The effectiveness of six sigma quality technique on construction projects in Pakistan

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Abstract— The purpose of this paper is to develop the interdependence of quality measure six sigma (SS) and construction projects in Pakistan. How effective SS can be if applied on construction projects and how continuous improvement methods can help towards improvement and stability of the processes of construction. Construction processes are not effectively followed through quality measures so, SS is considered and tested as an effective process to improve quality and reduce defects which ultimately increases the quality and productivity. Theoretical explanation of effectiveness of basic SS on construction projects in Pakistan contains the data collected by questionnaires and processed through SPSS tool for results and analysis. The study collected the data and it proves that SS methodology have positive affect on the success of the construction projects and organizations. Implementing quality measures such as SS can increase the efficiency and reduce defect rates. Six sigma have positive relation on basic SS knowledge, continuous improvement techniques and management team approach. Variables have positive affect on each other, project success is dependent variable and employee SS knowledge, continuous improvement and management team approach variables are independent. They have strong to stronger positive relation. This research will give a clear idea about how effectively SS can work in construction industry of Pakistan. Mostly SS is applied on mass production or services industry, it's a relatively different perspective to apply this approach to construction industry however for the future research this technique can be applied to critical success factors and different construction types and effectiveness and productivity can be measured.

Index Terms— Six Sigma (SS), Management team approach, Continuous Improvement culture, Pakistan construction industry.

1 INTRODUCTION

Construction industry has great impact on the economy and its contribution to the GDP and GNP is notable. Construction sector contributes 13.13 percent in industrial sector and in GDP its share is 2.74 percent against the share of 2.65 percent last year, it absorbs 7.31 percent of labor force. Construction is considered as one of the potential components of industrial sector in the economy of Pakistan. This sub-sector has witnessed a growth of 9.05 percent against the growth of 14.60 percent last year report of ministry of finance (Finance, 2017).

GDP from construction in Pakistan increased to 320769 PKR Million in 2017 from 294154 PKR Million in 2016. GDP from construction in Pakistan averaged 239361.33 PKR million from 2006 until 2017 it reaches the highest figures of 320769 PKR Million in 2017 (Economics, 2017). For the continuous improvement of this sector proper measures should be taken for the implementation of modern techniques such as SS. This statistical technique has potential to improve the processes and methods in the construction industry. Applying this method into construction involves dividing big processes into smaller sub tasks which can be analyzed and improved further. Using six SS's DMAIC model (Define, Measure, Analyze, Improve and Control) high level of defects can-be identified and improved and processes can be improved. Employee's knowledge of SS and continuous improvement culture in the organization creates the environment of effectiveness and it improves the success ratio of the projects. Management teams give strong impact on the overall productivity.

Six sigma methodology measures the variation in projects and it is having the process mean and the nearest specification limit. It improves the process, eliminates defects, reduce cost and saves time.

Six sigma technique is widely used in manufacturing, it has yet to be explored in the construction industry. This study applied SS technique on construction of metro rail, which is an aspect of construction. This work analyzes the performance through SS in construction processes. Research provides valuable insights of implication of SS technique and evaluate the current construction activity and quality improvement goals (Viraj Parekh, 2019).

DMAIC model is used to improve the construction logistics and process. This study on the process improvement target SS to achieve perfection to construction process. Construction and logistics integration with SS and DMAIC model help to reduce defect rates and delayed deliveries. The study verifies the performance to improve process through SS and comparison was made with existing method. The results were reduced time by 52% and 53% less defects were observed which save time (Zhongya Mei, Maozeng Xu and Yi Tan, 2019).

Construction sector consumes a massive amount of resources and generate large scale waste, the SS approach is critical in the construction process for the optimum use of resources, cost reduction, quality improvement and sustainability. The top barriers to quality construction are unstable political environment, lack of government policies, lack of customer involvement, and awareness. This work can further assist policy makers to make better decisions (Kramat Hussaina, 2019).

Increase in the inflation rates and increasing costs and completion will drive organizations to seek out methods to increase the efficiency and effectiveness of the processes. The six-sigma process improvement methodology have potential to improve efficiency through identification of defects in the processes and products and can minimize the variations. SS methodology follows a formal sequence of steps which includes targeted improvements.

Examples of possible defects includes:

- Reduction in the time of process cycle
- Reduction of waste in processes
- Increasing customer satisfaction and requirements
- Reduction in the number of defects
- Elimination of high cost reworks

Six Sigma methodology is mostly associated with manufacturing industry which was previously though it is but construction industry can apply these methodologies and techniques to improve processes and reduce defects. The quality techniques which are currently being practiced and used to improve processes in all type of businesses and organizations (one, 2015).

SS tool identifies the current position and increases the performance of the construction processes to an advanced statistical tool. SS ability refers to minimal number of process failures which exists in the external specification.

The method most frequently associated and basic methodology of SS is based upon DMAIC, model. Before starting any SS development project, it

is compulsory to select a potential important process that, if improvised, will result in reduced cost, higher quality or better effectiveness. This process should be measurable and realistic from the collected data because the process you can't measure you can't improve. The selected process may formally be undergoing quality hitches or creating a large sum of scrap, waste and reworks.

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Define (D)

During the define phase, quality teams must follow the following steps:

- Developing the problem statement: the statement must include description of the continuous issues in construction projects will address during implementation. In addition, to the problem statement must include data and information concerning 'critical to customer quality' (CTQ) requirements (includes external and internal)
- Identify Project Resources: Identify the responsible person for quality control, owner of process owner and other team members along with extra resources that may be required during implementation of quality.
- Develop or update the Project Plan (PP): The PP must include a concise statement of how and when the project tasks and milestones are to be accomplished with full explanation of delegation of authority.
- Develop a Process Map: The process map is often developed to see how the execution of processes is being practices to find loopholes and examine the whole system.

Measure (M)

During the phase of measuring in construction projects, the teams develops complete sketch of the present position of the processes and develops a baseline by measurement and analysis of current operational process system. The activities include:

- Process Map: Develop comprehensive process mapping for 'high-risk' areas of the processes or the most defected. A comprehensive process map may reveal the process inefficiencies and repeatable defects such as long or incorrect cycle times, or non-value-added process steps starting from excavation to finishing.
- Data Collection Plan: Define the methodologies and objectives for the data collection process. Identify what is required and planned to be measured, the tools or equipment required, how to measure, how many and how often during the ongoing processes.
- Validate the Measurement System: Collected data will be analyses and checked for verification and validation and results are developed. Minimum and maximum lines of average margins are set for improvement needs. Collect date with the full scope of what is being collected, how it will be used and what specifications and target market is needed.

Analyze (A)

In this phase identify possible factors and identify the root cause of problems.

- Analysis of the data collected: The analysis techniques used depends upon the type and nature of data collected. The collected data can be analyzed graphical representation by using charts and simple graphs. Statistical analysis should also be performed for the better visual representation of the data. In construction projects, an Analysis of Variance should be performed.

- Identification of Causal Factors: this can be done using statistical tools and techniques. The widely used method for gathering and organizing possible causal factors is the fishbone or Ishikawa diagram (Cause & Affect). The cause and affect diagram are mostly used during brainstorming sessions. Causal factors are then listed under each category adopted according to the division of the data. All factors lead to either positive or negative affect depending upon the relationship of factors.
- Determining the **Root Cause** of problems: Identify possible causes and implement countermeasures for prevention. Finding root cause and implementing permanent cure can solve problem once and for all.

Improve (I)

At this stage of the project, the teams have identified possible root causes of the problem. The Improve phase should identify, implement and authenticate corrective actions to resolve any process issues and improve performance.

- Identification of Possible Solutions: The project teams must find possible improvement processes which will increase efficiency of the existing processes, enhance quality and safety of employees during construction. Brainstorming technique is commonly used to generate a list of potential solutions for implementation.
- Analyze Proposed Solutions (to avoid future failures): Consider reviewing possible advances for their risk and possible influence on other processes.
- Validation of Improvements: Preceding to implementation, any process improvement should be validated by using statistical tools and techniques. The teams must validate that the improvement methods which resolved the issues. Validation may be attained through pilot builds, data collection and analysis and or creation of a future state process map.

Control (C)

The purpose of control is to support and sustain the improvements identified recognized through the Improvement phase. Appropriate prevention action must be taken to guarantee the process doesn't regress back to its previous state where defects and reworks occur. In order to accomplish this goal, the teams will be needing following steps to take:

- Updating the processes of documents: The project teams necessarily confirm that all processes are documented and updated with the alterations to the processes due to the enhancements implemented all construction processes must be recorded for further projects (historical artifacts).
- Associates trainings: Well trained emplyers and employees should be deployed on the process and understand the improvements that were introduced and how it affects their responsibilities. The associates should be informed of the purpose of the changes and the benefits of making these changes.
- Creating monitoring plan for the processes: This is the key area where SS sets itself apart from basic PM monitoring. The purpose of the monitoring plan is to document how the efficiency and performance of the process will monitor processes over time. The plan must include the metrics that will be observed, the method of documentation, frequency of measurement and

sample size. In addition, the plan should specify who will be notified if there is an issue, the method and timing of the communication, what response is required and who is responsible for executing the response.

After the control phase tasks have been completed, the transfer of ownership of the new process to the original procedure owner who will implement it on various projects under portfolios.

Construction industry in Pakistan is lacking quality assurance and control measures. Efficient processes are not implemented and quality strategies and techniques are not being followed by this industry and defects are not observed and reduced. Employees have less knowledge of quality techniques such as SS and continuous improvement culture. Repeated defects are being observed mostly and they are handled through project managers not the improvement process or quality measures are implemented to eliminate defects in construction process.
This study is highlighting the importance of SS knowledge among employees and continuous improvement techniques in this industry and how they can improve, management teams' approaches are also analyzed for their importance and further improvement in effectiveness of SS.

1.2 Research Motivation & Purpose

The motivation of this research is to address the current scenario of SS application in construction projects. Quality measures are important process which starts from raw material to finished products. Six sigma is usually applied on manufacturing and mass production units but on construction it will be a unique concept. How this quality assurance technique is applied and how this industry can reduce their defects and adopt continuous improvement. This research gathered the results from construction industry and analyzed how much adoption and implementation is necessary and how effective it will be to implement quality measures such as SS.
Six sigma improves the processes and reduces defects and for continuous improvement.

1.3 Gap Analysis

Six sigma is a process improvement methodology and it reduces defects in the production/building processes. Construction industry has a lot of potential and this sector occupied important part of the GDP. To grow and improve at macro level and compete in the international market, construction industry should face towards following the quality measures being followed worldwide.
Construction industry's underperformance is due to lack of modern techniques, methodologies and processes and much growth is await. The ongoing slow growth is because of the less realization of potential of this sector. Employees have less knowledge of quality techniques such as six sigma and continuous improvement culture is not appreciated, similarly management teams approach improves the productivity and success ratio of the projects.
For GAP analysis (process tools) SWOT analysis technique is adopted which provides the clear picture of the current standing of the construction industry and what weaknesses can be overcome and what opportunities can be utilized to improve the performance of this industry.

2 Literature Review

Just after Bill Smith introduced SS Motorola company was the first to apply. They started SS technique for their production processes and won first Malcolm Baldrige Excellence Award in 1988. Following the line General Electric and Honeywell also initiated SS for their improvement. It is a powerful tool for the performance improvements and it focuses on human resources of the company to improve the performance by reducing defects.
Basic focus of SS approach is on 'customer satisfaction' it reduces extra costs by reducing defects and variations in production process (Klefsjö, 2006)
Setting definite quantitative goals for performance improvement while considering the level of defects involved in the operations of construction. This methodology explores practical solutions for construction performance. It improves the overall performance through quality evaluations (Han, 2008).
Six sigma methodology is implemented through a problem-solving framework called DMAIC, which is Define, Measure, Analyze, Improve and Control (Harry, 2000).
The construction processes are complex and they change over with effect of internal and external factors so they change with the process maturity (Wil Van der Aalst, 2004). For the application of six sigma usually top to bottom and bottom up approach is adopted which stage stands on DMAIC rule of implanting six sigma methodology.
Construction industry use SS methodology for the performance assessment of projects and it aimed high control. It introduced to increase productivity and reduce defects and errors associated with processes (Buggie,2000).

2.1 Impact of six sigma on construction industry

Emphasis on six sigma I implementation on construction projects and their importance on critical success factors, most factors fall into red zone and these factors can be used as a content to understand the current standing of six sigma on construction projects. Critical factors are identified (siddiqui, 2016).
The investigation about implantation of six sigma on construction projects in Pakistan is conducted along with the analysis of current state of affairs and challenges. This industry is working under traditional and orthodox ways with low level of awareness. There is huge opportunity for the awareness and planning according to SS is needed which can lead to project success and improvements in the processes (Fahim ulllah, 2016).
SS can be considered as a waste reduction methodology and it can be implemented through systematic application to improve the processes and reduce defects and improve financial benefits as discussed by (Rehman, 2012).
Management initiative and support, relevant training, appropriate selection of pilot projects and commitment by team members is very important for the successful implementation of SS in organizations. SS improves the quality of processes in construction (Hui, 2002). Time, money and resources, both human and material, are wasted each year as a result of inefficient or non-existent quality management procedures, implementation of six-sigma method and its potential benefits, the paper describes the outcomes of a six-sigma process improvement project (PIP). CSF are identified to implement on the processes for overall quality improvement (Spencer, 2010). Construction industry presents an extremely complex combined process, production flow, various structures, high quality requirements and long construction cycle. Large scale construction projects have complex requirements and there is a high chance that customer requirements cannot be met. Quality measures can improve the process and reduce defects and variations. This research finds out what influence's construction process, construction quality and then adopts design and technique correction measures by (Tchidi, 2012).
The ability of SS quality management is to reduce the process defect rates and this leads researchers to investigate the relation between construction process and SS quality levels. Taguchi SS quality index is developed to retain advantages from quality management for construction processes. A hypothesis is developed for quality check to take reliable decision making for construction processes through SS (Chen, 2019)

2.2 Employees Six Sigma Knowledge

The individuals who lead projects and control quality of the processes must obtain the knowledge of process improvement techniques such as SS. Employees working on this methodology usually don't have partial field experience which causes defects and ultimately inefficiency of processes. Obviously inexperienced employees lean as they work on projects and implantation of SS. Project leaders learn valuable lessons that can be implied of processes for their improvement. During the process of finding defects and affected processes the SS knowledge plays vital part to give a thoughtful way to align defects for improvements.

Construction projects have defined repeatable processes depending upon physical factors such as landscape, topography and location. The education of quality measures such as SS can increase the efficiency of not only important processes but daily operations as well. Quality will be though and implemented at all levels of management. Higher management should interact with all levels of management to educate themselves about defect free production of goods and services so they can avoid the extra cost and reworks.

Six sigma can increase employee engagement to work says sunder m, vijay in his article that leading to continuous improvement and meeting customer's satisfaction we need to follow process improvement (PI) and in recent years SS turns to be most effective methodology in improving operational efficiency which is directly related to employees or human resources. Developing these business strategies on all organizational levels requires a cultural change and training of employees who actually perform. Six sigma follows a sequence of systematic approach for its deployment in the management. Top management is essentially prioritized and across all levels of management and it requires niche skilled professionals for the higher maturity level.
(Sunder M, 2013)

2.3 Continuous Improvement Culture

Improving business processes to reduce defects decrease expanses and improve profits, this process leads to continuous improvement which can be obtained by methodologies such as SS. Six sigma approach is used to maximize the profits through increasing customer satisfaction by reducing variations and providing consistent good quality products with no defects, to provide this quality SS is working on the back end on defects and processes to strengthen the productivity.

As far as construction industry is concerned the methodology is used to improve the processes and reduce defects in repeatable processes. It is based on quality performance (Yilmaz, 2012) as per interviews conducted for the principles of SS and quality concepts. Author's approach to interview to SS was based on quality, management and performance. There is positive affect of SS on construction projects as per this methodology provides broader concept of quality implementation, performance measurement and coordinated process improvement. Six sigma has a potential to increase the quality directly/indirectly and have positive effect on production processes and their efficiency. SS is said to be applicable on manufacturing industry for repeatable processes but it has a lot potential to accelerate fundamental and cultural challenges that construction industry needs.

Significant amount of cost, time and other resources are wasted due to inefficient or non-existent quality management procedures. To monitor the performance of construction processes the non-value-added activities should be minimized and internal and externa engineering should be monitored. To achieve market competitiveness the measuring tools such as SS should be used. In recent years SS is used by pioneers in the construction industry for SS process improvement project (PIP). Six sigma approach provides PIP teams with a structured process improvement which is continuous improvement strategy which reduces waste and other non-value-added activities for construction processes (Stewart, 2006)

2.4 Management Team Approach

Synergy and cooperation of employees is the backbone of quality implementation. Human resources are most complex yet most important to manage for the success for processes and reduction of defects.

Managing SS in teams and organizations requires responsibility and cooperation. SS is a quality enhancement methodology which requires cooperation at all levels. SS can be managed by strong management which must be led by especially qualified and trained individuals.

Success in managing SS teams starts with the top of the organization at strategic level. Company leadership and management should provide the teams with resources and the authority to implement SS methods to their daily operational activities to improve the processes. Management teams must also ensure that managerial objectives are aligned with SS projects and that any barriers to SS and quality deployment must be removed timely. The appropriate selection and training of SS for team leaders is also critical as they have the direct authority to manage the SS teams. Managing a SS team in organizations concludes to two important phases: leading and mentoring the effective teams. SS comprises of tools and practices that substitute irritable and resistant habits with a vibrant, responsive, proactive method of the management (Peterka, 2012)

SS methodology allows organization to support their strategic directions and increase awareness and need of training, coaching and monitoring. It gives an opportunity to effectively implement SS methodology on projects. The paper examines the evolution, benefit and challenges of SS methodology and it identifies the key factors influencing successful SS project implementations. Lessons learned from previous projects can be integrated for further improvements. Effective SS can be succeeded by referring the organizational culture and management team approach. Change in culture requires time and commitment to initiate to succeed (Anbari, 2004).

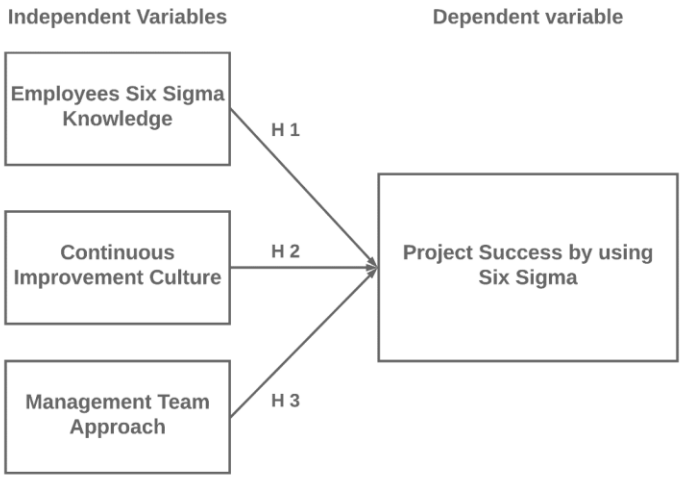
This study analyzed the impact of change management on leadership in SS teams. The research emphasizes on identifying the effects that change management has on shared leadership on each phase of the basic SS DMAIC (Define, Measure, Analyze, Improve, and Control) process. The study used a longitudinal approach to study how change management impacted SS teams during the DMAIC structure. At each phase, change management and team performance data was collected and analyzed to identify relationships. The study proves how change management and team performance changed over time. The degree of change management impacts the type of leadership that a team can select. As a result, as the degree of complexity for change management increases, a quality improvement team depends of collective leadership. The study results lead to two implications. The first revolved around the need for internal members and external coaches to be able to identify and understand the relationship between change management and leadership. The second was that a SS training program needs to include training and educational modules about change management and leadership so the management at all levels is synchronized (Galli, 2017).

3 RESEARCH MODEL

Methodological approaches are defined for the collection of numerical data and in this study a questionnaire survey approach is adopted to identify the effectiveness of SS on construction industry in Pakistan. A questionnaire is prepared for the feedback of SS according to continuous improvement, management team approach, basic SS knowledge and their effect on the success of the project. The feedback is collected though quantitative methods and data is analyzed for the results which shows the positive impact on each other. Statistical techniques are used to analyze the data. The results prove that dependent variable have positive affect on independents. The assumed data driven is proved by the results gathered.

3.1 Research Design

Following the idea from literature review and research objectives the methodology is developed with scope of what the research is about. Data collection from relevant representatives from the construction industry and defined variables according to the six-sigma methodology. According to the research model the data is validated and results analyzed to conclude the findings. The variables and their dependency are shown in figure 1.



3.2 Independent variables

Following variables are defined for the research:
Independent

- Employees Six Sigma Knowledge
- Continuous Improvement Culture
- Management Team Approach

H 1: Employees training and education of SS improves the success ratio of the project.

- Training and education of employees at all levels can increase the probability of success and decrease the ratio of defects. SS improves the overall quality of all processes and helps to maintain environment were quality and tools like SS are welcomed and implemented for the process improvements.

H 2: Continuous Improvement Culture in the organizations improves the productivity and reduces defects.

- Continuous improvement helps organization with the realization of reducing defects at all levels and point in time. It's a continuous method to keep improving and polishing the abilities of organizations.

H 3: Management team approach collaboration and positive interdependence increases efficiency and productivity

- Management and HR deploy the methodologies and help organization to grow and prosper. They are the back bone for any process or changes. Quality or SS implementation requires strong commitment and great help from human resources of the organization and successful implication is only allowed through management synergy.

3.3 Dependent Variable

H 4: Project Success by Using Six Sigma Approach

For independent variables employees SS knowledge is the first important step to realize the importance of quality in the organizations. Having this knowledge will have strong positive affect on the success of the organization. Similarly, continuous improvement and management team approaches are like to have positive impact on the success of the project by suing SS methodology on construction projects. Hence these three independent variables have positive affect on the independent variable which is project success. Data analyzed proves the results of their relation.

4 Research Methodology

4.1 Research Design and Method

Research design or process map explains the road map and cycle of research methodology. Starting from the scope and objective of research the identification on method the sources and collection of data, research model, scales, variables, collected data validation and authentication with the results are performed. Than analysis part of the research is done by defining all the relations and results, descriptive, regressive, correlated variables. The variables relation results are derived and analyzed to form a result.
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4.2 Population and Sample

Sample size reflects the part of potential target representatives from the industry which are qualified enough to give feedback and reviews about the industry. More than 200+ Questionnaires are circulated through email and other social media platforms to be filled by representatives from construction industry and their feedback is recorded. Target people are project managers, Contractors and senior engineer and site engineers.
The targeted population for sampling was from construction industry in Pakistan. Experienced companies were chosen for the feedback and construction industry related individuals are asked for the feedback about the effect of SS on construction industry. Random sampling techniques are used and population is targeted from revenant construction industry and 115 valuable feedbacks are collected and compared for analysis.

4.3 Data Collection Technique

Questionnaire survey is conducted for data collection. Hard copy of questionnaires was provided and google forms forwarded through emails and other social media platforms. Related instructions provided verbally and on questionnaire as well. Snow ball technique is used to create referral for feedback from questionnaires. Data is collected through quantitative techniques and recorded in spread sheets, SPSS software is used for the analysis of the data.
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4.4 Measurements

Items of the questionnaire were adopted and five-point Likert scale ranged from "1=Strongly Disagree" to "5=Strongly Agree".

4.5 Data Analysis Approach

Data analysis involves the collection of primary data which includes its screening, descriptive representation, analysis of responses, demographical analysis, reliability and the correlation between variables. SPSS Statistics software is used to process the data. Hypothesis are tested by validation, reliability, linear regression and correlation analysis (SPSS tests).

Variables	Cronbach's Alpha Values
Employees SS Knowledge	0.846
Continuous Improvement	0.856
Management Team Approach	0.824
Project Success	0.772

5 RESULTS

5.1 Sample Characteristics

A total of 114 completely filled valid questionnaires were returned by the respondents. This included all the questionnaires returned after issuing the two reminders to the respondents in addition to the initial request. In this way, the response rate was 57 percent.

The sample characteristics show that the majority of the respondents (46.6%) belonged to the public sector where as multinationals (28.9%), Locals and private sector (22.8%) contributed as well as others. The category of position in different companies were the contractors (27.6%) and construction managers (35.7%) in majority where as consultants (2.6%) and others (7.8%) also participated. Employment position statistics were less than 1 million (7.8%), 1-10 million (7%), 10-20 million (9.6%), 20-40 million (27.8%) and 60 and above million on majority (41.7%). Employment status among responses were that project managers (33.9%) participated most than site engineers (33.7%), senior engineers (16.5%) and others (5.2%).

5.2 Testing the Measurement Model

Validity Analysis

Kaiser-Meyer-Olkin Analysis

- KMO Value is greater than 0.7
- P-value is less than 0.05.

These outcomes show that data is valid for further analysis.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.791
Bartlett's Test of Sphericity	Approx. Chi-Square	337.248
	DF	6
	Sig.	.000

Cronbach's Alpha Analysis

The statistics according to Cronbach's Alpha is identified as follows:

4.6 Correlations

The correlation shows the relation between the independent and dependent variables. The dependent variable is the project success (PS) and independent variables are the following:

- Employee six sigma knowledge (SSK)
- Continuous Improvement (CI)
- Management team approach (MT)

Bivariate mean the relationship between two variables and that relation is dependent upon ± 1 relation between variables. Towards – mean negative to strongly negative relation and towards + mean vice versa the case, 0 mean no relation.

Independent variables have positive relation with the dependents. CI has most strong positive affect on PS and then SSK and MT have stronger positive affect on PS.

SSK, MT, CI and PS are positively correlated and results are positive to strongly positive.

Correlations					
		SSK	MT	CI	PS
SSK	Pearson Correlation	1			
MT	Pearson Correlation	.688**	1		
CI	Pearson Correlation	.743**	.772**	1	
PS	Pearson Correlation	.697**	.781**	.679**	1
**. Correlation is significant at the 0.01 level (2-tailed).					

4.7 Discussion

After the data analysis, it was found that two hypotheses H1 and H3 were supported and hypotheses is not supported in the study. The hypothesis H1 was "employees SS knowledge" provided the most positive support for the project success among all the other hypotheses. This shows that employees' training and awareness to quality measures such as SS is the most vital determinant influencing the efficiency in construction. One possible reason might be the fact that when employees related to initiation and planning are properly trained then their ability and exposure to quality measures can be enhanced due to the proper understanding of quality control and quality measures during construction process. Properly trained employees are considered to be the asset of any organization. In Pakistan, the poor training of contractors, engineers and builders in the history had been remaining the big hurdle in increasing the quality and productivity of this sector.

The hypothesis H3 was "management team approach for SS implication" also demonstrated positive support to the construction project suc-

cess. It means employees' motivation, synergy and cooperation of work is also crucial to enhance the productivity and quality. Employees' team work and synergy has already been proved to be an important determinant for their increased performance. When employees are motivated to work as a team, having quality measures knowledge, they put their utmost effort on the job tasks.

The hypothesis H2 which was "continuous improvement culture and methods" show no support for project success which means that can't guarantee the project success because in construction there are other factors and unforeseen risks are involved.

6 Conclusion

Six sigma is the most advanced and statistically calculated methodology for quality improvements methods. It improves the processes by making it defect free and reduces the defect rate and scrap values and reworks. SS can be implemented in all types of industries and for all levels of management but approach and purpose of implementation and getting results out of it is very important.

For further research and addition to the study of SS the critical success factors can be measured for successful SS implementation and SS can be viewed for several industries such as manufacturing, construction and other services industries, as far as construction industry is concerned this tool can further be applied through different SS models such as SS belt range where different perspectives of these measures are applied. For construction industry it can be applied in organizational range continuous similar processes.

6.2 Research limitations

This research is based upon the application of SS on construction projects in Pakistan and the data is collected from the construction industry of Pakistan so, the responses and collected data is limited to the range of specific target audience, though whole sector was targeted but the responses are limited as compare to immense construction industry. The data is limited in value and responses, there is a possibility if more data and responses were collected the results could have been slightly different especially the traits and variation in data. Taking the assumption further, the data collected from other countries about SS in construction, the results can show interesting variations and behaviors according to their responses. Economies, cultures, policies, inflation, exchange rates and expertise are different so, different countries or regions can show different responses. Six sigma have impacts on success factors, production methods, leadership and management and organizational culture so, these additions can redefine the study by taking it further by highlighting more aspects and sides of the picture. However, six sigma critical factors and be applied to this industry and other quality management techniques can find out more insights of this study.

Some of the limitation factors of the study are as follows:

- This study analyzed the construction industry of Pakistan. However, it doesn't include implications empirical evidences or factors for the current scenario in the country.
- This study covers the quantitative aspects of the approach, qualitative study can give more deep insights to the methodology itself.
- The questions asked were more general and collected positive relation of the variations, it could be vice versa the case.
- This study targeted the formal construction sector of Pakistan but informal and small industries can give more idea about current situation
- This study includes data from Lahore, Multan, Faisalabad, Karachi and some cities in Baluchistan only.

6.2 Future Studies

Six sigma is becoming one of the most researched topic as far as different industries are concerned. This methodology is applied on all sectors of the industry, as far as construction industry is concerned, SS can take charge of the different sectors of the industry. Innovation and technological advancements in the construction for Pakistan is of high importance and increasing urbanization and civil works in the country are ever increasing, so SS here provide the efficient solution to make construction processes more effective and productive. (Hassan, 2017)

SS can be applied to all types of projects from housing to mega projects and it can be applied in all sorts of construction. The chronicle growth of SS will lead to implication at all levels and advanced processes. The new e-construction methods can take help from this methodology for implantation of effective process growth strategy.

7.0 Acknowledgments

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