

# Literature Review - $6\sigma$ DMAIC (An Acronym For Define, Measure, Analyze, Improve & Control)

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**Abstract:** - Today, the manufacturing industry is changing rapidly in the economic situation. Due to globalization, the manufacturing industry is facing global competition in this scenario. The major problems facing these industries are the decline in profit margins, the demand for customers for high quality products and product diversity is declining. Today there is high pressure on the manufacturing industry of every short time. TQM, JIT MRP-I, MRP-II, Lean Management, ISO standards, Kaizen are some such industrial engineering and quality management strategies that have been developed to answer the requirements of broad competition. A very latest and powerful philosophy of this field is  $6\sigma$  in the manufacturing sector around the world,  $6\sigma$  is becoming very popular and it is being used to improve production rate and quality performance as well as for quality variations. It is also being taken to strengthen the Tea Paper Automobile Industries, small-scale industries, service industries and products. Imran provides a review of studies of  $6\sigma$  terms applicable industries.

**KEYWORDS:** -  $6\sigma$ , DMAIC, Quality

## I. INTRODUCTION

$6\sigma$  is a sigma-quality tool that is used in many organizations, trying to complete close in other words,  $6\sigma$  is a data driven, disciplined approach and method. It is based on removing the flaws in any process. This product or service can be used in industries. The purpose of the  $6\sigma$  approach is to obtain and maintain six standard deviations between the middle and the closest specifications. In order to achieve  $6\sigma$ , more than 3.4 out of every million errors will not arise from customer specifications, because nothing is said because of the  $6\sigma$  defects. The total amount of probability for a defect can be called the possibility of  $6\sigma$ . We can use  $6\sigma$  calculators to calculate process sigma.

Implementation of a measure-based strategy focused on improvement in the process and lack of diversity, this is the fundamental objective of the  $6\sigma$  method. It can be obtained systematically by using  $2\sigma$  sub-methods DMACC and DMADV.  $6\sigma$  DMACCC processes (defined, measurement, analysis, improvement, control) is an improvement system for current processes which is outlined below and is looking for incremental improvements.  $6\sigma$  DMADV process eg. Design, measurement, analysis, design and verified.  $6\sigma$  quality systems are a better system for the development of new processes or products. If the existing process only requires incremental improvement, DMADV can also be employed. Bill Smith defined the general sensor organized in 1989 as  $6\sigma$  [4] Alan Larson (2003) said that everyone in the  $6\sigma$  system is committed to meeting the customer's expectations through collaborative focus -Six mistakes There is a methodology for reducing and maximizing value. Each and every mistake is an end-customer of an organization or worker cost, again a certain task is needed, and a part that has replaced, time or material wasted, lost yheskill, or productivity was eliminated. Actually, many organizations spend 20 to 30 percent more of their revenues in garbage and mistakes! It is a shocking number Imagine that every time you give check cash, then throw 20 to 30 percent of your money in the garbage. It may seem ridiculous, but many organizations do have room to improve in every organization and individuals.  $6\sigma$  methods help in this. [3]

For securing, maintaining and maximizing business success,  $6\sigma$  is a comprehensive and flexible system. It is specially designed to improve the disciplined usage and business processes of customers' needs, facts, statistics and statistical analysis & motivated to understand diligently enough to rebuild them.

The definition that will provide the foundation for our efforts to unlock the opportunities of  $6\sigma$  for the organization. Business success type which you can achieve is widespread because proven benefits of  $6\sigma$ -systems are diverse, including a reduction in the following [2] costs

- Productivity improvement
- Market share development
- Customer retention
- Process-time reduction
- Reduce the mistake
- Product / service development

$6\sigma$  is focused on customer requirements, fault prevention and cost of the Savings. Thus, profit from  $6\sigma$  goes directly to the bottom line, unlike costless cost-cutting programs, which reduce value and quality,  $6\sigma$  recognizes and eliminates those costs that provide a value to customers Do not, waste costs. For non- $6\sigma$  organization, these costs are often extremely high Companies working in  $3\sigma$  or  $4\sigma$  are usually between 25 to 40 % of their income Problems are more accurately known about the economy of low quality. Operating companies  $6\sigma$  generally spend below than 5% of the revenue determining their problems. The COPQ values shown in Figure 28 are at the lower end of the range of results recorded in various studies. The difference of Dollar cost can be very large; General Electric estimates that the difference between three or four Sigma and  $6\sigma$  was estimated between \$ 8 billion and \$ 12 billion per year.

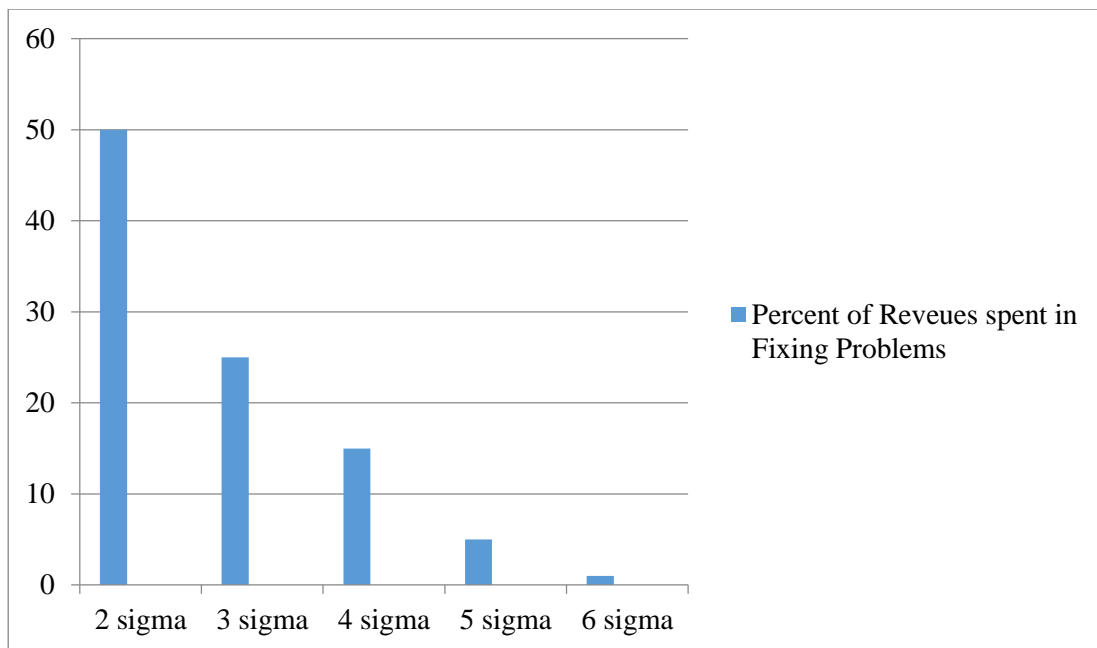


Fig.1 Price of poor quality vs sigma level 1

## II. 6 $\sigma$ SCALES OF DEFECT

TABLE-I- UNITS FOR MAGNETIC PROPERTIES

Sigma level 1	Defect Rate (PPM)	Yield In %	Cost of poor Quality (% of Sales)	Competitive level
6 $\sigma$	3.4	99.99	<10 %	Word class
5 $\sigma$	233	99.97	10 to 15 %	
4 $\sigma$	6210	99.37	15 to 20 %	Industry Average
3 $\sigma$	66807	93.31	20 to 30 %	Non-Competitive
2 $\sigma$	308537	69.14	30 to 40 %	

Table I show % yield for different sigma levels

## III. 6 $\sigma$ IN MANUFACTURING INDUSTRIES

**Kunal Ganguly (2012), [5]** used DMAIC 6 $\sigma$  approach to improve the rolling mill process. During the hot mill, he applied 6 $\sigma$  DMX to a hot aluminum company for the time of the horoscope due to the birth horoscope. The challenge for the company was to meet the demands of rapidly changing exports, as well as the current demand of sealed seals.

He used the 6 $\sigma$  DMAIC method to determine the project CTQ features; he defined possible causes, identified different sources, established variable relationships and implemented control schemes. Through its 6 $\sigma$  DMAIC project, it can achieve measurable results, such as decrease in cycling time, the sleep problem is over, and the broad width tests are successful.

**Hsiang-Chin Hung and Ming-Hsien Sung (2011) [7]** have used the DMACC approach in the food industry in Taiwan (remedy-analysis-improvement-control-control) by this method, they have an underlying effect to reduce the process difference. In this way, the result was that the small scrap rate of small custard buns was for 70% on their base basis.. He has also presented idea regarding the factors that are responsible for success of 6 $\sigma$  project in a food industry.

**Prof. Dr. Vidosav Megestorvic, et al. (2010) [9]** Some of his work has used DMAC method in Serbia Whether the metal processing manufacturing company has reduced the process variability achieved through its project, thus reducing the product of non-relation. This increased the level of sigma for building system / process and customer satisfaction

**S Pikasul, N. Sumsuch, W. Junboan, and T. Lescryththong (2013) [13]** 6 $\sigma$  DMAIC Applicable The method of improving the production process of laser computer mouse by operating under these results The yield of conditions, functional testing process increases from 96.2 to 98.6%.

**Mohit Taneja, Arpan Maanchand (2013) [14]** has used 6 $\sigma$  approach to improve productivity in the manufacturing industry. In his letter, he starts with an overview of 6 $\sigma$ , after which the literature is fully reviewed. 6 $\sigma$  in the DMAC phase, the use of small sigma in small-medium industries and also in large manufacturing industries.

**Tushar N Desai and Dr. R L shrivastava (2008) [15]**, they have discussed in their paper about quality and production rate Improvement in a manufacturing industry via. a case study. This paper define the application of 6 $\sigma$  DMAIC method in an enterprises that design a framework to define, quantify and reduce or scraps of sources of changes in a process, to adopt the variables of operation, modification & assist performance to wit. process yield with well-manner control plans. The process yield was improved as a result of implementing this Methodology. It has effect of improved and better utilization of resources and decreased variations. It is also helped in quality of the output.

Discuss the 6 $\sigma$  DMAIC method in context with the case study of the grinding process. The purpose of the DMAC approach was to solve the main problem of reduction in scrap or process variation by modified the process yield. This letter briefly states how to achieve the advantages of a manufacturing process through a systematic use of the above method for moving towards world class quality level. As a result of the application of 6 $\sigma$  Method, the defect in the fine grinding process decreased from

16.6 to 1.19%. With this, there has been a significant financial impact on the profitability of the company. This was due to rearrangement, reduction of scrap costs, reductions in human-hour and increase in production. The project reported savings of 2.4 million US dollars annually

**R. Gonzalez Falcon, D. Velazucci Alonso, L.M. Gallego Fernández, Luis Perez Lombard (2011) [22]** Proposed application of  $6\sigma$  method for increase the energy efficiency in Naphtha's distillation unit Improvement plant results show an estimated savings of 150,000 € / year through their project, they found that  $6\sigma$  method is extremely useful for improving energy efficiency of distillation units. The project is about using five-phase DMAC method to show and optimize the reforming unit's reform process. In useful information, the data is arranged in the measurement phase of the DMACC process, which establishes the baseline, with which all the improvements will be compared in the future.

**Jeroen Demast, Zoran Lokkerbol (2011) [25]** has analyzed the  $6\sigma$  DMAIC method from the perspective of problem solving. Their papers compare DMAC method with insights from scientific principles in the area of solving serious problems. The object of this is to identify the limitations of the method. They allegation that they can be examined to limit the boundaries of identity to improve the law He emphasized that some limitations can be contained by DMAC because it is not proper that a strong method can be implemented without restrictions under all circumstances. In those cases, the practical value of the identification boundaries is that when the user DMAIC method is appropriate, they provide the basis for advising.

**Ploytip Jirasukprasart et al (2012) [26]** has done a case study to reduce the flaws in making rubber gloves. Process of implementing  $6\sigma$  Principles and DMAC problem solving method is achieved through results this reduction of 1 million opportunities per million opportunities (DPMO) from 195,095 to 83,750. It shows that 50% Defect rate reduction and hence increase your  $\sigma$  level from 2.4 to 2.9. This work identifies the quality issues of a Thai rubber glove manufacturing company Eden Wallace et al (2009) [27] has used  $6\sigma$  DMAIC method in semiconductor company For the construction of circuit cartridges for inkjet printers, the electrical test is done in the final stages of accepting or rejecting the characteristics of electricity. During the data collection, they found that the failure of electricity is approximately 50% of all the defects, thus reducing the level of defects was necessary by establishing main problems, causes and tasks. They set important factors, identify optimal levels or tolerance and opportunities for improvement. At least 50% of the power failures are getting reduced, the results show that the proper use of this method and support for organization organizations and employees, positivity on quality and another important features for satisfaction of customer can be achieved

**Lateef ur Rehman, Attekh-ur-Rehman (2012) [31]** has used  $6\sigma$  approach for security management. The focus of the manufacturing company focused company was the health and safety department in the company and its purpose was to establish and improve the accident prevention system. Paper presents how to do  $6\sigma$  the technology will assist organizations in evaluating safety and environmental hazards in performance. The objective of this study is to use six-sigma technique to identify and reduce the occurrences of accidents at the company in consideration.

**Mohammad Anmul Kabir, SM Mahbubul Islam Bobby, Mostafa Lotti, (2013) [33]** Study and evaluate the processes of the existing organization in order to ascertain the current sigma level and finally improve the existing sigma level Productivity improvement. This has been done using the Chhattisgarh DMAC cycle; it is possible to reduce productivity by reducing the fault rate by using the DMAC method. This research work has been done in a financing company to show how to improve its productivity and quality by using six-sigma. This paper-related work applies not only to the fan company but also to any other type of organization. By applying Six-Sigma, a correct synchronization will be seen between cost, quality, production time and control time. It is possible to reduce the work repeatedly by saving time by applying the 5S.

As a result, there is less chance of making faulty fans, which is the main goal of Six-Sigma. On the other hand, by applying line balance, decreasing productivity decreases productivity from 240 to 312. In the end, it is said that six studies are possible to improve productivity, which is the main purpose of this study. In the future, it is possible that there will be more changes;  $6\sigma$  make even more beneficial applications for all types and sizes of organizations.

#### IV. $6\sigma$ IN AUTOMOBILE INDUSTRIES

**Dr. Rajesh Kumar u Equinox (2012) [8]**, is based on a mid-size auto subsidiary in his paper, which includes 350-400 employees, and used  $6\sigma$  method to increase the dream of  $6\sigma$  quality level. We do. This method is executed to reduce the defective level on the product assembly, which is important for the customer and its implementation has been an important

financial hit on the bottom line of the enterprise. In the defined phase, they developed the project charter and then defined the opportunity description and the target statement.

**J Antenie, M. Kumar and MK Tiwari (2005) [11]** have worked with the application of  $6\sigma$  based method to eliminate the problem of engine overhaul in the automotive company. Its aim was to reduce the difference in the process and the related high defect rate. This letter briefly explains how a foundry can use systematic and disciplined approaches to reach the goal of  $6\sigma$  quality levels. The output of the received cylinder head has reduced the problem of the problem and the process capacity has increased from 0.49 to 1.28. The financial impact was saving more than US\$110 000 per year.

**Rajesh Kumar A meeting and Dr. Rajendra S. Danal (2011) [19]** has evaluated  $6\sigma$  implementation Medium-level Indian Automotive Enterprises In this paper, they have discussed important success factors for successful  $6\sigma$  implementation in the automotive industries in the medium scale. Survey conducted using the questionnaire method. There has been little research done in its comments in the automotive sector, and it has been found in the study that only 25.64% of the mid-level automobile sector has implemented  $6\sigma$ . He also said that the medium scale automotive venture is keeping a good foundation of 9000. They also claimed that many enterprises have adopted other good quality management strategies like Casan and TPM, and concluded that MSAI has a small advanced quality management system such as  $6\sigma$  which can stop the profit from the global market. He has also said that costly consultation fees can be saved from internal training.

**Prof.S.N.Telie, Dr. U.M. Bhushi, Shri V.GSurange, (2012) [21]** has given the frame of the  $6\sigma$  implementation frame; He also said that  $6\sigma$  can be equally applicable for small and medium enterprises and service organizations. There is a huge research gap in the Indian small-medium enterprises so far.

**S Suresh, A. El Mo and A. B. Abu (2015) [28]** has used the  $6\sigma$  DMAIC method to reduce the flaws in automobile piston ring manufacturing. Using the  $6\sigma$  method, the current percentage of rejection has dropped from 38.1% to 13.2%. After the continuous implementation of all the solutions, there is hope for more rejection in the long run.

**S.N. Tilly, Dr. V. s. Majali, Dr. U.M. Bhushi, Sanjay Patil (2012) [29]** in his letter discussed the  $6\sigma$  Tool to reduce the cost of quality for the automobile industry. Initially,  $6\sigma$  DMACI method has been discussed briefly with its applications, and in addition,  $6\sigma$  devices have been briefly discussed. A case study has been introduced about the reduction of Exhaust Pipes and Cylinder Failures. Apart from this, it was also claimed that the use of  $6\sigma$  concept helps to control the quality of the product in a pleasant way, so that the overall benefit of one avoids unnecessary downsizing. In such cases where the quality of the business starts reducing the costs of the cost, the best way to save everything is to employ  $6\sigma$  method throughout the operation, thus increasing the quality of the production of the product and the morale of employees.

## V. $6\sigma$ IN SMALL SCALE INDUSTRIES

**Joshua Chen Ren G, Sanal Kamruddin and Ishq Abd Ajeed, (2014) [6]** has proposed DMACC as the Lin  $6\sigma$  (LSS) framework in its paper in Small Secondary Enterprise (SME). They have focused on the problem of SME to face the pressure of their competitors; mainly as a large company, they can provide high value products with lower prices than SMEs. The DMACI framework is developed and verified by the author in a label printing company. This SME label printing company makes a variety of labels, such as computer labels, offsets and silk read stickers and bar code labels. Productivity of the label printing section shows 584 impressions / hour increments, which is an increase of 21.93% in current production output.

**Rajesh Kumar U Sambha (2012) [10]** Discussed through the literary review of  $6\sigma$  in Indian SMEs. He mentioned that  $6\sigma$  is a method of improving the process and improving the sales of the company, reducing work flaws and making realistic organizational excellence on the appropriate practice of statistical instruments. Since  $6\sigma$  is a customer-based approach, it is important to prioritize those projects that meet the demands and provide great satisfaction for the buyers and get more profits for the enterprise. According to him, financial and human resources are two major obstacles in the implementation of  $6\sigma$  in small and medium enterprises. High management commitment is one of the most important success factors in the implementation of  $6\sigma$  method because it reflects the highest rank from most pre-research, choosing the right project is more than a challenge, but customer satisfaction and financial benefits

**UD Gullai, CA Nalawade, K.P. Sohni, V.S. Shirodkar (2012) [24]** has proposed to implement  $6\sigma$  models for the medium-sized appliance industry. He has chosen a file manufacturing company for this purpose, he started his DMACC project, which

aims at reducing the unacceptable rate of current, which is 6,000 regular cone files of 35,000 defects per million opportunities. For the potential rejection rate, it was measured as less than 10000 per million fault.

## VI. 6σ IN SERVICE INDUSTRIES

**Darshak A. Desai (2006) [12]** has used 6σ DMAIC method to improve customer loyalty in the small scale enterprises. It was found that distribution of existing customers and new business development due to distribution was satisfactory, the firm had registered an increase of about 25% in its business.

**K.G. Durga Prasad, President, Subabiya; Padmavati (2012) [18]** discussed the case study, where 6σ Methodology at an engineering education institute. He mentioned that this approach has helped to establish a new vision in an engineering academic institution with an approach to improve the quality. In this paper, students who are admitted to an engineering educational institute are considered as raw material and processed for the purpose of converting them to the final product in the name of engineering graduates to meet customer expectations Has been completed. The purpose of this letter is to increase quality in education. The authors strongly claim that the 6σ proposed in the letter has given quality assurance in education, desirable appointments in reputable companies, and opportunities for higher education, development of future entrepreneurs and high percentage of nearby students. To implement 6σ methodology in engineering education, the first and most important requirements are the mind of quality consciousness in the management of institutions, and continuous efforts of all the participants in the education system are necessary.

**S Arun Vijay (2014) [23]** In the multi-faceted hospital setting in India, the aim of his research work is to minimize the cycle time of the discharge process of patients using 6σ DMAIC model. He used various quality tools and techniques through the five stages of 6σ DMAIC model this study suggested several improvement strategies to reduce the cycle time of the expel process and its implementation; 61% minimization in the cycle time of the discharge process of patients. In addition, a control plan check sheet has been developed to maintain the reforms received. This study will be an exposure for health care managers, who will use the 6σ DMAIC model to minimize the cycle and minimize the cycle of release process in the hospital. This study has approved the application of 6σ DMAI methods to reduce and adjust the discharge process for patients who pay special attention to the medical and surgical department. However, the mean time of vacation has been reduced from 234 minutes to 143 minutes; it shows a 61% decrease.

## VII. 6σ REVIEW

**Darshak A. Desai, Mulchand B. Patel (2009) [17]** has analyzed the effect of 6σ on a developing economy like India. Studies have shown that the advantages of Indian industries are being accomplished by completing 6σ. This study has highlighted the difference between the benefits and benefits of the areas of Indian industries and the equality and the 6σ. This detailed analysis of the benefits made by Indian industries through 6σ can also be helpful with other developing countries of different developed countries, who have yet to use 6σ to pay more concentration to their expectations for this improvement. Not able to have given as completely, this study has given a comprehensive picture of the benefits made by Indian industries through 6σ repair drives till date. He blamed that this study shows how Indian industry has benefited from 6σ, it can assist other industries, which are still not capable of experimenting with 6σ, their improved hopes from this improved drive Depends on the analysis of this study, depending on their size and type of operation, individual industries can expect some specific benefits from 6σ implementation. Based on the operation of the industry, 6σ programs can be started with some special benefits

**Rakesh Kumar Tekade, Narendra Kumar Jain (2008) [20]** 6σ was discussed as an increasing quality management strategy aimed at promoting the need to adopt 6σ Is Before working on an existing quality management approach, there are additional benefits of 6σ Logic and Address Concern for its implementation. The authors discussed some important points such as the underlying theory and definition of 6σ, its historical possibilities, the process of 6σ, the deviation of the σ level, the calculation of the σ level, 6σ staff in this paper, he gave a brief description of the DMAIC method through literature review.

**Nilesh V. Fansul Dr. Satish V Bansod Swati An Fanyule (2012) [30]** discussed the benefits and limitations of 6σ method

through powerful literature survey. The main obstacles in the fulfilment of  $6\sigma$  are according to their organization's own management and employees, active supplier partnership, active customer participation. He emphasized that  $6\sigma$  is a long life organizational commitment. It will not work well without full commitment from the upper management,  $6\sigma$  thinks to teach a company a fact-based decision at all levels. The program has changed the DNA of a company by changing the ideas of the people and by improving the management pipeline by developing management skills and communication skills among the people.

**T.N.Goh (2002) [32]** has strategically evaluated  $6\sigma$  in his paper, some strategic approaches Subjects subject to possible and possible limitations of special  $6\sigma$  applications are presented With the help of literature, some underlying limitations of  $6\sigma$  are considered in a knowledge-based environment. Analysis. Figure shows that  $6\sigma$  DMAIC method

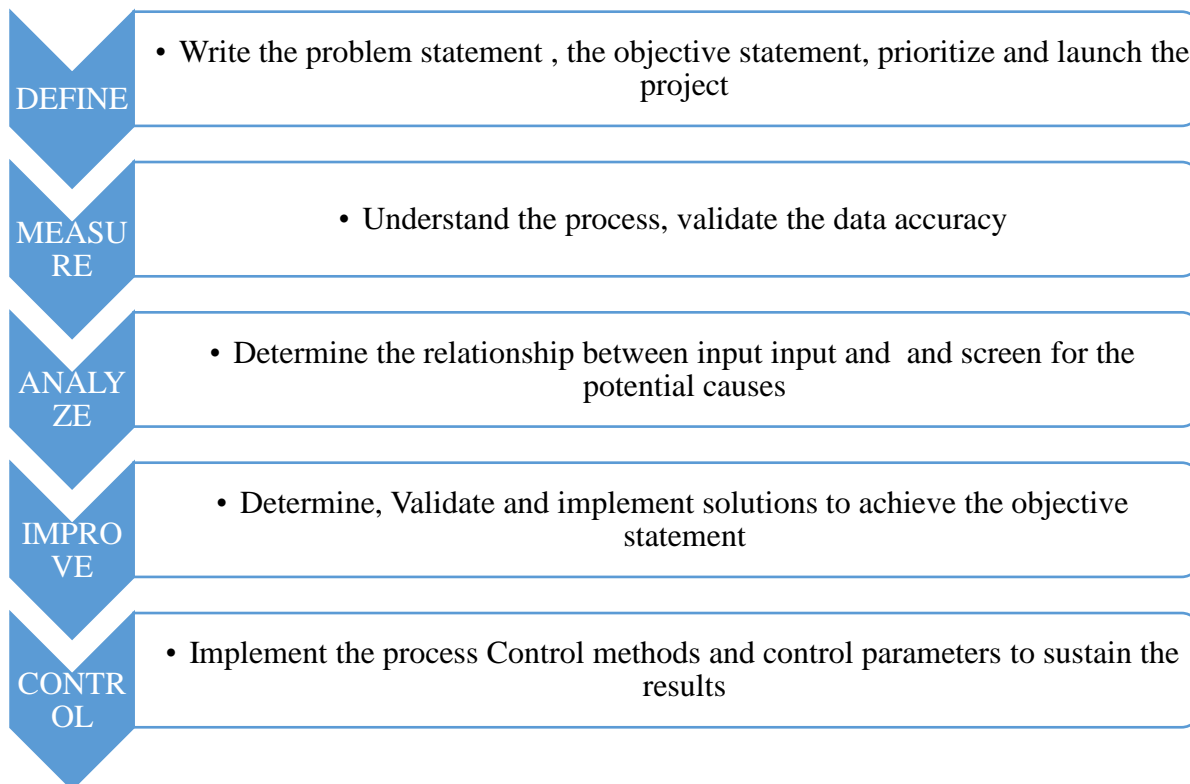


Fig 2  $6\sigma$  DMAIC Method [3]

## VIII. CONCLUSION

$6\sigma$  DMAIC method is manufactured in industries like automotive part manufacturing, Rolling Mills in Metal Processing, Manufacture of Gloves, File Manufacturing, Laser Mouse Manufacturing, Semiconductor Manufacturing, Grinding Operations, and One of Six Papers

### Define

- Write a statement of problem, prioritize, prioritize the project and launch

### Measure

- Understand process, confirm data accuracy Analyze

### Analyze

- Determination of connection between source and output and screen for possible reasons

### Improve

- Set, valid and apply solutions to get objective details struggle

### Control

- Apply process control methods and control parameters to maintain results

6 $\sigma$  DMACI methods are also used in the service industry to improve the sigma safety level, such as hospitals and educational institutions. 6 $\sigma$  DMX methods also got its application in the Delivery Commitment Completion Project. 6 $\sigma$  DMAIC methodologies have been thoroughly reviewed by many authors. The reviewed literature has found that there is not sufficient work to use the 6 $\sigma$  in the steel industry, especially in continuous casting processes. Thus, there is an opportunity to use 6 $\sigma$  DMAIC tools for quality improvement in the steel industry of continuous casting processes. The use of these DMAC tools can reduce the scraps in the steel industry. Apart from this, the quantity of defects can be saved by reducing defective products as a secondary result.

## REFERENCES

- [1] Pyzdek T, Keller PA (2009), "The Six Sigma handbook" 3rd Edition McGraw-Hill, New York
- [2] Pande, P., Neuman, R., and Cavanagh, R. (2000), "The Six Sigma Way: How GE, Motorola and Other Top Companies are Honing their Performance" (McGraw-Hill, New York).
- [3] Craigh Gygi, Neil DeCarlo, Bruce Williams (2005), "Six Sigma for Dummies" published by Wiley publishing Inc., Indiana police, Indiana
- [4] Alon Larson (2003), "Demystifying Six Sigma, Accompany Wide Approach to Continuous Improvement" published by AMCOM, A Division Of American Management Association
- [5] Kunal Ganguly, (2012) "Improvement Process for Rolling Mill through the DMAIC Six Sigma Approach" International Journal for Quality Research
- [6] Joshua Chan Ren Jie, Shahrul Kamaruddin and Ishak Abd Azid (2014), "Implementing the Lean Six Sigma Framework in a Small Medium Enterprise (SME) – A Case Study in a Printing Company" Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management Bali, Indonesia,
- [7] Hsiang-Chin Hung and Ming-Hsien Sung, (2011), "Applying Six Sigma to Manufacturing Processes in the Food Industry to Reduce Quality" Scientific Research and Essays
- [8] Dr. Rajeshkumar U. Sambhe, (2012), "Six Sigma Practice for Quality Improvement – A Case Study of Indian Auto Ancillary Unit" IOSR Journal of Mechanical and Civil Engineering
- [9] Prof. Dr. Vidosav Majstorović 1, M.Sc. Tatjana Sibalija 1, "Application of Six Sigma Methodology in Serbian Industry"
- [10] Rajeshkumar U. Sambhe, (2012), "Journey of Six Sigma in Indian SMEs–Literature Snapshots" International Journal of Engineering and Innovative Technology (IJEIT)
- [11] J Antony, M Kumar and M K Tiwari, (2005), "An Application of Six Sigma Methodology to Reduce the Engine-Overheating Problem in an Automotive Company" Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture
- [12] Darshak A. Desai, (2006), —Improving Customer Delivery Commitments the Six Sigma Way: Case Study of an Indian Small Scale Industry" Int. J. Six Sigma and Competitive Advantage
- [13] S. Pimsakul, N. Somsuk, W. Junboon, and T. Laosirihongthong, (2013), "Production Process Improvement Using the Six Sigma DMAIC Methodology: A Case Study of a Laser Computer Mouse Production Process" The 19th International Conference on Industrial Engineering and Engineering Management
- [14] Mohit Taneja<sup>1</sup>, Arpan Manchanda<sup>2</sup>, (2013), "Six Sigma an Approach to Improve Productivity in Manufacturing Industry" International Journal of Engineering Trends and Technology (IJETT)
- [15] Tushar N. Desai and Dr. R. L. Shrivastava, (2008), "Six Sigma – A New Direction to Quality and Productivity Management" Proceedings of the World Congress on Engineering and Computer Science 2008 WCECS 2008,
- [16] E. V. Gijoa, Johny Scariab and Jiju Antonyc, (2011), "Application of Six Sigma Methodology to Reduce Defects of a Grinding Process"
- [17] Darshak a. Desai<sup>1</sup>, mulchand b. Patel<sup>2</sup>, (2009), "Impact of Six Sigma in a Developing Economy: Analysis on Benefits Drawn by Indian Industries" Journal of Industrial Engineering and Management,
- [18] K.G.Durga Prasad, K.Venkata Subbaiah, G.Padmavathi, (2012), "Application of Six Sigma Methodology in an Engineering Educational Institution", International Journal Emerging Science, 2(2), June 2012



- [19] Rajeshkumar u. Sambhe, Dr. Rajendra S. Dalu, (2011), "Evaluating Six Sigma Implementation in Medium Scale Indian Automotive Enterprises" International Journal of Engineering Science and Technology (IJEST),
- [20] Rakesh Kumar Tekade, Narendra Kumar Jain, (2008), "Six Sigma: a Growing Quality Management Strategy" article from Pharma Review, Pharmaceuticals Research Laboratory, Department of Pharmaceutical Sciences Dr. Hari Singh Gour University, Sagar. August 2008
- [21] Prof.S.N.Teli, Dr. U.M.Bhushi, Mr.V.G.Surange, (2012), "Assessment of Cost of Poor Quality in Automobile Industry" International Journal of Engineering Research and Applications (IJERA),
- [22] R. González Falcón et. al (2012), "Improving Energy Efficiency in a Naphtha Reforming Plant Using Six Sigma Methodology" Fuel Processing Technology
- [23] S. Arun vijay (2014), "Reducing and Optimizing the Cycle Time of Patients Discharge Process in a Hospital Using Six Sigma DMAIC Approach" International Journal for Quality Research 8(2)
- [24] U. D. Gulhane et. Al (2012), "Six Sigma Implementation Model for File Manufacturing Industry" International Journal of Mechanical Engineering and Technology (IJMET)
- [25] Jeroen Demast, Joranlokkerbol (2011), "An Analysis of the Six Sigma DMAIC Method from the Perspective of Problem Solving" International Journal of Production Economics 139 (2012),
- [26] Ploytip Jirasukprasert et. Al (2012), "A Case Study of Defects Reduction in a Rubber Gloves Manufacturing Process by Applying Six Sigma Principles and DMAIC problem Solving Methodology" Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management Istanbul, Turkey 2012,
- [27] Adan Valles et. Al (2009), "Implementation of Six Sigma in a Manufacturing Process: A case study" International Journal of Industrial Engineering,
- [28] S. Suresh, a. L. Moe and a. B. Abu (2015), "Defects Reduction in Manufacturing of Automobile Piston Ring Using Six Sigma" Journal Of Industrial And Intelligent Information
- [29] S.N.Teli, Dr.V.S.Majali, Dr.U.M.Bhushi, Sanjay Patil (2012), "Automotive Product Development Process (APDP) Strategy by Integrating Six Sigma to Reduce the Cost of Quality" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
- [30] Nilesh V Fursule Dr Satish V Bansode Swati N Fursule (2012), "Understanding the Benefits and Limitations of Six Sigma Methodology" International Journal Of Scientific And Research Publications,
- [31] Lateef Ur Rehman, Ateekh-Ur-Rehman (2012), "Safety Management in a Manufacturing Company: Six Sigma Approach" Engineering, 2012,
- [32] T. N. Goh (2002), "A Strategic Assessment of Six Sigma" Quality And Reliability Engineering International Quality Reliability Engineering, International 2002
- [33] Md. Enamul Kabir, S. M. Mahbulul Islam Boby, Mostafa Lutfi, (2013), "Productivity Improvement by Using Six-Sigma" International Journal of Engineering and Technology
- [34] Hongbo Wang (2006), "A Review of Six Sigma Approach: Methodology, Implementation and Future Research" IEEE paper
- [35] Virender Narula, Sandeep Grover, "Six Sigma: Literature Review and Implications for Future Research", International Journal of Industrial Engineering & Production Research, January 2015,
- [36] Mr. Ganesh P. Jadhav, Mr. Sandeep B. Jadhav, Mr. Amol Bhagat, "Six Sigma DMAIC Literature Review" International Journal of Scientific & Engineering Research, , December-2015