

QUALITY FUNCTION DEPLOYMENT METHOD FOR ASCERTAINING INFLUENTIAL FACTORS ON TRANSFER OF SAFETY TRAINING SKILLS IN INDIAN CONSTRUCTION ORGANIZATIONS

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ABSTRACT

Safety training is crucial activity of an injury and illness prevention program that can assist management to identify and mitigate workplace hazards. Effective safety training will contribute towards transforming employees competent in health and safety aspects, to minimize accidents and eliminate the costs of accidents. Translating knowledge gained of safety training into the workplace environment by employees will assist the organizations to minimize work-related injuries. Most of the construction organizations in India are imparting safety trainings to all levels of employees and its impact on work place safety is marginal. In order to better understand factors influencing the transfer of safety knowledge acquired during trainings in construction organizations, quality function deployment technique has been applied; the trainee's expectations and technical requirements were analyzed. The study proposes to identify factors and to assist managements of Indian construction organizations to understand the interaction among trainee's expectations and technical requirements. Support from superiors, perceived importance and self-efficacy the most important expectation of trainees. Organization culture, management commitment and working environment are the most important technical requirements for better transfer of safety training skills.

Keywords: *Quality function deployment, house of quality, trainee's expectations, technical requirements*

1. INTRODUCTION

Safety training has been perceived as part of human resource intercession trying to enhance positive safety culture at work environment and it is a powerful tool in minimizing accidents at workplace. The impacts of safety trainings were transfer and retention of safety knowledge, skills, safety behavior, safe work practices and changes on employee's attitude towards safety (Bahari, 2013). Employees undergone safety training are expected to enrich safety knowledge, safety attitude, safety behavior as well as following safe operating procedures (Jensen, 2005). It is regarded that safety training could aid to minimize accidents, injuries, compensation costs and enhance employees' attention towards safety at workplace. Loss time injuries were considerably reduced in a construction company in Hawaii mainly due to systematic organization of tool box and weekly training sessions to employees (Johnson & Ruppe, 2002).

Safety training, linked with other safety events such as inspections and safety meetings, is often implemented at work sites to prevent the occurrence of accidents or to reduce their likelihood or severity as part of a safety and health program (Iyer et al., 2005). Skills, knowledge, attitudes, and behavior of trainees will change, if the employee wish to transform and the work place conditions are favorable (Carolyn et al., 2009). Continuous safety trainings are more effective in working environment where employees are exposed to hazardous conditions. The return on training investment can be underwhelming and in some cases, actually it is cost to organizations more than they get back. Several studies have been conducted to assess impact and results of safety training, ranging from technical aspects, behavior based studies and ergonomic considerations; the final result is safety training steer in big way towards promoting safe behavior and minimum work place accidents(Colquitt et al., 2000).Many organizations are starting to tune into the concept of training transfer, till date there remains a dearth of practical strategies that organizations can implement to maximize the transfer and increase the impact of training. The unique characteristic safety training require to identify the employee, training design, and organizational factors that contribute specifically to safety training transfer.

Previous studies have shown that employee attitudes, beliefs, values, and traits such as personality, predict learning during training, which in turn predicts motivation and confidence to apply trained concepts and skills in the workplace (Lim & Johnson, 2002).An employee who values safety is more likely to feel motivated to participate in safety training and remain engaged throughout. Success of safety training transfer depends on cooperation from all employees of the organization irrespective of cadre. Safety training is to be treated as regular training process and the participants must be motivated to participate in the training. Owing to the overall support in the literature it is believed that acquired safety knowledge and skills to the job contexts, changes in safe work practices, behavior and attitude that make it unlikely for employees to have accidents or injuries. The purpose of the study is to identify prioritized requirements in the perspective of trainees and technical requirements influencing the transfer of safety training in Indian construction organizations has been analyzed by using Quality Function Deployment.

2. MATERIALS AND METHODS

2.1 Quality Function Deployment

QFD is a method intended to enhance the quality by identifying customer expectations and contemplate the expectations to the technical specifications of a product/service. The method was developed in the 1970s by Yoji Akao and Shigeru Mizuno and it has wide area of application (Kuijt-Everset al., 2009). QFD was successfully adopted to assist design teams in ergonomic design of hand tools (Murat & Burak, 2007). A hybrid QFD and multiple criteria decision making technique has been used to estimate safety risks and to gauge significant environmental aspects (Azian Hariri et al., 2013). A study was conducted in automotive assembly industry in Malaysia to develop welding fumes index with an aim to enhance the welding workplace safety and health by adopting QFD (Sunday, 2013).

QFD provides a means of translating customer requirements into appropriate technical requirements for each stage of process. QFD is based on the expectations of the customers. The expectations are determined by adopting various techniques. Then these expectations are related with the required specifications with the help of the house of quality which is a central element in QFD. House of Quality made up of two main parts, the "What's" and the "How's" .While using QFD the most important task is to define and understand the "what's" of the needs of the customers and to define the "How's" to meet the customer`s need. House of quality is the tool used in the analysis phase of QFD method. House of Quality is a matrix in which customers' expectations are associated with technical requirements and this structure provides determination of how these expectations can be covered. Thereby customer expectations can be transmitted to the process. At the end of QFD process, the requirements are rated taking into account customer expectations. House of quality is a matrix consists of six sections which are shown in Figure 1.

2.1.1 Stages of QFD

Stage.1: Customer expectations: The first and vital step of the QFD process is the identification of what customers desire and foresee. In this step, customers' demands, expectations, and complaints are ascertained. In the house of quality matrix it is located on the left side. The expectations can be minimized by adopting statistical tools like factor analysis, cluster analysis, principal components analysis, neural networks, and affinity diagram.

Stage 2: Determine the technical requirements: In the second step, identified customer demands were translated into technical requirements. The objective is to interpret customer voice into one or more technical requirements (González et al., 2008).The role of QFD team is vital as it involves converting the customer expectations into technical requirements.

Stage 3: Interrelationship between technical requirements: The relationship between customer expectations which are located on the left side of the house of quality and the technical requirements which are located on the second floor of the house of quality. The association between technical requirements and customer expectations and to what extent these requirements are effective in meeting these expectations is shown. The relationship between expectations and technical requirements are usually rated in the three levels as strong, middle and weak by the

QFD team. To illustrate the relationships, symbols, points or letters are used. The scoring systems for strong, medium and weak relationship are 9, 3 and 1 respectively.

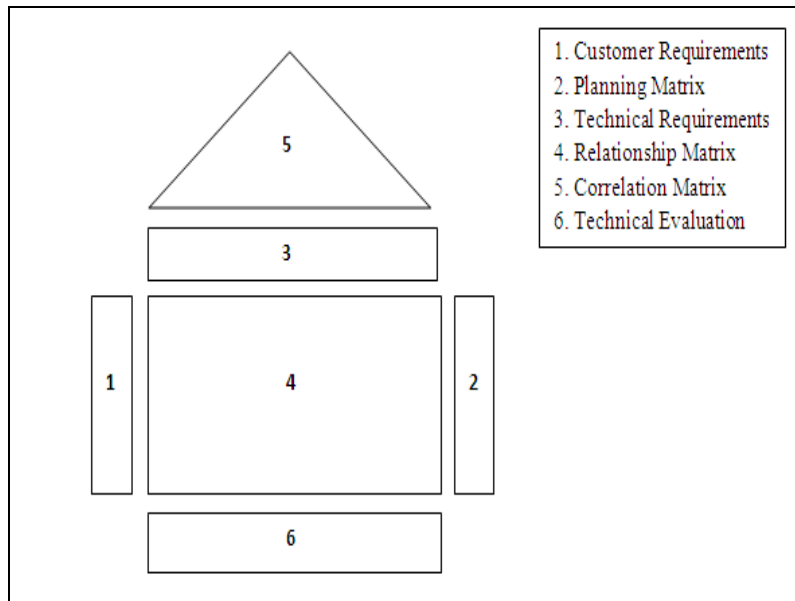


Figure 1.QFD Based model

Stage.4- Correlation matrix: The correlation matrix illustrating the internal relationships among the technical requirements is located on the roof section of the house of quality. Each cell in this matrix shows the positive or negative correlation between two technical requirements. The cell indicating technical requirements with positive correlation is indicated by '+' sign and a negative correlation with '-' sign (Prasad et al., 2010).

Stage 5-Competition and planning matrix: Competition matrix demonstrates the difference between the products of the enterprise and the rival product(s) considering customer expectations. Thereby missing and superior aspects of the enterprise in the market are determined. These matrices are placed in the columns to the right of house of quality. In the evaluation scores 1-5 (1: worst, 5: best) are given for determining the degree of meeting customer expectations of the company's own products and rival products. Planning matrix is placed next to the competitive matrix on the right side of house of quality. This matrix consists of columns called (i) value of importance for the customer, (ii) target value, (iii) improvement rate, (iv) sales point (v) absolute weight. The value of importance that customer attaches to expectations is in the column of the importance value for a customer. A variety of techniques such as analytic hierarchy process and conjoint analysis can be used in the determination of this value as well as 1-10 points (1:trivial, 10:very important) or likert-type scale (Eylem, 2015).The target value is the column indicating to what degree the company should develop according to its status in order to achieve the objectives. For rating, 1-5 points is used (1: worst, 5: best) and evaluated by the QFD team. Values for the improvement rate are calculated by dividing the points in the target value column by the points in the competitive matrix. The intended purpose of this evaluation is to see the difference between the current state of the product and the target status and to determine the characteristics to be improved. Sales point is the column where an

increase or decrease in the sales is evaluated if customer expectations are satisfied or not. Three scoring levels including "1", "1.2" and "1.5" are taken into consideration for the assessment of the sales point by the QFD team. If it is expected that a meeting of an expectation have no effect on the sales the sales point is deemed to be "1", if a small amount of increase in sales is considered the sales point is deemed to be "1.2" and if much impact on the sales is considered, it is deemed to be "1.5". The absolute weight located in the last column of the house of quality are determined separately for each individual customer expectations listed in the left side of the house of quality. These values are calculated by multiplying importance value, improvement rate and sales point value. (iv) Obtaining and interpreting the results: Final house of quality is obtained by the creation and placement of each part of the house of quality. In the final step of the QFD process, results on the final house of quality are yielded and interpreted. These results provide useful and introductory information about technical requirements that need to be improved by considering customers' expectations. It also yields importance levels of customers' expectations and leads to determination of the situation in the market of competing products (Rebecca& Eduardo, 2011).

3. RESULTS AND DISCUSSION

3.1 Analysis of the factors using QFD method

In the present study, factors influencing the implementation of transfer safety training learning's at workplace is studied QFD method. The study was conducted by considering the employees or trainees as customers who have undergone safety trainings past one year in various construction organizations across India. The managements of construction organizations aim to impart safety training all cadres of employees with an intention to apply the learning's of training at their workplace. The desired goals and the safety performance can be improved by listening to the voice of trainees. QFD method is commonly used to listen to the voice of customers is considered to ascertain difficulties in implementation of safety training learning's. The procedure carried out in the study is mentioned below.

3.1.1 Planning

Safety training is a continuous process to create awareness to employees about safety programs of an organization. All levels of employee's irrespective type of industry require safety procedures to be known. The purpose of study is to investigate expectations of employees /trainees regarding implementation of their safety training learning's at workplace. Therefore, the employees undergone safety trainings were taken into account for the QFD study. Five QFD teams were formed for five regions in India. A QFD team comprises of safety consultant, corporate safety manager, trainers and two senior employees / trainees.

3.1.2 Ascertaining trainee's expectations

Trainee's expectations have been identified with interactions, discussions and brainstorm sessions which are organized by QFD team at five regions in India and a total of 150 trainees participated during discussions across all the regions. All the trainees were informed about the purpose of the current study and requested to indicate their views about their expectations of

safety trainings. At the end of discussions and deliberations, ten common expectations were finalized from all regions. The ten factors were strongly supported by literature. The expectations of the trainees are shown in Table.1. Training inputs are thought to influence conditions of transfer both directly, and indirectly.

After ascertaining the expectations, a survey was held in order to find out the importance values that are related to these matters and to what extent these were met at the workplace. For this purpose, a questionnaire consisting of two parts was developed. In the first part of the questionnaire, there were 10 questions with 5 likert-type scale (1: not important, 5: very important) that provides the evaluation of trainees expectations. In the second part of the questionnaire, situation regarding to what extent the learning's of safety trainings are transferred at workplace. (1: never satisfied, 5: fully met) was measured by using 5 likert-type scale.

Table 1: Trainees' expectations

Customer requirements	Comments	Ref
Acquiring new skills and Knowledge gain	Trainees higher in subjective learning have success in possessing trained skills	Blume et al., 2008 ; Velada et al.,
Self-efficacy	Trainees higher in self efficacy are positive to learn and apply trained proficiency.	Zumrah,2014
Support from superiors	Transfer is possible when trainees are supported and motivated to learn and transfer learning's	Velada et al., Burke & Hutchins, 2007.
Perceived importance	Trainees who perceive training as useful and valuable are far more likely to apply new competencies in the workplace.	Zumrah, 2014; Blume et al., 2008.
Training relevance and applicability	Unfavorable trainings and conditions affect the effectiveness and its impact will be negative.	Kalemci, 2005; Burke & Hutchins, 2007.
Training Environment	Organizing training in simulated environment enhances the possibility that trained skills will transfer.	Gilpin-Jackson & Bushe, 2007
Scope to perform	Trainees must be committed to implement the new skills and abilities to the workplace	Burke& Hutchins, 2007; Blume et al., 2008
Frequency of trainings	Trainings must be part of organization culture and it is continuous process to impart training to all cadres.	Salas & Cannon-Bowers, 2001
Work pressure impede applying learning's	Safety learning's must be prioritized and implemented even in the situations involving work pressure.	Baldwin et al., 2009
Evaluation of trainings	To facilitate transfer, the training should be followed by after action reviews and feedback.	Burke et al., 2008 ; Keith & Frese, 2008

The questionnaire was circulated to 500 trainees of all cadres who have undergone safety training during year 2014 – 2015 in various construction organizations across India at the rate of 100 per region. Finally 462 completed questionnaires were considered for the study. After testing the reliability of the data, Cronbach's alpha value was found 0.89. As this value is larger than

0.70, it can be said that obtained data is reliable. After the survey, arithmetic mean value was calculated by considering importance values that were given to every expectation and mean values were obtained for each expectation. Trainee's expectations and importance values are given in Fig.2. Trainee's expectations were transformed into technical requirements by the QFD team. These technical requirements and related trainees expectations were given on the second floor of the house of quality. The technical requirements were also supported by literature and are shown in Table 2.

Table 2: Technical requirements

Technical requirements	Comments	Reference
organization culture	Significant impact on the post-training	Burke& Hutchins, 2007
Mode of Training	Greater transfer outcomes than error-avoidant training methods	Keith & Frese,2008
Management Commitment	Strong management commitment significantly impacted the transfer of safety training.	Burke et al., 2008; Clarke, 2002.
Safety Budget	Organizations make increasingly large investments in training because it serves as a powerful tool for learning outcomes.	Salas & Cannon-Bowers, 2001, Salas & Stag, 2009.
Competency of Trainers	Likelihood that competency will have positive effect on transfer.	Salas et al., 2006; Clarke, 2002.
Working Environment	Environments that resemble the workplace increase the transfer.	Kraiger, 2003.
Error Management	Allowing trainees to anticipate potential issues, providing them with knowledge of how to handle.	Burke & Hutchins, 2008.
Design of Programme	Positive transfer outcomes will not appear without the encouragement of work environment even the training programs are designed effectively	Grossman & Salas, 2011; Clarke, 2002.

Final house of quality obtained in this study is given in Fig.2. In this study, the trainee's expectations were determined and importance values were obtained with the aid of a questionnaire. The expectations were converted into technical requirements, competitive analysis was done and house of quality has been created. It is observed that the most important expectation of trainees is the 'support from superiors' (importance score = 7.46; percent importance=14); followed by 'perceived importance' and 'self-efficacy'. Therefore, the three requirements are to be prioritized. From the relationship matrix, the relation between trainee expectations and the technical requirements is located in the body of the house of quality and assists to resolve which technical requirements should be improved in order to meet trainee's expectations relating to transfer of training.

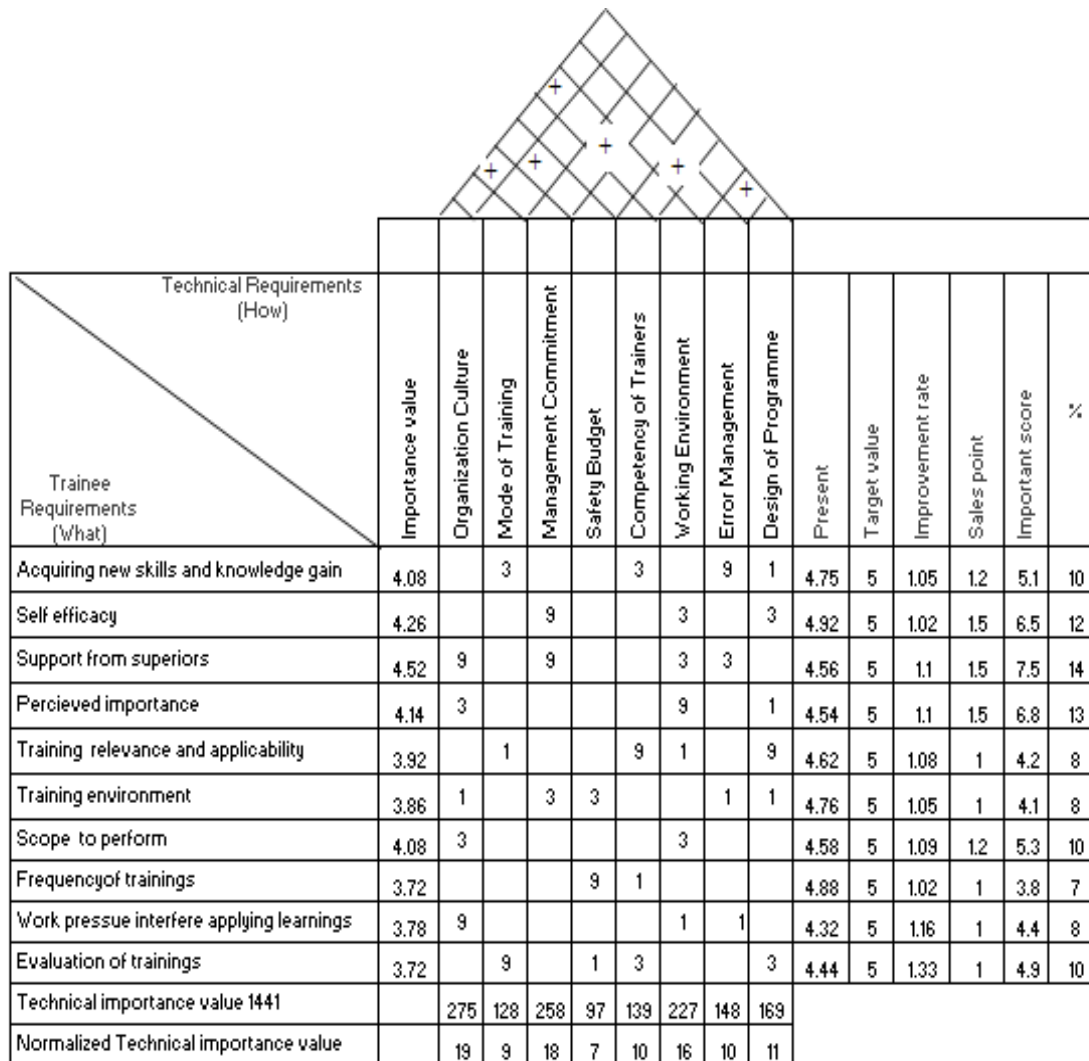


Figure 2: House of Quality

The analysis of matrix shows a strong correlation between technical requirements of ‘organization culture’ and the most important trainee expectation ‘support from superiors’. The second and third ranked technical requirements are ‘management commitment’ and ‘working environment’. The improvement rate column in the planning matrix located in the last four columns of house of quality is calculated by dividing the value in the target column by the present values and it shows the percentage to which current performance needs to be improved. ‘Evaluation of trainings’ and ‘work pressure interfere applying learning’s must be improved.

When correlation matrix on the roof section of the house of quality is examined, it can be observed that there is a positive correlation between technical requirements of (i) ‘organization culture’ and ‘management commitment’, (ii) ‘organization culture’ and ‘working environment’, (iii) ‘mode of training ‘ and ‘safety budget’ (iv) ‘management commitment’ and ‘ working environment’,(v) ‘competency of trainers’ and ‘error management’ and (vi) ‘design of programme’ and ‘error management’. The efforts of management towards transfer of safety knowledge will have positive effect on ‘organization culture’ and ‘working environment’.

Likewise, 'error management' depends on 'competency of trainers' and 'error management' and 'design of programme'

4. CONCLUSION

To better understand factors influencing transfer of safety training in Indian construction organizations quality function deployment technique has been applied. The present study identified ten factors vital for transfer of safety training in the perspective of trainees and the relationship with technical requirements was analyzed. The results of the study serve as a guideline for construction organizations to focus on influential factors and it can assure the return on safety trainings. Based on the results of the study, the construction organizations in India must develop safety culture as part of their organization culture as individual factors such as pre-existing safety attitudes and beliefs tend to vary by cultural heritage and management commitment towards conducting regular safety training programmes to all levels of employees related occupational safety & health and compliance of learning's from trainings are crucial for successful transfer of knowledge gained. Organizations need to work hard to crystallize learning and facilitate employees' use of learned skills and concepts of the job. The study implemented QFD as a tool for effective transfer of safety knowledge in Indian construction organizations. Similar studies can be conducted at organization level to ascertain deficiencies and to implement measures to improve transfer of safety knowledge.

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