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Original Article

An evaluation of the effectiveness of the Behaviour Based Safety Initiative card system at a cement manufacturing company in Zimbabwe



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ABSTRACT

Background: A behavior-based safety initiative card-issuing system was introduced at a cement-manufacturing company in Zimbabwe in 2008 to try and curb accident occurrence. The purpose of this study was to evaluate the effectiveness of the Behaviour Based Safety Initiative card system as a tool used for reducing accident frequencies.

Methods: A mixed-method approach that involving administering piloted questionnaires to 40 out of 244 randomly selected employees, making observations, and reviewing secondary data were done to collect data from different sources in the organization in 2013. A paired *t*-test was conducted to test whether there was significant difference in accident occurrence before and after the implementation of the BBSI. Scatterplots were also used to establish the correlation between the issuance of cards and the accident and injury occurrence.

Results: The findings suggest that the introduction of the card system brought a significant decrease in accident and injury occurrence. A negative correlation between card issuance and accident occurrence was observed, i.e., the greater the number of cards issued, the fewer the number of accidents. It was also noted that the card system positively influenced the mindset of workers towards safe work practices.

Conclusion: The card system had an influence on the reduction of accidents and injuries. The organization should leverage on issuing more cards to further reduce the number of accidents and injuries to zero.

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1. Introduction

The International Labour Organization estimates that the total costs of occupational accidents and work-related diseases are 4% of the gross national product [1–3]. The total gross national product of the world was approximately 34×10^{12} US dollars in 2003 [2], which means that worldwide the annual cost of work-related injuries and diseases is approximately 1.36×10^{12} US dollars [4]. The Southern African Development Community region ranges widely from 0.35 to 49.42 injuries per 1,000 workers, and reported occupational fatality in the region ranges from 0.85 to 21.6 fatalities per 100,000 workers [2,5]. This then translates to an annual injury rates for wage workers of 14.02 fatalities per 100,000 workers.

Workers spend a large part of their lives at the workplace, sometimes working in potentially dangerous environments where their lives could be seriously at risk and the necessary safety precautions are not taken [5]. According to the National Social Security Report in 2011, there 4,111 serious injuries at workplaces were reported [5]. Seventy-five people died as a result of workplace accidents [5]. During the previous year (i.e., 2010), 4,410 serious workplace injuries and 90 deaths were recorded [5].

There are three paradigms that have been identified to have been critical in the evolution of research on accidents and occupational safety [6–8]. The first paradigm focuses on normative, prescriptive theories concerning the way people ought to act. This paradigm aims at preventing occupational accidents through task

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design and safe rules of conduct, in which failure to follow stipulated rules might result in punishment [8]. The second paradigm focused on descriptive models of work behavior in terms of deviations from the normative, “best way” of working (i.e., aiming to reduce errors and biases) [8]. This paradigm guides efforts to control behavior by removing the causes of errors. The third paradigm takes a cognitive approach to safety [8,9]. The cognitive approach focuses on the interaction of the individual and the work system. It is concerned with the characteristics of the work system (features of the task, tools, and environment) that influence the individual decisions and actions, and the possibility of errors [8]. Studies have noted that human behavior has a huge impact on accident-prevention programs, as 88% of accidents are attributed to unsafe acts, which are strongly aligned with employees’ attitudes and behavior [7]. Most studies have, however, focused on normative and prescriptive aspects in accident prevention, and have ignored the cognitive approach to safety, which fosters safe behavior at the workplace as a tool of accident minimization [7]. The majority of studies have cited that targeting employees’ behavior results in a vast reduction of accident occurrences at the workplace [10]. This has made behavior-based safety (BBS) a necessity in most organizations, as it molds employees’ attitudes and behavior, in such a way that they are conscious about ways of ensuring that their attitudes and behavioral practices do not predispose them to accidents [11].

The cement-manufacturing company in question is one of the leading cement-producing companies in Africa [12,13]. This company is certified to National Occupational Safety Authority and is also compliant to Occupational Health and Safety Assessment Series 18001. The company also has other safety initiatives, such as awareness campaigns, training/induction of employees, hazard-identification-and-risk-assessment system, audit-based safety, and toolbox talks. The aforementioned systems seemed inadequate in reaching their safety target, which is zero injuries and zero fatalities, and hence there was the introduction of the card-issuing system in 2006 to try and achieve their safety goal.

Safety is one of the fundamental aspects of any manufacturing industry, hence the introduction of the behavior-based safety initiative (BBSI) in 2008 at this cement-manufacturing company [1]. Manufacturing industries like this one are prone to occupational incidents and accidents due to exposure of workers to dangerous environments and largely due to workers’ behavior regarding safety [1,6]. There are two types of BBS cards: green cards and yellow cards, which the workers issue amongst each other in this cement-manufacturing company. The person doing the observation becomes the referee, and the person being observed becomes the player, with the department supervisor having an oversight of how these cards are issued. The cards issued and the reasons for issuance are recorded for transparency and objectivity. The employees own the system and are motivated by the rewards they would get in displaying good behavior; therefore, they are bound to report any indulgence and unfair activities that may jeopardize the effectiveness of the program. There are two types of plays: (1) onside play, where a person is playing to high standards (recognition for good behavior, wearing the provided personal protective clothing appropriately, and consistently performing the tasks allocated according to stipulated safe procedures, just to name a few); and (2) offside play, where a person is not playing to the rules (at-risk behaviors, inconsistent use of personal protective clothing, horseplay, poor housekeeping, placing hands around moving parts, and many more risky behaviors). The employees who receive most green cards are honored in the right platform, and those who receive more yellow cards are summoned by the management for reorientation. The main thrust of the card system was to promote BBS in all plants in the organization.

Since its inception, the system has not been evaluated to determine its effectiveness in reducing accidents and injury occurrence. Attention has been given to occupational accidents and the implementation of different strategies to curb accident occurrence. However, we did not find any study that has examined or assessed the effectiveness of different strategies that have been implemented in this organization. This study, therefore, sought to evaluate the effectiveness of the BBSI card system as a tool used for reducing accident frequencies.

2. Materials and methods

2.1. Study design and setting

A cross-sectional survey was conducted at the plant in 2013. A cross-sectional survey enables data to be collected at a single point in time or over a short observation period. It enables the researchers to combine different data-collection tools (e.g., questionnaires, review of secondary data, and observations to be made simultaneously for triangulation purposes). The plant is a heavy manufacturing industry, producing clinker from limestone and clay, which are abundant in the area. This product is the main raw material, which is transported to its blending factory and is blended with other materials in order to produce cement. The factory has 11 departments (i.e., administration, risk/safety, quality assurance, quarry/mining, production, mechanical, electrical, civil, motor transport/garage, customer services, and warehouse/stores). It is an 8-hour-by-three-shift production plant, and, due to the nature of the employees’ work, they are likely to be exposed to occupational hazards.

2.2. Study population and sampling

Forty respondents were selected from a population of 244 employees using random sampling. Firstly, a sampling frame was drawn from the registers kept in the departments. Random numbers were then generated and assigned to each employee. Each employee stood an equal opportunity to be selected and to participate in the study.

2.3. Data collection

Data were collected through piloted researcher-administered questionnaires from the 40 randomly selected employees to establish their attitudes toward the BBSI program. The questions were adapted from a study conducted by Han et al (2015), which assessed the reliability of tools or questions to test workers’ attitudes toward a specific variable (i.e., obese patients) [14]. A dichotomous questionnaire with 15 questions with two potential binary answers (yes or no, or agree or disagree) was administered to assess employees’ attitudes toward the BBSI program. The correct option selected would score a “1” and the incorrect option selected would score a “0.” In the end, these points were aggregated to get a total score out of 15. The questionnaire length of administration was between 15 and 30 minutes with translations done in cases of illiterate respondents (Appendix 1). Covert observations were done on employees for five working days where trained observers were disguised and pretended to be repairing some equipment in the plant, or performing some tasks as if they were contracted. The observers were not employees at the cement-manufacturing company, but were trained data collectors specific for this task. The benefit of covert observation is that people are more likely to behave naturally if they do not know they are being observed. The observers collected data on whether or not cards were issued correctly in line with the behavior exhibited, and also

the response or reaction of the person being issued with a card. A total of 20 employees were followed closely and observed over a period of five working days.

Secondary-data sources from a period before the implementation of the BBSI (2002–2006) and after the implementation of the BBSI (2007–2011) were reviewed. A number of accidents that occurred before and after the implementation of the program were reviewed. The number of cards issued from the implementation of the program was also reviewed *vis-à-vis* the number of accidents that occurred before and after the implementation of the BBSI card system.

2.4. Data management

The data generated from the 40 questionnaires assessing employees' attitudes were captured in an Excel spreadsheet, and were then imported into Stata version 13 (produced by StataCorp LP) for analysis. The data were checked for internal consistency using Cronbach α , and a value 0.942 was obtained symbolizing 94.2% reliability.

2.5. Data analysis

The injury and accident frequency rates were summarized in Tables 1 and 2. A paired *t*-test was conducted to ascertain whether or not there was a significant change in accident and injury frequencies before and after the implementation of the BBSI card

system. Pearson correlation on a scatterplot was utilized to establish the relationship (correlation) between the number of cards issued and the number of accidents and injuries resulting thereof. Fifteen questions were asked of respondents to establish their attitudes toward the BBSI card system. A scale was then developed from these questions as adapted from various references [14–16]. If the respondents scored between 0 and 5, they were considered to have a negative attitude; those who scored between 6 and 10 were considered to be indifferent, while those who scored above 10 were considered to have a positive attitude toward the BBSI card system and its objectives. Observations were also made on the practices of employees while implementing the card system. Data from the observations were summarized and presented as themes.

2.6. Ethical considerations

The researchers were granted permission by the organization to access BBSI records and to extract data from these records relating to accident and injury trends. The organization also granted the researchers permission to administer questionnaires and do some observations on their employees. Consent was also sought from the study participants themselves. Participation was voluntary, that is, employees were free to opt out of the study at any given stage with no questions asked regarding the reasons leading to their decisions not to participate.

3. Results

3.1. Trends in accident occurrence per department

Table 1 shows the trend in accident occurrence per department, that is, 4 years before the card system was implemented and 4 years after the implementation. The accident frequencies symbolized a significant decrease after the implementation of the BBSI card system, as confirmed by the significant paired *t*-test conducted on the data.

3.2. Trends in injury occurrence per department

Table 2 shows the trend in injury occurrence per department, that is, 4 years before the card system was implemented and 4 years after the implementation. The injury frequencies show a significant decrease after the implementation of the BBSI card system.

3.3. Relationship between the number of cards issued and the number of accidents occurring

Fig. 1 shows the relationship between the number of cards issued and the resultant accident occurrences. There is a strong negative correlation (Pearson $r = -0.9158$) between the two variables, which means an increase in the number of cards issued results in a decrease in the number of occurring accidents.

3.4. Relationship between the number of cards issued and the number of injuries occurring

Fig. 2 shows the relationship between the number of cards issued and the resultant number of injuries thereof. The figure shows that there is a strong negative correlation (Pearson $r = -0.8651$) between the two variables. Increasing the number of BBSI cards issued to employees results in a vast decrease in the number of injuries that occur.

Table 1
Trends in accident occurrence per department before and after the implementation of the behavior-based safety initiative card system

| Department | Number of accidents per department before | Number of accidents per department after | Differences |
|-------------------|---|--|-------------|
| Production | 137 | 93 | 44 |
| Quarry | 196 | 102 | 94 |
| Mechanical | 164 | 52 | 112 |
| Electrical | 56 | 12 | 44 |
| Civil | 13 | 8 | 5 |
| Customer services | 68 | 25 | 43 |
| Quality assurance | 7 | 3 | 4 |
| Warehouse | 54 | 19 | 35 |
| Motor transport | 56 | 17 | 39 |
| Contractors | 94 | 65 | 29 |
| Average | 84.5 | 39.6 | 44.9 |
| Totals | 845 | 396 | 449 |

Paired *t* test ($t = 4.1434$), degree of freedom = 9, mean difference = 44.9.
 $p = 0.002509$ (<0.05).

Table 2
Trends in injury occurrence per department

| Department | Number of injuries per department before | Number of injuries per department after | Differences |
|-------------------|--|---|-------------|
| Production | 23 | 14 | 9 |
| Quarry | 21 | 5 | 16 |
| Mechanical | 27 | 6 | 21 |
| Electrical | 11 | 6 | 5 |
| Civil | 5 | 1 | 4 |
| Customer services | 11 | 3 | 8 |
| Quality assurance | 1 | 1 | 0 |
| Warehouse | 12 | 5 | 7 |
| Motor transport | 11 | 4 | 7 |
| Contractors | 24 | 9 | 15 |
| Totals | 146 | 54 | 92 |

Paired *t* test ($t = 4.6026$), degree of freedom = 9, $p = 0.001286$ (<0.05), mean difference = 9.2.

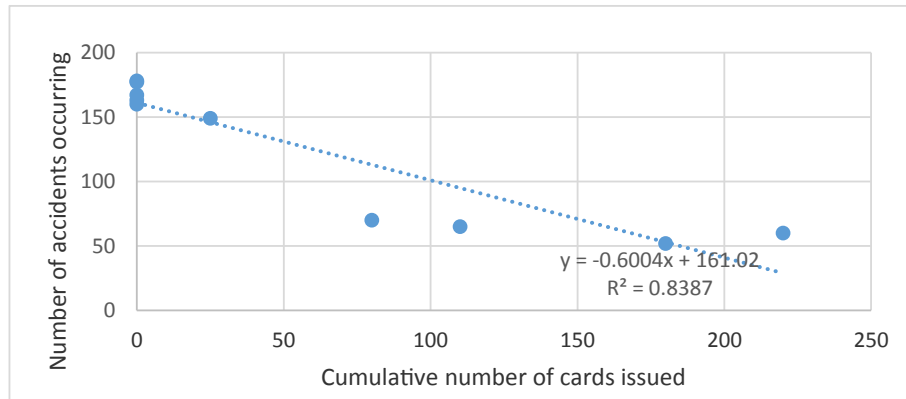


Fig. 1. Relationship between card issuing and accident occurrence (2002–2011).

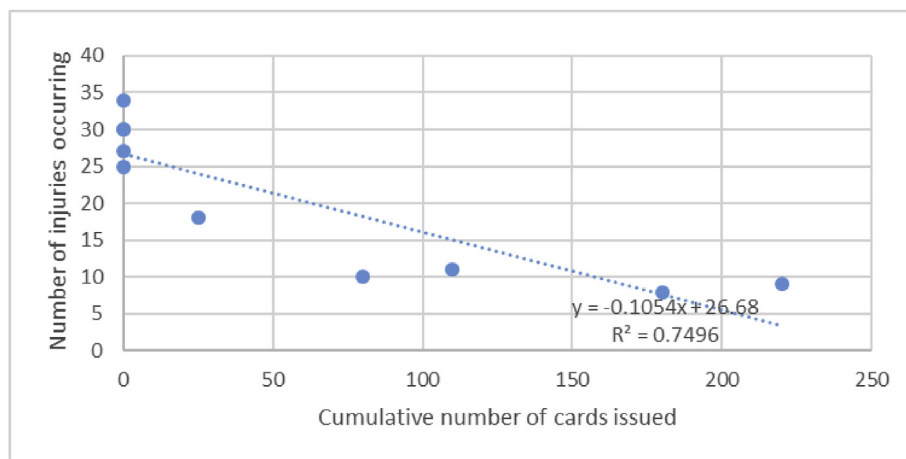


Fig. 2. Relationship between card issuing and injury occurrence (2002–2011).

3.5. Attitudes of employees toward the BBSI card system

Sixty percent of the respondents had a positive attitude toward the BBSI card system, while 30% and 10% were indifferent and had negative attitudes, respectively. The findings are summarized in Fig. 3.

3.6. Observations

The researchers observed an improvement of practices toward safe work in all workers. All employees were conscious of the practices which could result in them being given yellow BBSI cards. All individuals were seen to be ashamed if given a yellow card for an unsafe practice, as this meant they were going to be summoned by the management. Being summoned by the management was viewed negatively, as it puts concerned employees in the spotlight for unsafe acts. Employees who were given green cards ($n = 20$; 65%) displayed excitement and pride, and this led them to gloat in anticipation of amassing as many green cards as possible for them to be rewarded at a later stage. Most ($n = 20$; 90%) employees were seen to be putting a lot of effort in practicing safe acts so as to be rewarded for good behaviour.

4. Discussion

The findings of the study pointed out that there was a significant reduction in accident and injury occurrence after the introduction

of the BBSI card system. These findings are consistent with a study conducted by Kaila (2014) who found that unsafe or at-risk behaviors of employees are the root cause of most accidents [17,18]. The study further highlights that implementing behavior-targeting programs apprehends accident occurrences [17,18]. Employees become aware of the potential consequences that they are bound to suffer if they do not mold their behavior in line with the program expectations [17–20].

The study findings also highlighted that there was a strong negative correlation between the number of BBSI cards issued and the number of accidents and injuries that occurred. This means that the higher the number of cards issued, the lower the number of accidents and injuries thereof. These findings concur with the studies that were conducted by Hidley (1998) and DePasquale and Geller (1999), where critical success factors for BBS were explored [21,22]. Findings from these studies point out that employees avoid being accountable to the management through appraisals; therefore, they will do everything in their power to abide to the BBS program goals and objectives [21,22]. Our findings are, therefore, similar to these studies in the sense that employees at the cement-manufacturing company are subjected to rewards, and may suffer consequences if they are found in possession of many yellow cards; therefore, they will do anything in their power to avoid getting a lot of yellow cards.

The study also found out that majority of employees (60%, $n = 40$) had a positive attitude toward the BBSI card system. A study conducted by DePasquale and Geller (1999) highlighted that

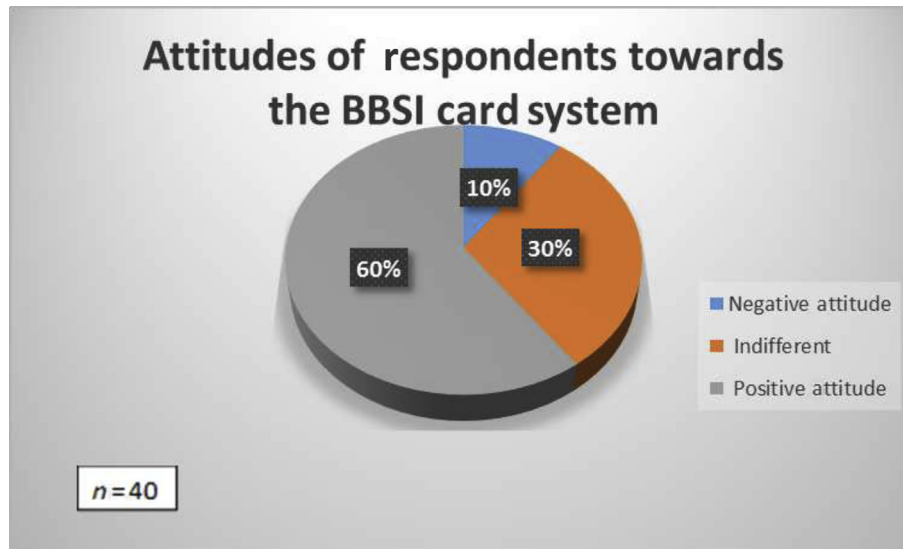


Fig. 3. Attitudes of employees toward the BBSI card system.

employees would abide by, and have a good attitude toward a BBS program if they value their tenure in an organization [22]. This normally cultivates a safety culture as employees trust their managements' abilities, and therefore, they are bound to support most of the safety initiatives suggested and adopted by their management [22]. In addition, this study further elaborates that employees that are involved in a mandatory process report high frequencies of giving positive behavior-based feedback [22]. This is consistent with the findings of our study where employees were not given a choice to opt out of the BBSI card system, as it was mandatory and compulsory.

It was observed that employees were very conscious of the BBSI card system and did everything to avoid being given yellow cards. A study conducted by Hidley (1998) reinforces this finding [21]. Hidley points out that employees would do everything to avoid being associated with negative behaviors in an organization where the organization rewards positive behavior and punishes those who engage in risk behaviors [21].

This study focused on the BBSI card system as one of the tools to reduce accident occurrence at the workplace. Most studies have focused on safety with particular reference on safety procedures (procedures to do the work safely), and also engineering techniques to reduce exposure of employees to hazards, but have ignored the human aspect of safety [7,8,22,23]. This study builds on the knowledge of existing safety programs that could target the behavior of employees to create a safe working attitude and behavior, which could yield positive results. Such studies would help to improve the safety outcome at the workplace, as the human behavior would be integrated into existing safety programs for optimal results.

It should be noted that the results from this study cannot be generalized for all manufacturing industries. The employees were not given a choice to opt out of the BBSI card system, as it was compulsory and mandatory. In as much as there was a change in accident and injury occurrences after the implementation of the BBSI card system, such outcomes cannot be exclusively attributed to the BBSI card system. There were some programs and systems that were running concurrently with the BBSI card system during the time of our investigation. Most of the information we reviewed did not specify whether or not the cards issued were green or

yellow, but it gave us the total number of cards issued regardless of color. This then led the authors to analyze the data based on the number of cards issued without paying attention to the color of the card issued.

5. Conclusion

The findings of this study suggest that the BBSI card system yielded positive results, as seen in a vast decrease in accident and injury occurrences after the implementation of this program. The safety culture generally improved as employees started appreciating the importance of the card system in safeguarding their safety, and also in making sure they are rewarded for safe acts and practices. There is sufficient evidence that the BBSI card system was effective, as the higher the number of cards that were issued, the lower the number of accidents and injuries occurred. The organization should then continue issuing more cards to attain even lower numbers of accident and injury occurrences. There is also a need for the organization to improve its record keeping and to classify cards issued according to color, as this would allow for in-depth audits to be conducted and a fair assessment of the effectiveness of the BBSI strategy to be done.

Conflict of interest

We confirm that there are no conflict of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Appendix 1. Respondents' attitude questionnaire

- (1) Accidents are a serious health problem in any organization. (Agree or disagree)
- (2) Can accidents be avoided? (Yes or no)
- (3) Do you know any accident-reduction systems that are in place in this organization? (Yes or no)
- (4) In your view, has the BBSI program been helpful in reducing accidents in this organization? (Yes or no)
- (5) BBSI has improved your chances of being safe at work. (Agree or disagree)

- (6) BBSI is the best strategy that has been implemented by the organization in relation to accident reduction. (Agree or disagree)
- (7) The accident-occurrence rates were high in your department before the introduction of the BBSI card system. (Agree or disagree)
- (8) Has the witnessed accident and injury reduction been an outcome of the BBSI program implementation? (Agree or disagree)
- (9) Do you think the card system has influenced behaviour change in employees? (Yes or no)
- (10) The card-issuing setup (i.e., referee and player) is appropriate for the reward system. (Agree or disagree)
- (11) Do you think the card system honors the right people at the workplace? (Yes or no)
- (12) In your view, the BBSI protocol violators are correctly identified. (Agree or disagree)
- (13) Are you committed to this strategy fully? (Yes or no)
- (14) Do you think the card system should continue being implemented in this organization? (Yes or no)
- (15) Would you recommend this strategy to any organization? (Yes or no)

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