

IMPROVING SAFETY PERFORMANCE THROUGH 5S PROGRAM

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ABSTRACT

Employees in the construction industry suffer from poor health and safety performance. Beyond the human suffering, this implies a vast economical problem. Among the most common accident causes in construction are slips, trips and falls (on same level) which often relate to poor order and tidiness.

This study describes a 5S program that was launched in a Finnish construction company. The aim of the program was to improve order and tidiness and consequently safety performance. The program consisted of the following phases: awareness campaign, management training, launch of three eLearning training modules, workshops at every site during one week, management site safety visits and follow up inspections.

The workshops engaged approximately 2770 employees at 190 jobsites during one week. 94% of staff employees that participated in the workshops considered the workshops beneficial. Actions to improve order and tidiness were achieved through personal engagement and pledges. Safety performance improvement turned out promising. Weekly safety inspection indices rose by 3.4 percentage points. Number of accidents associated with slips and trips reduced.

The suggested model enables personnel engagement into order and tidiness improvement. Safety performance follow-up after three months, however, reveal fading effect. Thus a recommendation is made that regular engagement activities on housekeeping improvement need to be incorporated into the construction process.

KEY WORDS

Safety, Accident, 5S, Construction, Housekeeping, Prevention

INTRODUCTION

From lean production point of view, workforce injuries and the resulting disruption to the progress of construction work represent waste. Beyond the human suffering, this implies a vast economical problem. Respective cost elements include victim's lost work hours, hours spent on changing work routines, investigation, repair of damages, transportation, capital cost during production stop, insurance expenditures, loss of income, cost of safety measures and medical treatment (Kjellén, 2000).

Opposite to the well-defined procedures in high-risk system (e.g. nuclear, chemical plant) construction work involves a large number of work processes that need to adapt to dynamic environment. Construction safety problems may arise from

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lack of recognition of the dynamic and dependent nature of construction work (Schafer, et al., 2008)

By integrating lean principles and tools in the production planning safety risks may be mitigated (Saurin, et al., 2002). Also use of lean construction and Last Planner™ tools presumably reduce waste and incident rates in the construction process (Thomassen, et al., 2002).

However, implementing lean production system is, especially for the social part, challenging (Liker, 2004). The tools, that represent the technical piece, form only a small portion of the package (Hafey, 2010).

At the same time, construction workforce generally suffers poor H&S performance. Slips, trips and falls (on the same level) generate 19% of major injuries to construction industry workers (Haslan, et al., 2005), and in the overall statistics they are among the most common accident causes.

5S is a basic method for cleanup and organisation of the workplace. It has been developed in Japanese just-in-time manufacturing. The name lists five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke, which are translated into English as sort, set in order, shine, standardise and sustain (Hafey, 2010).

There are several studies that confirm the relationship between housekeeping, order and tidiness and safety performance, e.g. a long-term study in the shipbuilding industry (Saari, 1989).

In the lean construction literature, the discussion of the use of 5S in incident prevention is limited. The aim of the current paper is to describe a model how a large construction organisation may run a 5S program.

This study suggests a model and offers observations and results from the development.

BACKGROUND

Current best practice discussions suggest that the proper approach to safety is not to impose more rules but to change the system's behaviour into being safer (Bertelsen, 2004). Also Rasmussen (1997) suggests moving ahead from normative theories concerning the way people ought to act ("one best way"). Acknowledging that causal attribution to an accident is a social construction more effort should be put on visualising the constraints of the workplace. Enabling work near the "edge" is explored by Abdelhamid, et al. (2003).

Personnel involvement is essential for tackling the social challenge in the change. In construction industry, work crews practises often determine how the actual work is structured, coordinated and how workers face the work situations (Mitropoulos, et al., 2007). A positive thing is, that construction workers possess a clear will to participate in making decisions in their jobs (Coffey, 2000).

The organisation, dealt in this study, has 2200 employees and a similar amount of workforce through contractors, working in approximately 190 simultaneously on-going projects. The company has published a strategic ambition to move towards zero accidents.

As a basis for housekeeping the company applies a goal-setting and feedback scheme developed for construction safety (Laitinen, et al., 1996). It is called TR safety observation method and it has been used since 1997. The method sets standards for some basic safety critical factors that are important in construction incident

prevention. The areas are 1) working habits, 2) scaffolding and ladders, 3) machinery and equipment, 4) protection against falling, 5) electricity and lighting, 6) order, tidiness and dustiness. The compliance is checked in weekly inspections. Both compliance and non-compliance are measured and the ratio is calculated. If a site achieves a 100% TR-index, it fully complies with the standards. The inspection is carried out by a team consisting of the site foreman and the workers' safety representative. The method has been influenced by the 5S concept.

Higher TR indices have been shown to correlate with a low accident frequency at the construction site (Laitinen, et al., 1999).

Order and tidiness have been traditionally managed through pre-task planning, induction process and daily supervision. In addition, the rules are educated in a one-day general safety training.

All site personnel are also encouraged to report safety observations. Once the observation card is filled and handed over to the site foremen they decide on respective corrective action and finally enter the data to the electronic scorecard. One of the hazard categories in the card is order and tidiness.

In practise there had been many accidents caused by poor housekeeping. In 2012 slips, trips and falls (on same level) was the biggest cause of lost time accidents in the organisation, namely 19% of all accidents. The majority of these cases relate to moving around at site. Access and walking ways must be clear of material and cables, surfaces must be as even as possible and not slippery.

From lean construction viewpoint 5S should be implemented by embedding it into the daily way of working - "how things are done". Excellence in 5S cannot be achieved by a centralized, top-down management approach, but rather by distributed responsibilities. By strengthening 5S all stakeholders should be able to appreciate themselves as process and change agents.

The company accident history and lack of personal engagement revealed the need to vitalise its current performance.

IMPLEMENTATION PROGRAM

The ultimate objective of the 5S program was to achieve better working environment and to reduce accidents caused by slips, trips and falls (on same level).

Secondly, it was recognised that better housekeeping would support reliable work flow, increase productivity and personnel satisfaction. This was, however, not an official objective of the program, and therefore would not be evaluated.

It was also stated that the 5S program should engage all site personnel including contract partners, thus helping to augment individual and organisational understanding of safety issues, stimulate safety awareness and culture, and indicate steps to improve safety performance.

Nominal group technique was chosen to engage personnel to 5S. Nominal group technique is a group process involving problem identification, solution generation, and decision making (Delbecq, et al., 1971). In the sessions participants are encouraged to share and discuss reasons for their choices, thereby identifying common ground. This allows the creation of a hybrid idea often found to be even better than the ideas being initially considered.

In order to strengthen engagement and personalisation, pledges were asked from all participants.

The program consisted of following elements:

Sort. The first step challenges to sort through everything in work areas and to identify what is required to do the work.

Set in order. In this step the remaining materials and tools etc. are set in order with planning, organising and labelling. Special attention was paid to site storage areas and facilities.

Shine means cleaning the working environment. This includes the general arrangements like waste bins and vacuum cleaners but also the evaluation of individual work procedures, such as cleaning the work area daily after the shift.

Standardise. The TR-method has fairly simple rules on what is considered correct or incorrect. These standard-rules include:

- No waste, besides the waste related to the on-going work, is accepted on the area that is evaluated. An area is considered to be visible to the observer. Each area will be evaluated separately and marked either correct or incorrect.
- Stored materials must be in a single place and in good order. Access ways must be clear.
- There must be room for more waste in the waste bins and containers. Waste should be sorted if necessary.

Sustain. The last S means making sure the standard remains. Formal checks are carried out weekly as described earlier.

In the following, the 5S program launched in 2013 is reported over two phases:

- Phase 1: Preparation and pre-campaign
- Phase 2: Workshop week

PHASE 1: PREPARATION AND PRE-CAMPAIGN

Prior to the workshop week launch preparation and a pre-campaign were carried out. This phase consisted of the following actions (table 1 and 2).

Table 1. Communication prior to the workshop week

Communication actions	Content	Weeks before
Pre-campaign, awareness poster [figure 1]	Disseminated to all work sites. It introduces a pre-campaign that challenges personnel to identify housekeeping issues and to share good practices. Most common challenges were highlighted: Are the access ways clear? How does the site look from outside point-of-view? Are the welfare facilities in good shape? Is there a designated smoking area? Are the storage areas and material containers well organised? What is the fire risk of combustible materials? Risk of oil spills etc. leakages?	10
Housekeeping challenge on good practises	All respondents to the housekeeping challenge are rewarded. Pictures are collected and shared across the organisation.	10-5
Letter to the line organisation	Management team letter to line organisation stressing the importance of participation and action.	7

Internal communications	Internal news on the upcoming program.	Weekly
Housekeeping campaign poster [figure 2]	Disseminated to all work sites. It invites audience to think what elements constitute a tidy and “neat” work environment	4
Video interview	Site personnel were interviewed. They contemplated the various aspects of order and tidiness and relation to productivity and safety.	5
Video message	Company CEO video message on why the program is important to the organisation. The video was shared also to contract partners.	3
Letter to contract partners	900 invitation letters were sent to contract partners. Partners were asked to consider the housekeeping issues and to participate in the workshops.	3
Facebook and YouTube	The campaign was released also through Facebook and YouTube.	10-0
Workshop communication meeting at site	Every site had a start-up meeting for the workshop week. In the meeting the week’s purpose and actions to be taken were explained to the personnel. Everyone, including subcontractor employees, was asked to participate.	1
SMS	All staff employees got an SMS reminder of the program.	0



Figure 1. Pre-campaign awareness poster



Figure 2. Housekeeping campaign poster

Table 2. Training prior to the workshop week

Training actions	Content	Weeks before
A3 Workshop material [figure 3]	For the housekeeping workshop participants an A3 worksheet material was prepared. It follows the structure of an A3 practical problem solving tool, which has been introduced by Toyota. See figure 3. It takes one hour to go through the workshop.	13

Workshop and the A3 contains the following sections (figure 3):

Consequences of bad housekeeping – disruption, stress and accidents (the problem)

1-2. Get to know two real accidents caused by bad housekeeping. A fall accident through loose opening cover. A finger wound while using circular saw in a messy environment.

3. Take a close look at the following pictures and think what led to this situation and how it can be prevented. Discuss with your group. The situations are the same as described on table 1.

4. What should change in order for us to have a tidy and orderly site? What are the 5S principles and how can we use them?

5. What can I personally do better? What do we do together differently? Discussion and agreement.

Project director training	All project directors were trained to hold a housekeeping workshop.	9
Site managers training	To make sure that enough competence is available, also all site managers were trained to hold a housekeeping workshop.	3
eLearning [figure 4]	Three eLearning modules were released for the staff employees. The first one was about the 5S concept. In the module the student must rehearse housekeeping and see what the different S's stand for.	11
[figure 5]	The second eLearning module was on how to manage order and tidiness at construction site.	5
	The third eLearning module was preparing everyone for the workshop week: Why and how to participate?	5
Health and safety specialist training	Specialists were trained to support line organisation to succeed in the program.	4



Figure 3. A3 practical problem solving exercise for housekeeping workshop participants



Figure 4. Snapshot from the eLearning module on 5S concept



Figure 5. Snapshot from the eLearning module on how to manage order and tidiness at a construction site

PHASE 2: WORKSHOP WEEK

The workshop week consisted of the following actions (table 3).

Table 3. Actions during and after the workshop week

Actions on Workshop week	Content
Opening on Monday	Every site had an opening meeting for the week. Line directors participate in the meeting. Top management had site safety tours.
Housekeeping workshops	Every site had housekeeping workshops which take one hour each. The personnel were divided into small discussion groups. Nominal group technique was used. The discussion was based on potential hazards and real accident cases which have been caused by bad order and tidiness. The sites may use either general pictures or take their own. See table 2 and picture 3. Also 5S steps were discussed, as well as their application to site. In the end of the workshop participants were asked to make a personal pledge that they will improve housekeeping.
Daily news	Daily news from sites was published across the organisation. They included among others: Workshop reflection, dust extraction solutions available, site safety visits and photos.
Weekly safety inspection	Every site carried out weekly safety inspections in which also housekeeping level was evaluated.
Feedback questionnaire	After the campaign there was an electronic feedback survey.

RESULTS

More competence on 5S through eLearning

Staff employees were encouraged to complete eLearning training modules on 5S and the workshop program. In average, one module takes 25 minutes to complete. This makes up to a total of 450 hours of training to the staff employees (Table 4).

Table 4. Number of eLearning modules completed

Actions on Workshop week	Modules completed
eLearning module on 5S concept	349
eLearning module on how to manage order and tidiness at construction site	315
eLearning module preparing everyone for the workshop week	416
Total	1080

Feedback was received through the learning management system (some open comments on table 5). Reflecting to the eLearning content 88% of respondents said that they either almost or fully agree that workshops seem to be a beneficial tool to carry out. 91% said that they either almost or fully agree that they recognise their role in the program.

Table 5. Feedback from eLearning management system

Feedback on 5S eLearning
“Housekeeping workshops are an excellent thing.”
“Safety staff should take responsibility for leading the workshop.”
“Not every site manager has natural characteristics to lead these type of presentations. Let the foremen concentrate on making money, not to be in show-business.”
“Best campaign ever. Workshop was very good!”

Raise awareness and commit into action

There is no exact number of how many people participated in the workshops during one week. At that time there were 191 sites, from very small ones up to sites that had 150 employees. The survey revealed that 84 % of the sites had a workshop or several workshops. According to the working hours from the safety statistics 4129 people were working that month. We can expect 80% of people participating to the workshops, i.e. 2770 people.

All participants were asked to make a safety pledge: to name a way or ways by which they would personally improve housekeeping. Some examples of the pledges are presented in the table 6.

Staff people answered to a survey after the workshop week. Following results were gathered from an electronic survey: 84 % respondents (N=246) say that their site carried out a workshop or several workshops. 94 % respondents (N=205) say that the workshop was a successful event. Most attention to the campaign was caught by the following communication channels (in this order): Intranet pages, Poster, SMS, Internal blog writings, Internet pages, YouTube –videos and Facebook.

Table 6. Some examples of the pledges to improve housekeeping

Pledges to improve housekeeping
“I promise to follow the rules. I will immediately organise the waste that I create. I will also challenge my co-workers to do the same.”
“I will clear walkways. Electric cables or water hoses do not belong to walkways.”
“I commit to organising my tools and keeping them in good condition. “
“I will insist subcontractors to follow the rules.”
“I promise to keep my office tidy. I cannot tell others unless I do it myself.”

Change in the site safety indices

The site safety index describes the number of correct observations versus all observations. Thereby, an index of 100% means that all observations made comply with the safety rules. Figure 6 describes how the average safety inspection indices from 20 sites reacted. The average is calculated month-by-month before the workshops (months -4 to -1) and the index for the workshop month (0) and five months after (1-5).

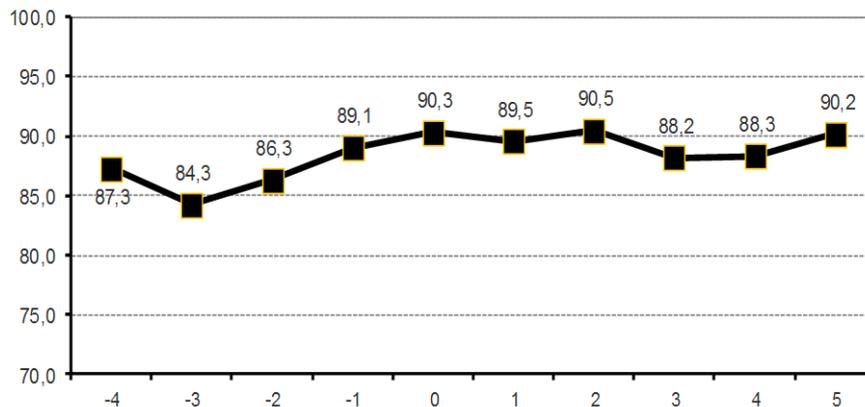


Figure 6. Average safety inspection index from 20 sites calculated on a monthly basis before the workshop week (months -4 to -1), the index for workshop month (0) and five months after that (1-5).

The average weekly safety inspection index rose by 3.4 percentage points, comparing four months before the workshops versus three months after (from 86.8% to 90.1%). After three months there is decrease of a 1.2 percentage points (88.9%, average of months 3-5). The level stays, however, higher than before the workshops. Graph shows that commitment to the order and tidiness standard needs to be strengthened on a regular basis. It is also a fact that workforce rotates, so there are new workers that have not been to the workshop at jobsite. This concerns especially contract partner’s workforce. Therefore it is suggested that a similar workshop should be run every three months to sustain the performance.

Change in accident statistics

The number of lost time accidents that had order and tidiness problems as causal factor is presented in the figure 7. Accidents were collected from the whole organisation. Common sense would dictate that the accident statistics would determine the effectiveness of the 5S program. However, accident frequency data is often statistically unreliable due to restriction of variance. Figure 7 shows rough fading effect of the program; after six months these types of accidents appear again.

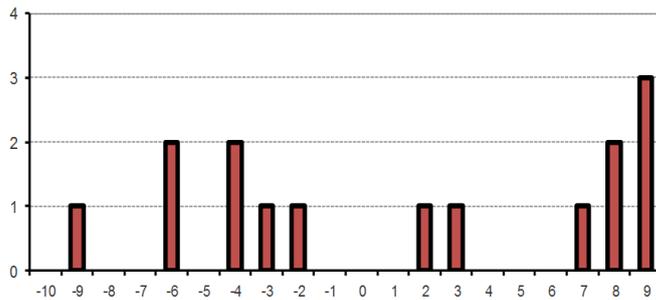


Figure 7. Number of lost time accidents that had order and tidiness as cause factor. Accidents collected at all jobsites. Accidents are presented monthly before the workshop week (-10 to -1), the workshop month (0) and nine months after that (1-9).

More safety observations on housekeeping

Despite no effort was put to activating more safety observations regarding housekeeping issues, there was a peak seen in the data (figure 8). Housekeeping observations generated 22% of all observation during months -4 and -3. Once the campaign began, the proportion rose to 26% (month -2) peaking to 35% (month -1). After that the monthly proportion got lower; 27%, 21%, 30%, 23% and 21% (months 0, 1, 2, 3, 4). It is expected that the more safety observations are recorded the more corrective and improving action is put on place.

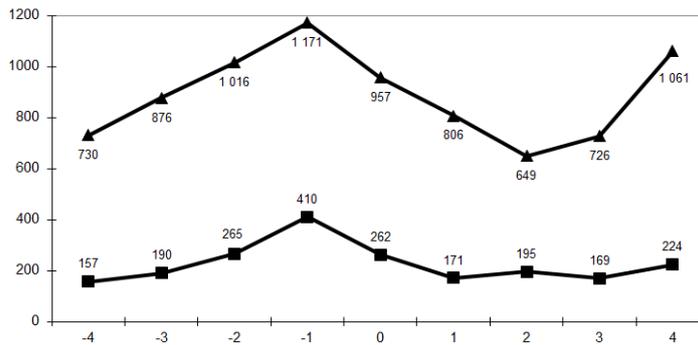


Figure 8. Total number of safety observations (upper line) versus number of safety observations on housekeeping (lower line) month by month. The month with the workshop week is marked by 0.

DISCUSSION AND CONCLUSIONS

The company had identified a need to improve order and tidiness at its operations. The present performance seemed to block further progress on safety performance. Trivial slips, trips and falls (on same level) were the largest cause of accidents.

A program was put in place to engage personnel to improve order and tidiness. There was a base set in the TR-target-setting and monitoring, but it needed revitalisation. The program used 5S components.

By using this model all personnel, including own and subcontractor personnel, were influenced. Approximately 80% of the site personnel were participating in workshops during one week. Actions to improve order and tidiness were achieved through personal engagement and pledges. The safety performance improvement turned out to be promising. Weekly safety inspection indices rose by 3.4 percentage points. The index is put together from six safety indicators. No other campaigns or initiatives were going on at that time and also no seasonal trend has been found affecting the index. Therefore, it may be estimated that the change of 3.4 percentage points is actually a result of a bigger change in the order and tidiness performance. The accident statistics show also that the number of accidents associated with slips and trips reduced. These results were, however, not statistically evaluated.

The model integrates 5S elements with communication actions, training, participation and engagement to improve order and tidiness. Line organisation took lead in the workshops contrary to typical use of safety specialist. Approaches used are recognised also as good practise both in modern safety management and lean production.

The program generated general and specific discourse on housekeeping and the ways of working through all organization levels. E.g. the proportion of safety observations relating to housekeeping rose by 13 percentage points during the pre-campaign. The discourse is expected to enrich the overall safety awareness and culture. As Hollnagel et al. (2006) say safety should not be viewed as a system property but "...as something a system or organization does, rather than something an organization has".

The safety performance follow-up after three months, however, reveals a fading effect. Further experiment should be carried out if this could be overcome with incentives or rewards. In any case, it is a fact that new personnel enter jobsites and constantly challenge order and tidiness standards. Thus a recommendation is made that regular engagement activities on housekeeping improvement need to be incorporated into the construction process.

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