

An Assessment of the Combined Effects of Quality and Safety on Construction Productivity- The US Experience

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Abstract

Quality and safety concerns have been main issues in construction industry for a long time. Previous researchers suggested various theories and models to increase quality and safety in organizations from construction and other industries. There is a plenty of work pointing out the importance of quality and safety but their combined impact on productivity still needs further investigation. This study aims to reveal the mutual influence of quality and safety practices on productivity in the limits of construction industry and gather information about the current perspectives of construction companies regarding the correlation of quality, safety and productivity. This objective was achieved by a two-step approach. Firstly, the existing quality and safety management practices were examined by a detailed literature review. Secondly, a survey was conducted to learn U.S. construction companies' perspectives and applications for quality and safety management as well as their impression on productivity in construction. The survey enabled the researchers to gather information about the current situation and point of view of the U.S. construction companies. Additionally, questions regarding the interrelation of these three concepts were analyzed. It was learned that the companies were aware of the correlation among quality, safety and productivity; however they need to exert more practical efforts to execute their ideas in real working environment.

Keywords

Quality, Safety, Productivity, Mutual influence, Correlation

1. Introduction

Quality and safety concerns have been main issues in construction industry for a long time. Similar to other industries, the success of construction projects depend partially on maintaining employee productivity which is directly affected from the performance of quality and safety management systems. In management literature, there is a plenty of work pointing out the importance of quality and safety. In addition, previous researchers suggested various theories and models to increase quality and safety in organizations. However, literature has very little work to point out the mutual effect of quality and safety on productivity. Das et al. (2008) state that quality depends on employees who need motivation to perform the required job. The theories about employee behavior such as motivation show that it is affected by workplace safety in a positive or negative manner. In other words physiology of employees, which is an important factor in productivity, forms a link between quality and safety. Therefore, approaches for both quality and safety have a combined effect on the overall construction productivity

through workers. This study aims to reveal the mutual influence of quality and safety practices on productivity in the limits of construction industry and gather information about the current perspectives of construction companies regarding the correlation of quality, safety and productivity.

2. Scope

In the scope of this study, the existing quality management approaches that can enhance safety and conversely safety systems that can improve quality are summarized. The connections between quality and safety management procedures based on employee perception and behavior are also included in this paper. The objective of the study is to investigate the joint effect of quality and safety management issues on construction productivity. The mutual relationship between quality and safety as well as their impact on productivity is revealed by carrying out a basic literature review. The practical is obtained by learning the perspectives of construction companies in the U.S. Company perspectives are expected to give information about the combined quality and safety culture adopted by construction companies. By this way, the study will present to what degree the construction companies consider the importance of interrelation between quality, safety and productivity subjects in practical.

3. Objectives

To sum up, the objective of this study is to investigate the combined effect of quality and safety management issues on construction productivity. The mutual relationship between quality and safety as well as their impact on productivity was revealed by carrying out a detailed literature review. The existing quality management approaches that can enhance safety and conversely safety systems that can improve quality were summarized. The connections between quality and safety management procedures were also included with the help of previous studies. The practical information was obtained by distributing the Quality, Safety and Productivity Survey prepared in the limits of this study. The survey aimed to learn the perspectives of construction companies in the U.S. The results were analyzed and company perspectives gave information about the combined quality and safety culture adopted by construction companies. By this way, the study presented to what degree the construction companies consider the importance of interrelation between quality, safety and productivity subjects in practical.

4. Methodology

The research is based on two different types of sources for collecting relevant information and having an idea on the combined effects of quality and safety in construction productivity. Firstly, literature review is performed to have basic knowledge in quality and safety management practices. Their relationships among each other and with productivity is exposed and discussed by using previous studies. Secondly, the Quality, Safety and Productivity Survey is prepared in the limits of this paper to learn companies' perspectives and applications for quality and safety management as well as their impression on productivity in construction.

For the analysis of results, the participant observation data was presented by using charts. As both parts of the survey had a logic in-between, at first they were analyzed separately. True/false and yes/no answers were calculated for each question. By calculating the total number of true/false answers in each question, the writer was able to obtain an overall idea about the construction industry. After having background information about the industry, it was time to get specific opinions about quality, safety, and productivity. The answers to yes/no i.e. second part questions were calculated in the same manner as the first part questions. The perspective of the construction industry regarding the correlation of quality, safety and productivity was gained by summing up the results. Second part of the analysis focused on revealing the effect of safety and quality on productivity. Therefore, specific questions asked for this purpose were filtered and answers to these questions were examined. By this way, the analysis of both parts was achieved to fulfill the research objectives.

5. Literature Review: The Common Impact of Quality and Safety on Productivity

McLain (1995) and Hackman and Oldham (1980) stated that employees' psychological conditions about workplace were reflected in work attitudes and task performance. The psychological conditions of employees were connected to employee perceptions and behaviors in quality, safety and productivity literature. Engelman (1993) and Krause (2000) handled positive employee perceptions of safety and showed that they could improve quality. Another study was from (Evans et al.'s 2005) who worked on relationships between organizational climate and safety at wood manufacturers. They found an indirect relationship between quality perceptions of employees and safety mediated by productivity climate. Das et al. (2008) evaluated theories about employee motivation and decided that the theory of motivation formed a link between safety and quality. They believed that the link between safety and quality were based on employee behavior. Motivation theories by (Maslow 1943) and (Herzberg et al. 1959) recognized safety as a prerequisite to achieving higher-order goals. As quality is a higher-order target, it can be based on safety. Besides, Brown (1996) proposed that employees with greater safety perceptions would produce higher quality output. A number of studies are present in literature to combine quality and safety concepts. One of them is from (Matias and Coelho 2002) who discussed the integration of quality standards (ISO, 9000) with safety standards (OHSAS, 18001). Organizations had also combined well-known quality principles with safety programs. For example, Deming's principles adapted to improve worker and plant safety as argued by (Sommerkamp, 1994; Salazar, 1989). Department of Energy was another institution which borrowed Deming's principle to integrate quality standards with worker safety programs (Prevette, 2005).

Based on previous literature (Mearns et al., 2001; Probst and Brubaker, 2001; Probst, 2002), employees could be expected to form quality production when they perceive a positive safety climate at work in construction industry. Yarborough (1993) mentioned that Juran's "team approach to problem solving" did well when implemented to enhance quality and productivity by analyzing and resolving worker safety issues. Furthermore, Probst (2002) conducted an experiment to show the role of job insecurity in safety. When the participants were faced with the threat of layoffs, they were more productive. However, more safety rules were violated and quality was lower than the control condition. It can be concluded from the last two studies that the interrelation among quality, safety and productivity can be in a positive or negative manner.

When literature is investigated, maintaining safety is regarded as a must to move on and improve quality. On the other hand, adaptation of quality practices is frequently observed in literature in order to develop safety programs. Then it should be accepted that both quality and safety are indispensable in a successful management system. The hypothesis of this study is that there is a mutual effect of quality and safety on productivity in construction. This section showed how this mutual effect is supported by the previous studies. Although all of the previous works were not related to construction industry, they emphasized the correlation between quality and safety through employee who is the main factor to achieve productivity

6. Analysis

The analysis of the responses received is presented in the succeeding subsections.

6.1 General Information about the Quality, Safety and Productivity Survey

The Quality, Safety and Productivity Survey is prepared in the limits of this paper to learn companies' perspectives and applications for quality and safety management as well as their impression on productivity in construction. The survey was composed of two parts. In the first part, there were true/false questions while in the second one there were yes/no questions. Only polar questions were selected for the

survey as they were not only useful to assess knowledge in a quick way but also they were believed to increase the response rate. Since some people refuse to fill up and return lengthy surveys because of time constraints, these questions reduced the chance of being ignored. Additionally, they allowed collecting only the desired information about quality, safety and productivity. The Quality, Safety and Productivity Survey instrument was distributed among a choice of construction companies in the U.S. via e-mail. There was the difficulty of obtaining data as the survey contained questions about company's current status, beliefs and management practices. Some companies refused to fill the survey stating the required information was confidential or it was the key to their achievement and they did not want to share it.

6.1.1 Identification and Analysis of Survey Results

For the analysis of results, the participant observation data will be presented by using charts. It is very important to classify answers and make connections among questions. As both parts of the survey has a logic in-between, at first they are analyzed separately and true/false and yes/no answers are calculated for each question.

Firstly, Part-I includes questions regarding to the general situation of company like if it has quality/safety departments or trainings for any of quality, safety or productivity. When the number of true/false answers was counted, it was obvious that all (100% of) companies pay attention to safety management. On the other hand, 83% of the companies practices quality management and adopts total quality approach. Although 83% practices quality management, only 67% has trainings for quality and productivity. Additionally, productivity is tracked on site by 83% of the companies participated in the survey. Figure 1 and Figure 2 show the results about quality management and quality training as pie charts. Answers obtained as true are denoted by blue color while false answers are represented by red.

**Your company practices
Quality Management.**

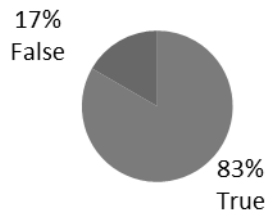


Figure 1: Percent results for practicing quality management

**Your company has trainings
for quality.**

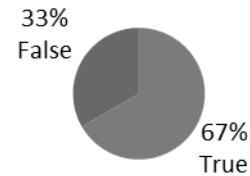


Figure 2: Percent results for quality training

Secondly, Part-II is composed of yes/no type questions about the point of view of the company and surveyor. The answers to yes/no questions were calculated in the same manner as the first part questions. Considering the results, training employees about quality and/or safety is not considered as a waste of time and money by all (100% of) the surveyors. Similarly, all of the surveyors believe that training employees about quality and/or safety improves productivity. In addition, none of the companies think that quality management and safety management applications slow down overall production in construction industry. Although the participant companies regard quality and safety management as key factors for improving productivity, all of them do not have practices and training for quality and safety management when Part-I is considered. Besides, only 83% of the involved companies think total quality approach is needed to improve productivity in construction industry. Another question about quality, safety and productivity relationship was to ask if they agree that quality comes by itself in construction industry when safety and productivity are achieved. As small as 33% of the evaluators were agree with this statement (Figure 3). 83% of the companies think quality, safety and productivity are correlated in construction industry (Figure 4) while all of them said their company considers the interrelation between quality, safety and productivity (Figure 5). 50% of the companies have regular meetings among quality

and safety departments (Figure 6) and 83% of the companies state that they adopt a combined quality, safety and productivity culture and thus give equal emphasis to these three concepts.

Do you think when safety and productivity are achieved quality comes by itself in construction industry?

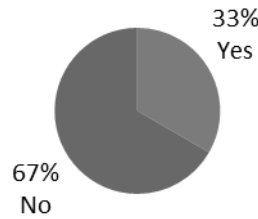


Figure 3: Percent results for the impact of safety and productivity on quality

Do you think quality, safety and productivity are correlated in construction industry?

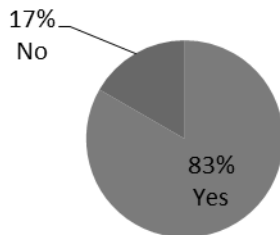


Figure 4: Percent results for quality, safety and productivity correlation

Does your company consider the interrelation between quality, safety and productivity?

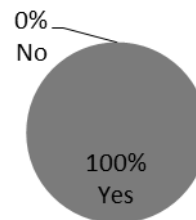


Figure 5: Percent results for interrelation between quality, safety and productivity

Does your company have regular meetings among quality and safety departments?

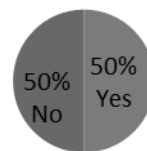


Figure 6: Percent results for regular meetings among quality and safety departments

The answers to true/false i.e. first part questions helped the writer to understand current company management status. By calculating the total number of true/false answers in each question, the writer was able to obtain an overall idea about the construction industry. After having background information about the industry, it was time to get specific opinions about quality, safety, and productivity. The answers to yes/no i.e. second part questions were calculated in the same manner as the first part questions. The perspective of the construction industry regarding the correlation of quality, safety and productivity was gained by summing up the results. Second part of the analysis focused on revealing the effect of safety and quality on productivity. Therefore, specific questions asked for this purpose were filtered and answers to these questions were examined. The answers about the mutual influence of quality and safety practices

on productivity were tried to be related to the company situation and point of view gathered from the first part of the analysis. By this way, the analysis part was designed to fulfill the research objectives. Considering the answers given to Part-I and Part-II, all of the companies are aware of the correlation among quality, safety and productivity. However, safety has given the highest importance among three mostly because of the strict regulations about this issue in the U.S. Most of the companies practice quality management and believe that total quality approach is needed for improving productivity. Yet only half of them have regular meetings among quality and safety departments. Thus it can be concluded that although the companies state that they give equal emphasis to quality, safety and productivity, some of them do not focus on the connection among them. All of the involved companies think training about quality and safety brings improvement in productivity but not all of them have training programs for these issues. The thing revealed from this survey is that construction industry is mostly responsive to the effect of quality and safety on productivity however in practical they need to improve company structures to form an incorporated culture based on the combined effects of quality and safety in construction productivity.

6.2 The Combined Effects of Quality and Safety in Construction Productivity

The relationship between quality, safety and productivity was explained by using different concepts in literature. The most common two concepts were to connect psychological conditions of employees to employee perception and behaviors. The relationship between quality perceptions of employees and safety mediated by productivity climate was regarded as indirect by some researchers while some others who thought that the theory of motivation formed a link between safety and quality, believed that this link was based on employee behavior. When the two sources of quality and safety relationship was identified, it was revealed that their combined impact can form a positive or negative change in productivity. The previous studies were conducted by using data from a variety of industries, but they were applicable in and accepted by the construction industry.

Based on the detailed literature review about the basic concepts of quality, safety and productivity; the mutual relationship among these three subjects was significant. The prerequisite of a successful management system was regarded as safety in literature. When the working environment was safe, the quality perception and motivation of employees were developing. The employee perception and behaviors were maintaining the linkage between safety and quality while supporting their impact on productivity. In other words, the effect of quality and safety on productivity was explained by employee perception and behaviors (motivation) in the previous works. This effect could be in a positive manner when safety programs were developed and quality management was practiced in the company. However, any problems regarding the decrease of safety or quality were shown to decrease productivity in construction. The combined effect of quality and safety was studied through literature as the influence of only one item would be disregarding their interrelation. This would not reflect the actual impact on productivity as the linkage between quality and safety was actually maintained by two sources such as employee perception and behavior of productivity. The literature review was an important step to reveal how quality and safety affects productivity. However, it was not enough to learn the current ideas of construction companies regarding quality, safety and productivity, which was also a goal of this study. Therefore, the Quality, Safety and Productivity Survey was prepared and distributed among a number of U.S. construction firms. According to the results of this survey, most of the companies were aware of the relation between quality, safety and productivity. Besides, the companies stated that they gave equal emphasis to quality, safety and productivity. Training being a good way of improving employee perception about quality and safety was thought to bring improvement in productivity but not all of the involved companies had training programs for these issues. The survey results also showed that construction industry needs to improve company structures to form an incorporated culture based on the relationship among quality, safety and productivity.

7. Conclusion and Discussions

Quality and safety concerns have been main issues in construction industry for a long time. In management literature, there is a plenty of work pointing out the importance of quality and safety. In addition, previous researchers suggested various theories and models to increase quality and safety in organizations. However, literature has very little work to point out the mutual effect of quality and safety on productivity. Their combined influence on productivity was explained by mainly two concepts: employee perception and behaviors. The previous researchers found an indirect relationship between quality perceptions of employees and safety mediated by productivity climate. On the other hand, some other studies were observed the link between safety and quality by using the theory of motivation/employee behaviors. The combined effect of quality and safety on productivity was observed as both positive and negative in construction and other industries. When safety and quality management practices were successful, the productivity was improving. Conversely, the decrease in safety or quality was influencing productivity in a negative manner.

The Quality, Safety and Productivity Survey prepared in the limits of this study collected information regarding the current situation of U.S. construction industry about quality, safety and productivity issues. The company structure and point of view were asked by using multiple choice questions and the results were analyzed in this study. According to the results, most of the participant companies were accepting the correlation among quality, safety and productivity. Training being a good way of improving employee perception about quality and safety was regarded as an important issue to improve productivity in construction, but quality and safety trainings were not given by a number of the participant companies. Although the companies stated that they gave equal emphasis to quality, safety and productivity, some of them did not conduct regular meetings between these departments. That is the construction industry is mostly responsive to the effect of quality and safety on productivity however in practical they need to improve company structures to form an incorporated culture based on the combined effects of quality and safety in construction productivity.

To sum up, the objective of this study is to investigate the combined effect of quality and safety management issues on construction productivity. The mutual relationship between quality and safety as well as their impact on productivity was revealed by carrying out a detailed literature review. The existing quality management approaches that can enhance safety and conversely safety systems that can improve quality were summarized. The connections between quality and safety management procedures were also included with the help of previous studies. The practical information was obtained by distributing the Quality, Safety and Productivity Survey prepared in the limits of this study. The survey aimed to learn the perspectives of construction companies in the U.S. The results were analyzed and company perspectives gave information about the combined quality and safety culture adopted by construction companies. By this way, the study presented to what degree the construction companies consider the importance of interrelation between quality, safety and productivity subjects in practical.

This study is a good start to investigate the mutual effect of quality and safety on construction productivity. It is obvious that the subject can be further improved by eliminating the current limitations. As an instance, the feedback rate of the surveys can be improved. Although the survey was composed of multiple choice questions to allow ease of answering, most of the companies did not reply and some refused to share their information. If the time to collect data can be increased, more feedback can be obtained to increase the amount of data collected. This is expected to reveal other ideas regarding quality, safety and productivity and increase the reliability of the research. Another limitation was about the literature review. As the combined relationship of quality, safety and productivity has not been practiced yet, the available literature was limited. The problem is although productivity was in the content of the papers its name was not used directly between quality and safety by some of the authors. This was a handicap for the writer as search engines could not find such resources with productivity key word. Therefore the literature was investigated with using different combinations of words. In future studies, this research can be enlarged by using additional literature resources.

The recommendations obtained from this study are applicable for the construction companies in quality, safety and productivity issues. Although the construction industry is mostly responsive to the effect of quality and safety on productivity, they need to improve company structures in practical. It is suggested that the companies form an incorporated culture based on the combined effect of quality and safety in construction productivity. By this way, they will be able to maintain quality and safety while continually improving productivity in construction. Focusing on increasing employee perceptions in quality and safety by training while caring about employee motivation can help construction companies achieving the objective of a quality, safety and productivity based company culture.

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