Studying and Understanding the Behavioral Based Safety Management and its Relevance to the Industries in India with Reference to 6M's for Enriching the Productivity

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Abstract

Productivity improvement for 6M's through the roots of BBSM, is to do the right things better and make it a part of continuous process. Therefore, it is important to adopt efficient productivity improvement technique so as to ensure individuals and organizations growth with productivity. There are many productivity improvement techniques like method study and work measurement, cost reduction, modernization, investment in machine and equipment, re-engineering etc. Automation is about speed, accuracy and precision of the process continuing with BBSM. There are many systems where we can apply automation for better and accurate result. Automation is one of the most effective methodologies for cost cutting by the elimination of the waste such as scrap, reduction in man power, reduction in time, controlling the quality and improving the overall performance of any machine, system or process in any industry with the complete assurance of large annual profit margins using 6M's improvisation. This project focuses on examining key factors of productivity enhancement for 6 M's using BBSM (Behavior Based Safety Management).

Keywords:

BBSM (Behavior Based Safety Management), ERP (Enterprise Resource Planning), SCM (Supply Chain Management), CRM (Customer Relationship Management), MRP (Manufacture Resource Planning), OPC (Operational Process Cycle), ABC (Antecedent Behavior Consequence).

LITERATURE SURVEY

Productivity improvement is to do the right things better and make it a part of continuous process. Therefore it is important to adopt efficient productivity improvement technique so as to ensure individuals and organizations growth in productivity [1]. There are many productivity improvement techniques like method study and work measurement, cost reduction, modernization, investment in machine and equipment, re-engineering etc. automation is about speed, accuracy, precision of the process [2]. There are many systems where we can apply automation for better and accurate result. Automation is one of the most effective methodologies for cost cutting by elimination waste as scrap, reducing man power, reducing time, controlling quality, and improving overall performance of any machine, system or process in any industry with the complete assurance of large annual profit margins [3]. Productivity improvement is to do the right things better and make it a part of continuous process. Therefore it is important to adopt efficient productivity improvement technique so as to ensure individuals and organizations growth in productivity [4].

Rachna Shah *et al.* [7] examines the effects of three contextual factors, plant size, plant age and unionization status, on the likelihood of implementing 22 manufacturing practices that are key facets of lean production systems. Plant size, unionization and plant age, matters with regard to implementation of lean practices, although not all aspects matter to the same extent. Second, applying synergistic bundles of lean practices concurrently appears to make a substantial contribution to operational performance over and above the small but significant effects of context.

Ma Ga (Mark) Yang *et al.* [8] explores relationships between lean manufacturing practices, environmental management (e.g., environmental management practices and environmental performance) and business performance outcomes (e.g., market and financial performance). This research model presents lean manufacturing as an important antecedent of environmental management practices. Krisztina Demeter *et al.* (2011) studied how companies can improve their inventory turnover performance through the use of lean practices. They found a significant relationship between LM practices and inventory turnover. Hung-da Wan et al [9] presents an adaptive lean assessment approach that provides an effective way to guide the lean implementation process. Using the web-based program, an assessment model is generated adaptively for each user to evaluate the current status of the system, pinpoint the urgent targets for improvement, and identify the appropriate tools and techniques for developing action plans. Yi-fen Su et al. [10] studied the Enterprise Resource Planning (ERP) and SCM represent important information technology investment options for operation or IT managers, and have been acclaimed in the practitioner and academic literature for their potential to improve business performance.

The studies found that changes to the IT system would lead to significant changes to many other aspects on the shop floor. Experience from the showcases and other literature showed that these non-IT related issues should be handled separately by a lean manufacturing project. Kevin B Hendricks *et al.* [11] ERP, SCM, and Customer Relationship Management (CRM)systems on a firm's long-term stock price performance and profitability measures such as return on assets and return on sales. CheriSpeieret al. [12] developed the framework to examine the threat of potential disruptions on supply chain processes and focuses on potential mitigation and supply chain design strategies that can be implemented to mitigate this risk.

The framework was developed by integrating three theoretical perspectives—normal accident theory, high reliability theory, and situational crime prevention. Jyri P PVilko and Jukka M Hallikas [13] present preliminary research concepts and findings concerning the identification and analysis of risks in multimodal supply chains. They present a new framework for categorizing the risks in terms of their driver factors in order to assess the overall impact on the performance of the supply chain. Mahmoud Houshmand and Bizhan Jamshidnezhad [14] presented an axiomatic modeling of lean production system design, using Process Variables (PVs). There are some factors, playing the key roles in the failure of lean implementation practices like: lack of a scientific foundation for lean manufacturing and its associated transformation process, lack of precisely identified needs and reasons for change, resistance to change etc. They proposed an axiomatic model as the form of FR-DP-PV relationships that provide a scientific model for concepts, principles and methodologies of lean manufacturing and thereby alleviating many existing implementation shortcomings. The proposed hierarchical structure clarifies the interrelationships of concepts, principles, and methodologies in the best way.

Jan Riezebos and WarseKlingenberg [15] discussed the changing role of Information Technology (IT) in advancing lean production. Lean principles and techniques have been applied in a wide variety of organizations, from make-to-stock to engineer-to-order industries, and even in typical service sectors, such as healthcare. In order to apply lean principles in various areas, variants were developed of well-known techniques, such as Kanban, Kaizen, SMED, and 5S. They suggested to stimulate research efforts that further advance lean production in manufacturing and service industries.

Application of lean production principles in engineer-to-order industries and industrial services appear to best ill lagging behind, because many of the traditional techniques cannot be applied directly in their processes. Fawaz A Abdulmalek and Jayant Raj Gopal [16] described a case where lean principles were adapted for the process sector for application at a large integrated steel mill. Value stream mapping was the main tool used to identify the opportunities for various lean techniques. They also describe a simulation model that was developed to contrast the ‘‘before’’ and ‘‘after’’ scenarios in detail, in order to illustrate to managers potential benefits such as reduced production lead-time and lower work-in-process inventory. Many industries in the process sector actually have a combination of continuous and discrete elements, and it is in fact quite feasible to judiciously adapt lean techniques. David J Meade *et al.* [17] their research explores the magnitude and duration of the negative impact on reported profits experienced during a lean manufacturing implementation. Their research uses a multi-period simulation model of a production operation that incorporates a manufacturing planning and inventory tracking system. A hybrid simulation approach is employed using Microsoft Excel to model the Manufacturing Resource Planning (MRPII) function, while Pro Model simulation software issued for the development and operation of the model production environment. Microsoft e Visual Basic is used to create a bridge between systems for schedule dissemination and inventory updates. Ann Maruchec*k et al*. [18] studied the product safety issues and challenges that arise in five industries that are increasingly globalizing their supply chains: food, pharmaceuticals, medical devices, consumer products and automobiles. A major conclusion is that in each of these industries, a pressing safety or security problem can be traced back to conditions in the global supply chain.

Thus, in the food industry a major problem is contamination, while in pharmaceuticals, it is counterfeiting. The medical device industry is coping with ensuring safety given the rapid pace of technological change Michael Knemeyer*et al.* [19] studied the effect of the catastrophic events in supply chain systems. The planning process provides a systematic approach for managers to identify key locations subject to catastrophic risk and then estimate both the probability of occurrence and the financial impact of potential catastrophic events. In addition, the proposed process provides managers with information to assist in the generation and selection of appropriate countermeasures designed to mitigate the potential effect of catastrophic events on supply chains. Christopher S Tang [20] studied the various quantitative models for managing supply chain risks. He found that these quantitative models are designed for managing operational risks primarily, not disruption risks. These strategies can make a supply chain become more efficient in terms of handling operational risks and more resilient in terms of managing disruption risks. De Xia *et al.* [21] studied the supply chain risk management system. He concluded a decision-making model based on the internal triggering and interactive mechanisms in an SC risk system, which takes into account dual cycles, the Operational Process Cycle (OPC) and the Product Life Cycle (PLC).

A strong bilateral influence-imposed relationship is the key of SC risk management while there are internal circulations among elements of OPC, which make the risk system more complex. GoncaTuncelet al. [22] studied the Petri nets framework that can be used to model and analyze a Supply Chain (SC) network which is subject to various risks. They studied that that PN can be used effectively to model dynamic and stochastic nature of SC. They provide a thorough understanding of the control logic of the network structure, and can assist the evaluation of various operational strategies. PN can potentially play a significant role in risk modeling and analysis.

SooWook Kim [23] studied the causal linkages among SCM practice, competition capability, the level of SC integration, and firm performance. They concluded that SC integration may have a significant influence on the linkage between SCM practice and competition capability inversely. Petri Niemiet al. [24] studied the effect of improving the impact of quantitative analysis on supply chain policy making. They concluded that the impact of quantitative analysis on supply chain policy making can be improved by adapting the different roles of the analysis in the different stages of the policy-making process. Meloet al. [25] studied the supply chain performance measures and optimization techniques. He studied that the role of facility location is decisive in supply chain network planning and this role is becoming more important with the increasing need for more comprehensive models that capture simultaneously many aspects relevant to real-life problem.

The primary goal for the any organization is customer's satisfaction and if organization cannot reach perfection in this area then all the processes are worthless. All parts of the value chain and everything in the enterprise must be healthy for realization of competitive business processes. If the company wants strong and long lasting value chain all the links within the chain must be prepared to overpass all existing problems. If the company wants to have a JIT concept it does not mean that everything must be done very fast. The most important thing for the company is to have good organized resource allocation.

Also, the management and employees must have on their mind that this concept can help the organization to solve many problems in logistics. It is true that implementation and development of JIT is a long-lasting and expensive process, but if the company can manage with these difficulties it is possible to achieve high levels of workflow. JIT production system identifies the hidden problems in the value chain and reduces the production waste of the system while increasing the throughout

(Sales-Raw Material Cost). Even though the JIT system seems to be interesting and less complicated it requires lot of coordination with supply chain to avoid delays in the production schedule. This article discusses in depth the implementation of JIT manufacturing. The objectives are twofold. The first objective is to acquaint the reader with the overall JIT concept and the factors necessary for its implementation; the concepts presented here represent the ideal principles and methods of implementation [26]. Productivity is a fundamental concept in economic analysis. The evolution of mid-to-long-run economic growth — which is a crucial assumption of analyses, on fiscal sustainability, for instance — relies substantially on perspectives on productivity growth. Productivity is also important in the light of short-run economic dynamics. For example, when an economy grows, the desirable policy accompanied by a rise in productivity will be totally different from that without the rise. Considering monetary policy, immediate monetary policy tightening is not necessary if an economy grows with a rise in productivity and labor market conditions are not tight. By contrast, central banks should be cautious about economic growth without rising productivity, because economic bubbles and accelerated inflation are fairly likely to happen through economic overheating. While it is widely recognized that productivity is conceptually important, measuring productivity is quite difficult. One challenge in measuring productivity is that productivity measured in real time will be revised due to revisions to its source data. Objectives of Study

Justification of the work

A substantial number of workplace accidents are instigated through unsafe Acts and the unsafe conditions created by the employees in the work place. The employers need to be aware that further reducing accidents can only be achieved by identifying, examining and focusing upon such unsafe behavior or the At- Risk behavior. The steel industry is unique in the sense that it is capital intensive as well as labor intensive process with technology mix available in the industry. The literature review reveals that there is no enough research evidence from India about a comprehensive study in the area of Behavioral Based Safety that has been taken up in the specific sense of a multi-unit integrated steel plant in the public sector in India. In view of the above, a modest attempt is made to study the safety management to identify the need for implementation of Behavior Based Safety to enhance the total safety culture at RINL, Visakhapatnam Steel Plant, and Visakhapatnam for the implemented 6M's.
Finally this work is for enriching the productivity of the industries for 6M's using the Behavior Based Safety Management(BBSM) ,6M's are Man ,Machinery , Materials , Money , Methods and measurements .

A Behavior-Based Safety Management (BBSM) is a process through which work groups can identify, measure and change their behaviors. [It is a process that applies the principles of the **A**ntecedent **B**ehavior **C**onsequence (ABC) behavior model. This assumes that all behaviors have one or more antecedents or activators or prompts which initiate the behavior and one or more consequences that either encourage or discourage repetition of the behavior. Employees should caution co-workers when they observe them perform at risk behaviors. In simplistic terms it's an observation and feedback process that uses a continuous improvement technique called DO IT.

D – Define critical behaviors to improve while at work with 6M's
O – Observe target behaviors to set a base line to set specific goals for achievement
While at work with 6M's
I – Intervene to change target behaviors while at work with 6M's
T – Test the impact of the intervention while at work with 6M's

Therefore the justification of the objectives lied in improving the existing productivity levels for the 6M's with the best principles, policies, theories, practices, procedures and tools /techniques with the Behavior Based safety Management (BBSM).

Any simple, complex time. Wicked, defined and ill-defined problem could be solved .resolved or dissolved with the use of a validated and reliable product.

Research Methodology

The methodology for the present study comprises of:

1. Studying and understanding the Behavioral Based Safety Management and its relevance to the industries in India with reference to 6M's for enriching the productivity.
2. Studying the international perspective on Behavioral Based Safety Management with reference to 6M's for enriching the productivity.
3. Studying the profile of a steel industry in global& domestic perspectives w.r.t (VSP).
4. Studying the Safety Management Practices, the causes of various accidents and assess the Safety w.r.t Institute of Industrial fire &safety (IIFS).
5 Analyzing the perceptions of the respondents from the various levels of employees in Visakhapatnam Steel Plant in order to understand the existing management systems.
6. Suggesting the strategies and action programmers for further enhancement of the Safety Culture by implementation of Behavioral Based Safety Management at Visakhapatnam Steel Plant for the proposed management system.

Data – Collection / Data – Interpretation
Findings from VSP &IIFS and their effects towards 6M's and BBSM revealed the below mentioned:

From the study, it had been observed that in executive cadre 96.3 percent respondents are males and 3.7 percent are females whereas in non-executive cadre 99.1 percent are males and the remaining 0.9 percent is females. So it can be concluded that in VSP greater part of the employees are male while the female employees are less in numbers both in executive and non-executive cadre. It has been derived from the study that as the plant works round the clock and women cannot work in shift system as per the Factories Act 1948, women are more in administrative type of jobs in VSP. The dialogues were collected from all the genders immaterial of the nature of the work.

The study found that cadre-wise 97 percent of the executive respondents are married and the remaining 3 percent are unmarried whereas in case of nonexecutive cadre 98.6 percent are married and only 1.4 percent members are un- married. So, it has been observed that only a few employees are unmarried and a majority of the employees both in executive and non-executive cadre are married. This factor is important as it might have a lot of bearing in the attitude and behavior of the individual towards safety.

It had been noted from the sample that a majority of the employees were having 3 to 4 dependents in case of Non-executives cadre (60 percent) as well as in executive cadre (45 percent). The study finds that nuclear families are playing a major role in the present society. The predominance of nuclear family system was observed in the present study. It shows that the respondents were conscious of the adverse effects of large size families. Exposure to urban life made them to shed traditional and superstitious beliefs and more careful in observing family planning to have concise families.

The study witnessed that an overall of about 82 percent of the employees' spouse from both the cadres were not employed and hence this factor might not have any impact in our study. Educational qualifications are well as those associated with the variables of the safety culture dimensions do also matter a lot. The study reveals that almost all the employees are well educated except a small lot of 8 percent in the non-executive cadre who have done below Intermediate. From this analysis related to educational background of the respondents of the sample study, it is observed that the level of education varied according to the requirements of job.

It is evident from the study that a majority (83 percent) of the employees were of above 40 years of age in both executive cadres as well as in the non-executive cadre. This factor was very important as this had a lot of bearing in the attitude and behavior of the individual towards safety.

The study make it clear that more than 70 percent respondents from executive cadre were living below 10kms from the plant and that the executives were living very nearer to the organization when compare to Non-executives.

The study showed that 67.7 percent respondents from executive cadre and 78 percent from non-executive cadre were coming by motor cycle. The mode of transport is an important factor as far as the employees' behavior while driving and the road safety is concerned.

From the study, it had been concluded that the employees of Visakhapatnam Steel Plant were paid good salary and the payments were according to their cadre, qualification, and work experience in the organization while taking other aspects into consideration. Besides the monthly income the employees were provided with incentives based on monthly production targets which motivate the employees to increase the productivity.

It had been noted from the study that in the non-executive cadre a majority (68.3 percent) were doing field work whereas the majority (63.4 percent) of executive cadre do both office and field works. So, it could be found that the majority of the employees in VSP&IIFS work at the site in the shop floor.

From the study it had been observed that a majority (70 percent) of the employees had more than 20 years of experience from both the executive cadre and non-executive cadre.

The study showed that a greater part of the employees were from 85 percent of the respondents from both the executive and non-executive cadre were either from town/taluk or from village/panchayat during their childhood. This shows that the employees of VSP might be having high values and ethics towards the work.

The study had witnessed that the average value of safety behavior was greater than the remaining dimension followed by team work which divulges that on these two dimension respondents' opinion is more positive than the remaining dimensions. Then it was followed by the average value of Safety Compliance, Safety Awareness / Communication Safety Commitment and Stress Recognition were also the criteria for the productivity.

The study found that from the overall opinion of the respondents on the dimension safety commitment is high at Visakhapatnam Steel Plant. It can be conveniently concluded that the safety practices followed was up to the satisfaction of the employees. As Visakhapatnam Steel Plant is a public sector organization which gives much importance to safety measures, more than 60 percent of the respondents of the total sample agreed with the statements in the dimension safety commitment at Visakhapatnam Steel Plant that is the vital aspect of safety in any organization. However, in some areas it is found that whether the Senior Managers seem interested in health and safety before an incident / accident happens, the response is negative and some were silent about their answers. Also the neutral answer is more in numbers in case of accidents investigation and follow-up measures, Safety Committee and Safety audits / inspections also effect the productivity.

From the study, it was asserted that the overall safety compliance at Visakhapatnam Steel Plant was prompt and to the satisfaction of its employees. But, it was to be noted that here also almost a quarter 25 percent of the responses are neutral that were related to workplace incidents / accidents and near misses reporting , work environment viz. noise, dust, heat and vibration , SPOC i.e. Specific Point Of Contact system and seriousness of liquidation of safety related issues raised in various audits / inspections .

The study had revealed that the overall opinion of the respondents on the dimension Safety Awareness / Communication was positive and interested to note that the safety awareness of the employees at VSP was well. However, it is worth noting that the responses were neutral in both the cases of information on type, cause and recommendations of accidents to employees and imparting new training based on any accident.

The study exhibited from the opinion of the respondents on the dimension safety behavior that optimistically responded towards the said dimension. About 30 percent given neutral on timely identification of hazards and correction of Safety and health issues which perhaps indicates that the employees are not interested in revealing the facts. Also it is to be noted that about 85percent of the respondents opined that observing both the safe / unsafe behavior of individuals and giving them feedback will improve the safety levels in the plant and rewards and incentive for safe performance would cause employees to work more safely.

It had been observed from the study that VSP recognizes employees' stress. It can further be stated that there exists a healthy co-operation and co-ordination between the management and its employees.

The study had revealed that the overall opinion of the respondents on the dimension team work and conveys that a healthy percentage of respondents had perceived the aspects of the dimension positively. From the majority assenting opinion of the respondents, it may be concluded that the ambience at the Plant is conducive to team work as it fosters a sense of unity among the employees. It can be found that in the dimensions safety behavior, stress recognition and team work the difference are found to be statistically not significant In the remaining dimensions such as safety commitment, safety compliance and safety awareness / communication, the perception of the respondents belonging to executive cadre is greater than the non-executives; this may be due to the awareness of non-executives cadre in these areas are less when compared to executive cadre. So, it may be conveniently concluded that the majority of the respondents attend the safety training for academic purpose only.

The study divulges that there is no significant relationship between the dependent variables Safety commitment, safety compliance, safety awareness / communication, safety Behavior, stress recognition and team work with the independent variable number of dependents, but the relationship is negative.

The study revealed that there is no significant relationship between the dependent variables related to safety management practices with the independent variable educational qualification i.e., as the education level increases the opinion of the respondents on these dimensions are not significantly increased. Further, there is a positive relationship between dependent variables safety commitment, compliance, communication and overall with the independent variable education whereas the remaining dependent variables have negative relationship between them.

From the study, it had been found that except the variable stress recognition, suggested that as the salary increases the opinion of the respondents on dimensions related to safety culture are increased statistically. Whereas for the stress recognition it could be concluded that as the salary increases the opinion of the respondents on this dimension decreases but the decrease is not statistically significant. It had been found that there is no significant correlation between the dependent variables with the independent variables in experience.

From the study, it was evident that the average opinion scores of all the four positions on the dimension safety commitment have no significant difference. Further, the average opinion score of the respondents belongs to below supervisory position is less than the remaining three positions. The average opinion score of the respondents from senior management is greater than the remaining three positions which concludes that the respondents belongs to this position has more positive opinion on this said dimension when compare with the remaining position.

It had been observed that the perception of the respondents on the aspects of safety awareness / communication at the plant is positive i.e. the employees are satisfied with the system of awareness / communication and training in the area of safety. The average opinion of the respondents from senior management is greater than that of the remaining three positions i.e. below supervisory level, front line management and middle management.

It had been revealed in the study that the respondents among the four positions chosen for the study on team work are positive. Besides this, the average opinion score of the senior management is greater than the remaining three positions followed by front line management.

The study indicated that there is a significant difference between the average opinions scores of the respondents belongs to all the four positions on the factor related to safety management practices. It is observed that the opinion score of the senior management is greater than that of the remaining three positions, which indicates that the senior management are more satisfied with the aspects of safety management practices facilitated by aegis when compared with the remaining three positions.

It may be found that the average opinion scores of the respondents of all types of jobs indicate a positive orientation. This implies that safety commitment at Visakhapatnam Steel Plant is somewhat effective and employees are satisfied. Further, the study clearly suggests that the respondents doing both the types of job.

The study indicated that there is a significant difference between the average opinion scores of the respondents belongs to all the three types of jobs they are doing on the dimension of safety compliance. It is observed from the above that the average opinion score of the respondents who were doing both office and field work is greater than that of the remaining two.

The study reveals that the average opinion score of the respondents who were doing both types of jobs is more when compare with the remaining two.

From the study it can be observed that the occurrence of accidents at the plant for has been on the decline. It can be inferred from these details that the management of VSP is very keen on reducing the accidents in the organization and this expounds the sincerity of the organization in the effective implementation of safety measures. It is also found from the secondary data in the study that the frequency of accidents had been reducing.

From the accident statistics of VSP, it is observed that the maximum numbers of accidents are on account of general safety and particularly on housekeeping aspect.

The study revealed that the Plant is providing good safety measures as such the accidents occurred are less and most of them are minor accidents. A look at the Secondary data reveals that VSP has drastically reducing the severity rate in accidents that occurred in the organization.

The study concluded that the safety inspections and effective implementation of safety inspection points will definitely improve the safety at shop floor. OHSMS: 18001 ensure the regular safety inspections at shop floor and its compliance report. Conducting safety inspections by appropriate authority is a healthy sign because they will identify the major and minor unsafe conditions in the department. As such the study concludes that in VSP, routine safety inspections are being conducted by an appropriate authority.

The study found that the employees at VSP are mostly helpful, friendly and courteous with each other in discharging their duties. This may be one of the reasons that the Plant is progressing in all dimensions. It could be concluded that among the work force of VSP, there is a better

understanding and everyone respects each other. This is because of the changing environment in the present industrial scenario with high education, morals, etc. people are developing good attitudes towards others. From the above study, it could be concluded that the employees of the plant share a healthy relationship.

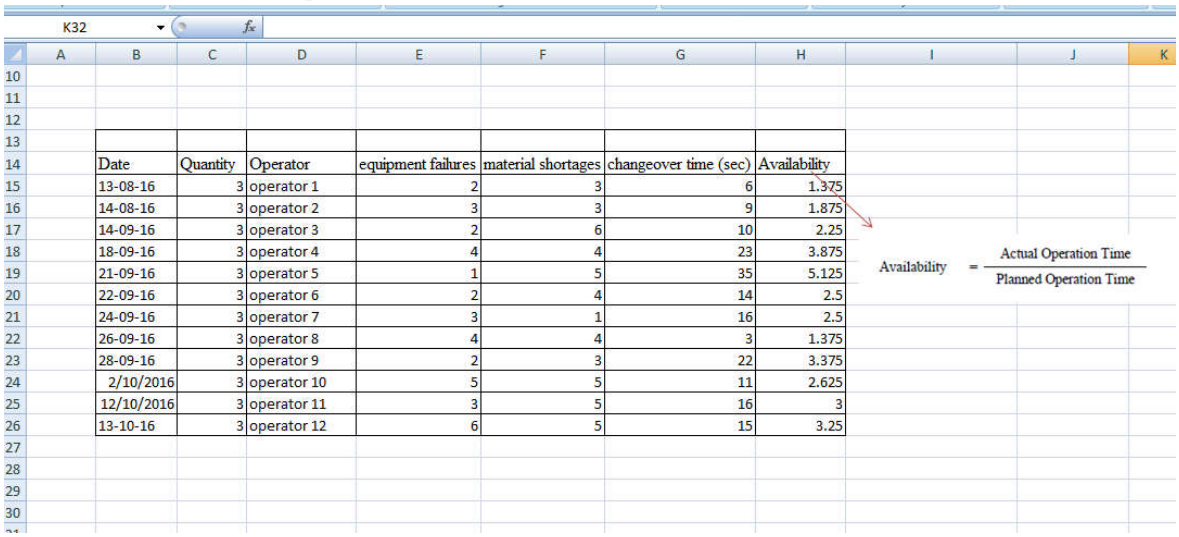
It may be concluded from the majority opinion of the respondents that the employees of the Plant are aware of the fact that being hurry in a work leads to accidents. And this awareness among the employees of the organization will certainly help in mitigating the accidents. If this tendency in the employees prevails, the organization will better its goal in the safety aspects very soon. The opinion of all the respondents on this aspect is more or less similar.

It may be concluded that the management of Visakhapatnam Steel Plant conducts meetings on safety at regular intervals to ascertain safe working atmosphere to its employees. It can be inferred that the employees at VSP take active participation in the decision making process on safety measures. In VSP there are lots of committees on different safety activities like; shop floor safety committee, central safety committee, incident enquiry committee, safety inspection committee, internal audit on safety, safety week celebration committee, etc. and most of the employees are involved in one of these safety committees. As such the participation of employees in decision making on safety measures is considerably high.

Data –Analysis / Data- Validation

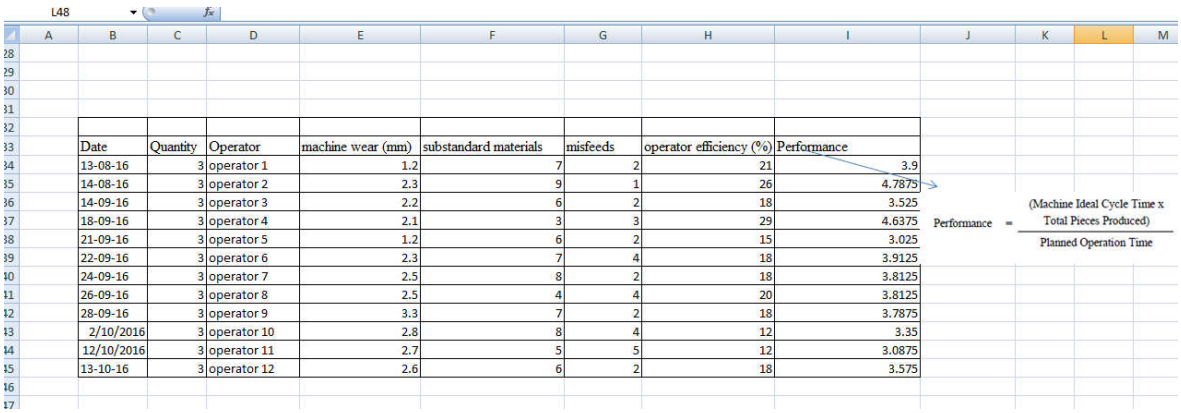
Sample Calculations to measure 6M's with BBSM that are connected with this kind of work are as mentioned below:

Data about availability and performance:



Date	Quantity	Operator	equipment failures	material shortages	changeover time (sec)	Availability
13-08-16	3	operator 1	2	3	6	1.375
14-08-16	3	operator 2	3	3	9	1.875
14-09-16	3	operator 3	2	6	10	2.25
18-09-16	3	operator 4	4	4	23	3.875
21-09-16	3	operator 5	1	5	35	5.125
22-09-16	3	operator 6	2	4	14	2.5
24-09-16	3	operator 7	3	1	16	2.5
26-09-16	3	operator 8	4	4	3	1.375
28-09-16	3	operator 9	2	3	22	3.375
2/10/2016	3	operator 10	5	5	11	2.625
12/10/2016	3	operator 11	3	5	16	3
13-10-16	3	operator 12	6	5	15	3.25

$$\text{Availability} = \frac{\text{Actual Operation Time}}{\text{Planned Operation Time}}$$



Date	Quantity	Operator	machine wear (mm)	substandard materials	misfeeds	operator efficiency (%)	Performance
13-08-16	3	operator 1	1.2	7	2	21	3.9
14-08-16	3	operator 2	2.3	9	1	26	4.7875
14-09-16	3	operator 3	2.2	6	2	18	3.525
18-09-16	3	operator 4	2.1	3	3	29	4.6375
21-09-16	3	operator 5	1.2	6	2	15	3.025
22-09-16	3	operator 6	2.3	7	4	18	3.9125
24-09-16	3	operator 7	2.5	8	2	18	3.8125
26-09-16	3	operator 8	2.5	4	4	20	3.8125
28-09-16	3	operator 9	3.3	7	2	18	3.7875
2/10/2016	3	operator 10	2.8	8	4	12	3.35
12/10/2016	3	operator 11	2.7	5	5	12	3.0875
13-10-16	3	operator 12	2.6	6	2	18	3.575

$$\text{Performance} = \frac{\text{(Machine Ideal Cycle Time x Total Pieces Produced)}}{\text{Planned Operation Time}}$$

Data about machineries:

Data distributed in table 1 shows the performance of a machine. By inserting these data into formulae discussed in the previous section. Detail breakdowns affecting the machine can be visualized. Analyzing the data shown in table 1 clearly indicated that the overall equipment effectiveness of the machine used as the test bed is at 20.75%.

From table 2, the machines availability is at 83.96% followed by quality of parts produced is at 57.89 % and the worst is on the machine performance at 42.70 %. Based on the collected data, it is very clear that none of the factors have compiled the set targets. This implied that the true performance of the machine is at a very poor condition and if necessary measures are taken by the responsible personnel, then the improvement could be seen by the management. Stage by stage all the figures in this factors can be corrected to improve efficiency of the machine. Once the factor of OEE is broken down into categories, analysis is simplified by tracing the crucial factor affecting the machine.

OEE Factor	Actual OEE	Target OEE
Availability	**83.96 %**	85.00 %
Performance	**42.70 %**	90.00 %
Quality	**57.89 %**	95.00 %
Overall OEE	**20.75 %**	73.00 %

Table 2: Data on machine overall efficiency

Data about man power:

Table 3 shows the actual performance of the operator on a certain shift is 22.35%. Based on this, the management could optimize their human capital. From the data collected in table 3, the management can easily trace the major contributor for unmet targets. The management can also differentiate table 2 with table 3 for more details analysis to identify the root cause of the unmet targets.

Factor	Calculated Data		Performance
Man Power Utilization	(19 x 3) / 445 - (19 x 10)	=	**22.35 %**

Table 3: Data on man power utilization

Data from supporting Departments:

Table 4 shows the individual performance of all the supporting departments involved in the Production process on a particular shift. The actual performance of the production planning and control departments and others is at 100%. The actual performance of the maintenance department is at 98.11% and the highest down time contributor is the total quality management department which is at 85.85%. Such valuable information in table 4, will be sufficient for the management to attempt on rational actions to ensure improvements can be seen on the process line. After analyzing each factors, the process line operator is clearly the major contributor towards the unmet target. The second crucial factor is the machine on the process line which is far below the bench mark set by the management on each factors under OEE which also contributes towards the unmet target. The rejection rate of the parts produced is also high and this indicates that the machine on the work station is not properly calibrated or the standard operating procedure (SOP) is not complied by the operator.

Department	Calculated Data		Performance
Total Quality Management	530 – 75 / 530	=	**85.85 %**
Production Planning & Control	530 – 0 / 530	=	**100.00 %**
Others	530 – 0 / 530	=	**100.00 %**
Maintenance	530 – 10 / 530	=	**98.11 %**

Table 4: Data on supporting documents

Understanding each of these factors helps the management to improve factors affecting unmet Targets. Such data should also assist management in optimizing their usage of man power and machines efficiently. Actions should be taken to remedy the faults of each section in order to meet a better target and yield.

Therefore it could be summarized and concluded from the above data that there are quite a good chance that the productivity could be improved when the 6M's are dealt from all the angles of the BBSM.

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2. Behavioral Science Technology, Inc., 417 Bryant Circle, Ojai, California, USA. 93023: toll Free 1-800-548-5781; fax 805-646-0328; Internet at www.bscitech.com; email bstojai@bstsolutions.com.

3. Liberty Mutual at web page www.libertymutual.com/business/safety/performance.

TRAINING RESOURCES

1. Associated Training, Educational and Consulting Services Ltd., 69 Geneva Crescent, St. Albert, Alberta, Canada. T8N 0Z3. Phone 780-459-2128; fax 780-459-2084 –-Behavior Based safety: Getting Started.

2. Sarnia - Lambton Industrial Educational Co-operative, 252 Chippewa Street, Sarnia, Ontario Canada. N7T 8A9. Phone 519-337-5935; fax 519-3830-1305; email iec@ebtech.net – Behavior Based Safety Training, Course I.D. – BBS.