Improving safety in maintenance of the railway system by reducing latent errors – a way forward?

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Abstract. The company INFRANORD AB in Sweden works with production and maintenance of the railway system in Sweden. Risks and violations of safety rules have been observed by the organisation and a project was started 2010 with the aim to improve safety. The project was led by researchers from Luleå University of Technology and was based on the Tripod-Delta method, an established proactive safety philosophy. The results of the project were followed up two years later, in 2012. Improvements in the design of equipment were reported, as well as a positive tendency for the quality and safety of maintenance activities. The quality of communication was reported as being improved, incident reporting increased slightly and accidents decreased. On the negative side, a decrease in efficiency was reported. The results were interpreted as a positive trend towards a safety culture. A number of factors beside the project may have had an impact on the results in the 2012 follow up study.

Keywords: Maintenance, railway, accidents, tripod-delta

1. Introduction

It is well known that the railway system offers a dangerous working environment. The interaction with heavy machines, high altitudes, fast moving trains, electricity, bad visibility, extreme temperatures creates a number of risks. Maintenance activities must often be performed under different working conditions, in summer and winter, often during conditions of time pressure (5), exposing the workers in the field to a number of different risks. Regulation of the work in the Swedish railway infrastructure has been decided by Swedish Transport Agency. Rules and procedures have been developed and decided by the agency and can be found in a document named JTF. After a political decision and a deregulation a large number of private companies are now working with maintenance in the railway system, with contracts from the Swedish Transport Agency. This has increased the complexity of maintenance activities and made communication and coordination of efforts between involved partners much more complex. In most complex organizations there exists a number of conflicting goals and the railway system is no exception. One conflict is between the goals to deliver efficient and timely transportation of people and goods and safety. Safety is officially stated as one top goal and need human as well as material resources to be fulfilled. The top goal of productivity will sometimes be in conflict with safety, especially as new players have entered the scene and are competing for jobs by offering maintenance services for a low cost. Other factors, such as stress resulting from time pressure, lack of personnel and bad working conditions, time consuming or badly adapted safety rules may also have a negative impact on safety. A number of different

approaches to the improvement of safety in complex systems exist. An established proactive approach to enhanced safety is Tripod-Delta (2), a safety philosophy where the assumption is that a positive change in working conditions will have a positive impact on safety. Another assumption behind Tripod-Delta is that it easier to change the conditions under which people work, compared to changing people's behaviour. Finally, still another assumption behind Tripod-Delta is that safety is, to a large extent, an organizational problem. In Tripod-Delta a number of factors, named General Failure Types (GFTs), that may interfere with safe behaviour and encourage unsafe acts have been identified and integrated in a systematic view. The eleven factors, or GFTs, defined in Tripod-Delta are based upon analysis of major accidents as well as field studies (3). The GFTs can be regarded as latent errors in any system, errors that under some conditions may contribute to unwanted outcomes and accidents. If some or all latent errors in an organisation can be reduced or eliminated then safety should improve according to Tripod-Delta philosophy. The General Failure Types are: Hardware, maintenance management, error-enforcing conditions, incompatible goals, communication, defences, design, procedures, housekeeping, organisation, and training.

INFRANORD AB works with new production, service and maintenance of the railway infrastructure in different districts of Sweden. A concern for safety and an intention to improve safety started a project to improve safety in one rather complex part of the organization. Researchers from LTU (Luleå University of Technology) were given the task to develop a project capable of improving safety in one part of the organization. The project was strongly influenced be the Tripod-Delta philosophy.

The aim of this project was to analyse risks and improve safety in the company Infranord in the region Stockholm East, Sweden.

2. Methods

The project started 2010 with seminars involving all employees in the organization working directly or indirectly with maintenance activities. These were field workers, administrative personnel, and work leaders. Eight seminars were held, and each seminar lasted four hours. In total 65 employees participated in the seminars, which represented all but one employee. The seminars were finished March 23, 2010. During the seminars the focus of the discussion was on risks in the organisation during maintenance, each individual's perception of risk, and choice of method(s) to cope with risky situations. The discussions also covered attitudes to risk, psychological aspects of risk assessment, unsafe behaviour, and safety culture. The participants answered questions on paper about the type of risks they perceived during their normal working activities, and how they coped with risky working tasks. The answers to the questions about risks in different tasks and coping strategies were collected and later transcribed.

The next phase of the project started April 2010 and involved structured interviews with 62 employees in the ages 26 – 61 years, representing all but three employees, field workers, administrative personnel and work leaders. The intention was to interview all employees but for different reasons that was not possible. Three skilled interviewers performed individual structured interviews with employees. The interviews lasted one to two hours and were recorded on tape (with one exception) and notes were also taken during each interview. The interviews were structured and followed an interview guide. The aim was to focus on the eleven General Failure Types as specified by Tripod-Delta.

All respondents made ratings on scales, from 1 (does not agree at all), through 7 (agree completely) on 11 questions. Four questions were answered by a yes/no response, and nine questions were answered by ticking one of three boxes (sometimes, often, and always). After the ratings, yes/no responses, or choices of box to tick, each respondent explained his or her response in own words, and was asked to suggest improvements for each GFT. As a final question each respondent was asked to state, in his or her own words, if there was something else of relevance for safety that he or she would like to add.

The interviews were transcribed and analysed, documented in a summary report, and presented to the steering committee and later to the field workers, administrative personnel and work leaders who had earlier been interviewed. Thereafter action plans were developed together with a group of employees. The group consisted of seven participants, representing different technology divisions involved in maintenance activities plus one safety officer and was created by the steering committee. The group was given the task to select three to five of the General Failure Types identified in the earlier phase of the project and presented later, and develop action plans to minimise or eliminate these. The choice of GFT: s were to be decided by the group themselves as the most important to address and also possible to change in a positive direction. The group had a first meeting January 2011 and decided to put a focus on work leaders and technicians in order to speed up the process as much as possible. The aim was to improve incident reporting and calibration of some equipment used, select and buy better equipment in some cases, create clearer roles for safety, improve training and increase the time available for performing field work. The group held 13 meetings, one every month since the start, and ended their work late May 2012. In seven of these meetings one of the authors of this paper (Sara Saellström Bonnevier) participated and assisted in structuring the work.

3. Results

Concerning the equipment, the results indicated that it was old, heavy and not very well calibrated. About 50% of the workers considered that the availability of the equipment was optimal. The system used for planning and the incident reporting systems were both criticised and not regarded as user friendly. Maintenance tasks were perceived as quite efficient, but in many cases performed under time pressure and under unsafe conditions. Violations of safety rules were often necessary due to restrictions in time available for the different tasks. It was reported that safety rules often were impossible to follow and designed by people in the organization without any real experience of the real working conditions. A common error enforcing condition was lack of personnel ant lack of time. As mentioned earlier this error enforcing condition invited the workers to invent shortcuts and to violate time consuming safety rules. Housekeeping activities were not regarded as optimal and the maintenance of some equipment was not performed as expected. The most common incompatible goals were the conflict between productivity and safety and it was often mentioned that it was more important to get the trains moving in time, compared to work under safe conditions. Different communication problems were highlighted, both of social and technical character. The way work teams were organised was criticized. Training to cope with difficult tasks should be improved according to the answers. Finally, defences or barriers existed but sometimes reported to be heavy and difficult to use. Training to cope with difficult working tasks could also be improved according to many answers.

Two years later, 2012, 49 employees in the ages 29 – 61 years were interviewed. The inclusion criteria were that they should have been interviewed earlier, 2010. All interviews were performed with the same questionnaire as in the 2010 interviews and by one skilled interviewer who also participated in the 2010 interview sessions. The interviews were recorded and notes were taken during the interviews. As in the earlier interviews the answers from each respondent were processed and summarised into separate word files. Each participant was interviewed individually and each interview took about 60 to 90 minutes to perform.

Concerning the equipment a slight improvement was noted and the quality of equipment was reported as improved, but no improvement of availability or usability of the equipment could be noted. The system for work planning was still a major problem and hard to use. Maintenance work was reported as improved by technicians at the sharp end. It was now easier to work under safe conditions. However the efficiency of maintenance activities showed a negative trend due to lack of personnel and more actors involved in the maintenance work, and lack of communication and coordination of activities. Safety rules were still regarded as hard to follow, due to time pressure and that some rules were not adapted to real working conditions. But it was reported that safety rules now were followed more strictly. The conflict between safety and productivity was now less pronounced, and safety more in focus. Safety was now seen as strongly supported by the top management. Communication between employees was reported as being improved. The number of reported incidents increased from 63, 2010 to 74, 2012. The number of accidents in the organisation decreased from 57, 2010 to 38, 2012.

4. Discussion and Conclusion

The aim of this project was to reduce or eliminate some General Failure Types and thereby improve safety in the organization. To some degree this seems to have happened and safety was now reported as being regarded as more important compared to productivity. Some improvements of equipment could also be noted even if availability was not improved. The system for planning of work was still regarded as a major problem. Maintenance work was perceived as safer but less efficient. The introduction of more actors working with maintenance activities has increased the complexity in these activities and imposed new demands on communication and coordination of activities. Safety rules were reported to be followed more strictly now, but due to time pressure and lack of personnel it is sometimes necessary to make shortcuts. A reasonable interpretation is that the organisations safety culture has improved slightly from 2010 to 2012.

The results we found may have been caused by a number of factors, beside the existence of the project (4). History, the fact that time goes by and people learn more is one factor that most likely has had an impact on the results. A number of changes in the surrounding world may have had an impact on the results. New actors appeared and changed working conditions in different directions. Some of the employees at the company were recruited to new companies and this has created a competition for jobs and different consequences for working conditions. It was not possible to interview all workers 2012 due to different reasons, some had left and started to work for another company and some were absent for other reasons, and this may have had an impact on the results. Another possibility is that since new actors appeared on the scene they may have taken over some of the tasks with a higher risk, compared to an average task, and risk migration may have occurred. The 11 GFT:s specified inTripod-Delta offers a general framework for latent

errors in an organisation. During the interviews some other possible threats to safe behaviour were mentioned. Lack of time or time pressure was mentioned repeatedly by many of the employees. In addition factors outside the organisation, such as political decisions with an impact on resources devoted for maintenance were also mentioned. Increased complexity in the system, due to the deregulation of maintenance work and a need to coordinate work done by different partners seem to have had an impact on work conditions. A conclusion is that the Tripod-Delta approach has a focus on the internal workings of an organisation and could be expanded to include important latent errors caused by what happens in the surrounding social context, especially when it comes to resources devoted for safety and processes that may lead to an increased complexity in the work environment.

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