overall safety (messages 1-4), and another is particularly for the pens with messages about hand safety (messages 5-8). Workers are likely to read the message once again and then place the pen in the right cup (See Fig. 5). This pair of cups is located in three different places in the plant: the passage area, the machining shop, and the foundry. Thus, it makes it easy for workers to return the pens to the correct cups. There are about 40 people on shift at a time, so


Fig. 4: Pens were used in the experiment.

if only two cups are placed at the exit, there will be a crowd, and the experiment will not be fully realized. Each section, on the other hand, holds an average of 10-15 people, making it much easier to interact with the shikake.

The reason for using two cups instead of multiple cups is much the same: it might become an obstacle, and sooner or later, workers would get tired of finding the right cup. However, using two cups to group pens by meaning of the messages might probably increase the effectiveness of the shikake.

The experiment meets all three FAD requirements [16]: it can be fairly used by all the workers, it attracts attention, and there is a duality of purpose. The workers want to place the pens right, and the managers want the workers to learn safety rules.

Since the company is concerned about the safety of its employees, a number of events are held annually to raise awareness of safety rules at the company. The largest of them is Safety Day, which is held in August every year since 2020. The start of the experiment was timed to coincide with this event so that employees would pay attention to it, but it is worth noting that for the purity of the experiment, they were not given any explanation of how to interact with the shikake beforehand.

The data will be collected as before by the managerial staff responsible for health and safety at the plant (hereinafter, H&S Coordinator), using the same data sheets to compare the results to those before and after

Fig. 5: Workers put pens into a cup.

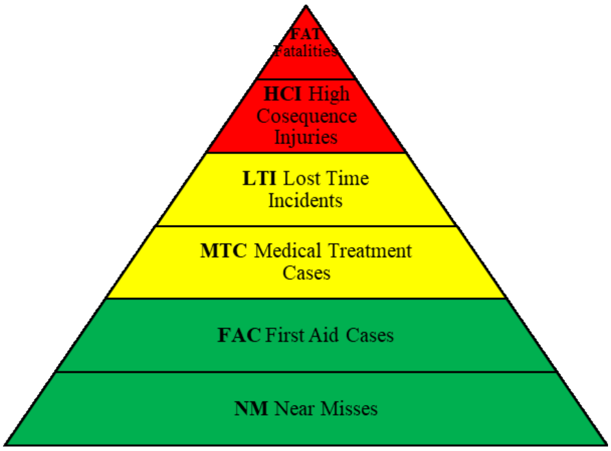



Fig. 6: Incident recording triangle.

the experiment. For this purpose, a triangle, which is similar to a combination of Heinrich's and Bird's models, is used, albeit slightly altered by the management of the company (See Fig. 6). It is divided into three main parts: the top part, which is referred to fatalities and heavy injuries, the middle part, which is mostly connected to time loss at the plant and mild injuries, and the bottom part that represents near miss incidents and first aid cases. To understand what can be defined as near miss, the H&S Coordinator refers to the definition based on GRI 403 (Global Reporting Initiative): near miss is a work-related incident where no injury or ill health occurs but which has the potential to cause these.

It is expected that right after the start of the experiment, nothing will change for a short period of time, then probably the number of near misses will go up as workers become more aware of the hands' safety, and after, it will slowly go down as the workers get used to the rules and become more conscious about using hands in work.

Table 2: Near misses, distribution by groups in all the plants and in Plant A.

| | Near misses in all the plants (%) | Near misses in Plant A (%) |
|---|---|---|
| Technical | 24 | 16 |
| Behavioral | 52 | 56 |
| Organizational | 23 | 28 |

## 4 Research Results

Statistics have been taken since 2019 at all the company's plants in Russia. Near miss data is recorded several times each month by the H&S Coordinator during safety walks. The H&S Coordinator notes where and at what time a potentially dangerous situation occurred and briefly describes the circumstances, attaching a photo. This is important for assessing which causes are the most common and what should be avoided in the workplace to minimize the number of such situations.

The near miss data for all the years of observation (2019-2023) was divided into three categories of near misses according to Heinrich: behavioral, organizational, and technical. If we analyze the data for all the plants, we can see that the cause of more than half, namely 52% of the total near misses, is employee behavior (See Table 2). At plant A, the situation is the same - 56% are behavioral near misses. This means that potentially dangerous situations arise because workers neglect safety or, due to personal reasons (poor state of health, unwillingness to work that day, fatigue, etc.), decide to simplify the processes performed in the production.

If we refer to the detailed statistics of near misses (See App. 1), it can be said that the reason for most of the nearly missed incidents that could end up with injuries to hands or the whole body (for example, as a result of using the handmade tool (See Image 3) is that the direct workers intentionally neglect the safety rules to complete the task fast. That is undoubtedly done for a behavioral reason, which was described by Heinrich and others.

Also, workers often overlook a potentially dangerous situation that they have created for behavioral reasons. For example, a worker puts a mug with a

Fig. 7: A handmade tool that was used instead of an arm file.


Fig. 8: A mug on an electrical panel.


Fig. 9: A soldering iron inside an electrical panel.

drink on an electrical panel (See Image 4) or puts a soldering iron inside an electrical panel (See Image 5).

Issues at the organizational level rank second, accounting for approximately 28% of cases, implying a lack of effective management or unclear directives. The remaining 16% indicate technical shortcomings of the organization, specifically problems related to equipment.

This experiment addresses both prevalent categories. Firstly, through the shikake method, employees are expected to become more attentive to their interactions with equipment and their adherence to the factory's safety protocols. Secondly, the experiment is anticipated to enhance workers' comprehension of safety instructions, aligning with the plant manager's objectives.

After the experiment was set up, the H&S Coordinator noted that the workers started using the shikake. Also, most of the employees looked at the pens and read the messages written on them at the beginning of the shift and at the end of the day when it was time to put the pen back into a cup.

Also, the data on near misses was collected. As mentioned before, there are some cases where the cause of near misses is mixed, so it can be interpreted from all the perspectives concerning categories by Heinrich (organizational, behavioral, and technical). It may contain the H&S Coordinator's subjective judgment, as when the Coordinator registers a near miss event, he decides which category it belongs to. Thus, to be more precise and objective, the total near miss count was the central object of this research.

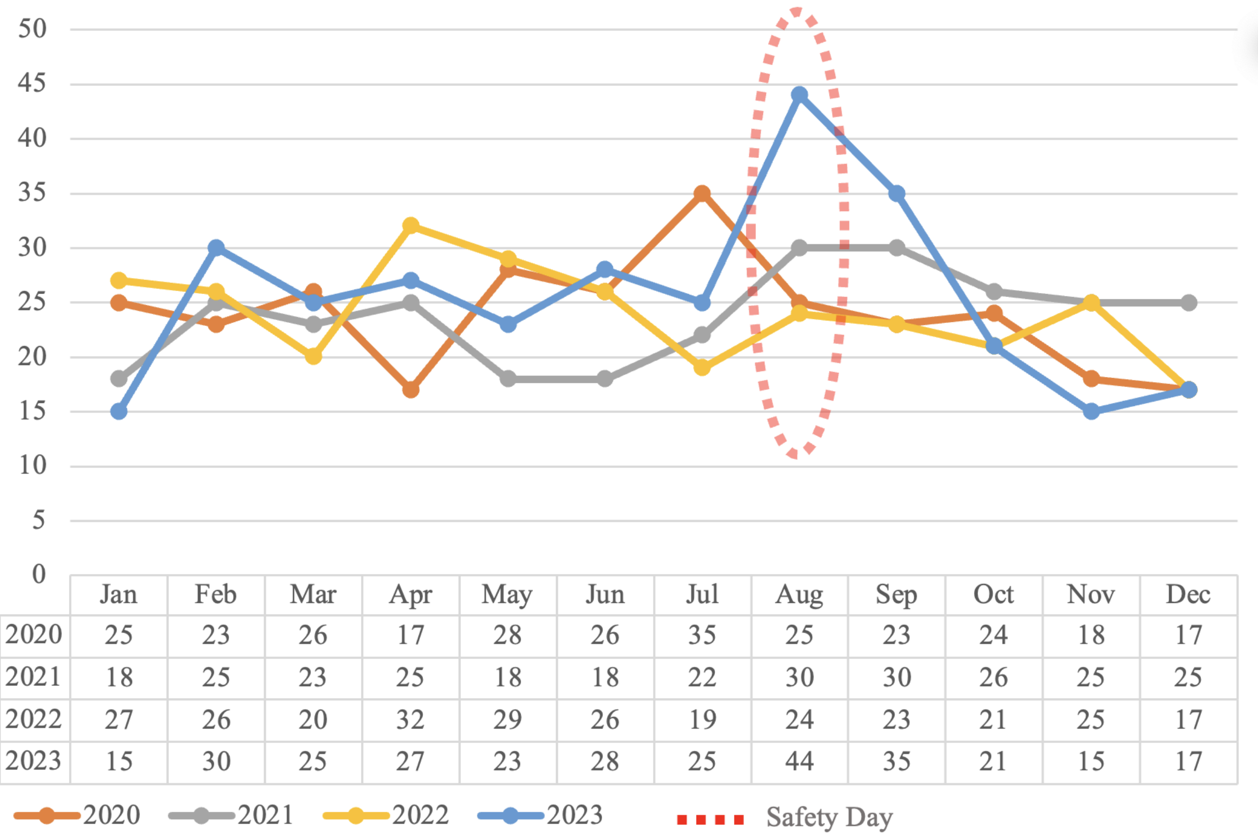
If we look at the statistics of all near misses at Plant A in Fig. 10, we can see that, based on four years of observations, it is difficult to identify obvious trends that could be called seasonality of errors. In other words, when the highest or lowest number of errors are committed at the same time each year. It is also worth noting that observations are made by the H&S Coordinator, who, at the time of summer vacation, New Year vacations (in Russia, New Year holidays last on average two weeks after the New Year), or due to illness may be absent, and as a consequence, may record fewer near misses.

However, what is certain based on the statistics for 2023 is that this year's data is significantly different from previous years.

To make a detailed chart description, one should also compare the charts for previous years in the same interval – three months before Safety Day and three months after, starting in 2020. Also, it is worth adding the context of the events held each year to the review of the schedules so that the result is more informative.

In 2020, meetings were held to explain the safety rules in detail. Brochures were also given to each worker to duplicate the content of the meetings, with children's drawings on each page. In 2021, similar activities were carried out, but instead of brochures, posters explaining safety were put up on the plant premises. In 2022, magnets with safety information printed on them were added to the previous year's activities, and employees used them to attach documents required for their work to the machines.

Of all the years of observation, only in 2020, there




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | 25 | 23 | 26 | 17 | 28 | 26 | 35 | 25 | 23 | 24 | 18 | 17 |
| 2021 | 18 | 25 | 23 | 25 | 18 | 18 | 22 | 30 | 30 | 26 | 25 | 25 |
| 2022 | 27 | 26 | 20 | 32 | 29 | 26 | 19 | 24 | 23 | 21 | 25 | 17 |
| 2023 | 15 | 30 | 25 | 27 | 23 | 28 | 25 | 44 | 35 | 21 | 15 | 17 |

Fig. 10: Near misses in total, Plant A. 2020-2023.

was a decrease in near misses after Safety Day (from 35 to 25 cases). In 2021 and 2022, the statistics increased, albeit slightly. In the following months, the statistics level off and reach the average level of near misses committed by employees. However, if we turn to 2023, there is a clear spike in near misses. In the graph, it can be seen that the number of near misses fluctuated between 22 and 27 for several months prior to the Safety Day at the plant, but afterward, it sharply increased to almost double by August (44 cases). This was followed immediately by a gradual decrease in cases, first to 35 cases in September and then to 21 in October, i.e., below the pre-survey period.

A decrease or insignificant change in the number of cases immediately after the start of the experiment may indicate that the activities have not had the expected effect on the target audience. If they are successful, workers become more attentive, first becoming accustomed to behaving in a different manner than they are used to, and then gradually changing their behavior to safer ones. If there is no spike in the number of incidents, it may indicate that the information was not perceived as important by employees or that it was delivered in the wrong way. For example, the problem with the magnet campaign in 2022 is due to the fact that most employees took the magnets home rather than using them daily in the work environment. Therefore, the graph for this year shows the smallest change.

Other campaigns were also not so successful since the content of the meetings is likely to be quickly forgotten by workers, and the brochures and posters are viewed and read by few. Also, the frequency of exposure to safety rules plays a great role. The more often a worker sees a safety rule, the more likely he or she is to follow it.

The purpose of the shikake experiment is to have workers look at a message each day about what to do to stay safe at work and then consciously select the category where the message should be placed. Also, because there are many pens, these messages rotate each day, making it difficult to foresee which one to be picked the next day. This encourages workers to read the safety rules time after time and eventually memorize them.

The sharp increase in the number of incidents in the month of Safety Day 2023 indicates that the H&S Coordinator became more attentive to catching near misses related to hands than before. But why? Probably due to the so-called Observer (or Hawthorne) Effect [13]. This phenomenon suggests that people may alter their behavior when they are aware that they are being observed or studied; thus, they feel motivated to try to present the best performance for the task that is being observed. As a result, an increase in the encouraged or expected behavior can be observed after the experiment begins because the person pays more attention to the action than before the study. For example, when the police launch an anti-shoplifting campaign, policemen become more attentive, possibly increasing their visibility in stores. Paradoxically, instead of deterring shoplifting, the campaign may lead to an increase in reported cases in the short term due to the increased attentiveness to this particular offense.

This is similar to the experiment made in the plant. Thus, it can be said that shikake had its effect firstly not on the direct workers of the plant but on the H&S Coordinator who registered near misses.

Then, from September onwards, the number of cases decreased consistently and reached its lowest point in all previous years during the period from Safety Day in August to the end of the year (15 cases). Therefore, it can be concluded that the plant workers gradually changed their behavior to comply with safety rules and minimize the risks of near misses.

There is no doubt that follow-up observations will be needed for a more accurate assessment, but at this stage, it can be said that a) the shikake experiment had a more pronounced effect compared to all previous experiments; b) in the first month, the effect on the H&S Coordinator was probably the greatest; c) the reaction of the direct plant workers showed the greatest response to the experiment, and thus resulted in a change in workers' behavior and a reduction in the number of near misses.

## 5 Discussion

This study presents a new approach to solving safety problems in the workplace. The results of the experiment showed that shikake can be used to increase the safety awareness of employees and, as a result, reduce near misses and, consequently, help to avoid serious injuries.

Of course, this study has some limitations. First, since it is a case study, it is difficult to say whether this method would be suitable for solving similar problems in other settings and in other types of enterprises. This method is probably most suitable for reducing near misses in relatively small-scale plants where the number of employees does not exceed 100. Secondly, the author suggests that the effectiveness of this method in Russian-speaking societies is higher than in societies where other languages prevail since there is an associative link between the words "hand" and "pen." Finally, in this paper, the concepts of Heinrich and Bird (domino model) were taken as a basis because, in the context of plant A, the author considered them to be the most applicable for solving the problem of near misses since the safety problems at the plant can be evaluated as consistent – near misses do lead to injuries of different types of severity in the end. However, there are other concepts that would be more appropriate for other industries (e.g., chemical, I.T., service, etc.) where the injury rates and sequence of operations are quite different.

## 6 Conclusion

This study showed that the use of shikake, namely safety message pens and return cups, was effective in reducing the number of near misses at Plant A. Two months after the start of the experiment, the number of near misses decreased to a level lower than before the experiment. Follow-up observations will undoubtedly be needed to understand whether the application of shikake in the long term affects the number of near misses committed by workers. However, it can be concluded that in the short term, namely at five months of observation, shikake had the expected effect.

This allows us to say that the main objective of this study has been fulfilled, and the hypothesis has been proven: shikake can be applied in manufacturing plants to reduce the number of near misses, and, therefore, reduce the subsequent injuries to workers and improve the company's reputation.

From the above, it follows that this experiment can be introduced in companies with similar conditions in order to solve safety problems in a novel and original way.

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