IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, June 2024

Improvement of Safety Culture in Steel Manufacturer Industries by using Behavior Based Safety

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Abstract: *Behavior based safety plays an important role to minimize the accident due to unsafe behaviors in the workplace in the organization. It is evident from the past accidents that 88% of mishap is due to the unsafe act in the organization and reducing the accident is quite challenging. Behavior of the employees changes in the workplace, though the rules and procedures are enforced in the organization. Behavior safety maturity of the employees varies in accordance with the standards, risk management, communication and involvement of the employees. This paper describes about the assessment of maturity level of the employees in biscuit making process based on four different themes such as standards, risk management, communication and involvement. The maturity level is assessed by paper-based survey for the group of 165 employees whoever is involved in repeated violations in the biscuit making process. The gap in the expected behavior is identified and necessary corrective action is provided to bridge the gap of expected behavior among the employees.*

Keywords: Behavior based safety, Risk management, Mishap, Corrective action, Maturity level, BBS Training and Orientation & Expected Outcomes etc.

I. INTRODUCTION

In the ancient period the accidents were considered as act of God and there was no efficient technique to identify the reason for the accidents and incidents in the industry. In the year 1931 Heinrich theory came into existence from which it is clear that 300 no injury case will lead to29 minor injuries and 1 major injuries. Also, it is evident from Heinrich theory that 88% of the accidents are due to unsafe act in the industry. Behaviour based safety plays an important role to minimize the accidents and incidents in the workplace. So traditional safety is not effective to reduce the accidents, hence behaviour-based safety concept came into existence in the 21st century. Behaviour based safety deals with the conduct of the individual in the workplace. The behaviour of the people is observed in the workplace and on the spot coaching is given to the people to avoid injury due to at-risk behaviour. It is important to have constant follow up bythe management towards behaviour-based safety to change the at-risk behaviour to safe behaviour in the workplace.
The accident rate in current study is due to unsafe behavior of the employees in the workplace. All the injuries that are happened in the past are due to repeated violations by the employees at all levels such as workers, supervisors and managers. Though there are certain system gaps in the workplace, the violations of the workers are high and there is lack of supervision by the officers.Hence the Behavior based safety maturity level assessment is carried out to know the Behavior-based safety understanding of the employees in the organization.

II. BEHAVIOUR THEME

Heinrich theory says that 88% of accidents in the industries are due to unsafe act and this fundamental theory is used to design the behaviour-based safety model. The behaviours of the employees are assessed by categorizing them at different levels under different themes. The four important behaviour themes which talks about the interdependence are standards, communication, risk management and involvement.

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Fig 1: Interdependence of behavior

III. AIM, OBJECTIVE AND SCOPE OF RESEARCH

The aim of the project is to prevent the work place accidents and to eliminate workplace incidents.
Objective of the project are the:

- To identify the gaps in Behaviour Based Safety.
- To designate a plan to improve the system with respect to Behaviour Based Safety.
- To check the effectiveness of the plan by conducting the BBS survey.
- Scope of the Research is Safety culture and capability enhancement to prioritized zones (packing, baking, mixing and pre-mixing) in steel plant industry.

IV. SYSTEM DOMAIN

This theory chapter will cover the basics of process developed in the industry by taking a steel plat casting as the casting process will simplistically be described. The process then follows theory about simulation methodology, input data management, Generic and specific modeling with boundary objects.
Casting for steel plate manufacturing is one of the oldest manufacturing processes and has been used for more than 5000 years. From the beginning it was things for decoration and jeweler, mostly made of bronze that was casted. The use of casted products has since then increased dramatically and is used in several industries. Due to the heavy automotive industry, Sweden is one of the countries that per capita use most casted products. Generally, there are two kinds of casting, casting done with permanent molds and casting done with one-time molds. The method of interest for this thesis is casting in one-time molds and more specifically, sand molds. In this process, the mold and eventual core is made out of sand, the sand is mixed with a binder to "glue" the grains together and to gain a more stable structure. The sand is then poured onto a pattern, which is a model of the desired product and pressurized to create a steady mold with a cavity in the shape of the pattern. Figure 2, represents an overview of the casting process. All processes will be described after the figure

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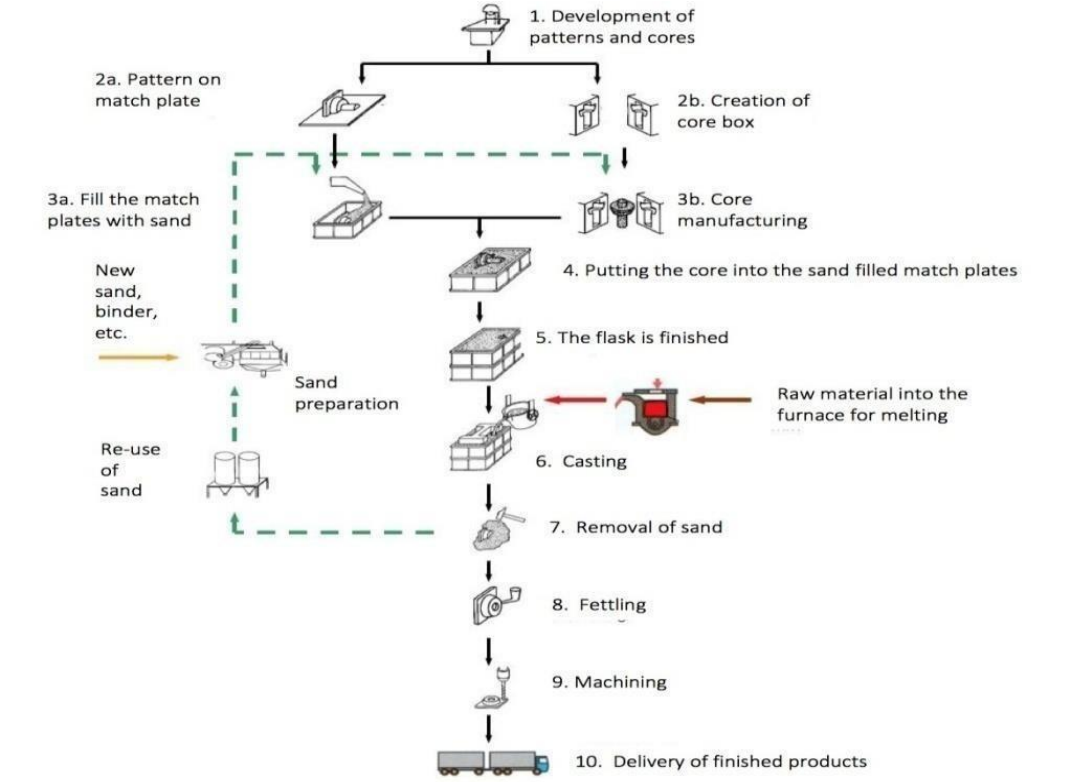

Figure 2 the production flow of casting

V. PROBLEM DESCRIPTION

Identification of Hazards and risk to the health Activity / Hazards & Risks Analysis is conducted for all activities considering followings:

5.1 Listing of activities/ processes in the company.

Involving skilled/ regular / contract workers depending upon the activities.

Studying of their activities / behavior / reactions.

5.2 Whenever new processes / activities are introduced or any of the existing process / activities is to be altered then the impact of the change is reviewed before incorporating the change. In addition once a year HIRA is reviewed to identify the changes.

5.3 While identifying OH&S hazards and risks following issues are considered.

All routine & non-routine activities.

Activities of all personnel having access to the work place (including subcontractors and visitors).

Human behavior, capabilities and other human factors.

Identified hazards originating outside the workplace capable of adversely affecting the health and safety of person in the organization/within the workplace.

Hazards created in the vicinity of the workplace by work related activities.

Infrastructure, equipment and materials at the workplace whether provided by the organization or others.

Changes or proposed changes in the organization, its activities or material.

Modifications, including temporary changes and its impact on operation, processes and activities.

Legal requirements related to activities performed and related controls.

Design of work areas, processes, installation, machineries / equipment, operating procedures and activities performed including their adaption to human capabilities.

Investigation results of previous incident, accidents.

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Feedback, suggestion, observation from workmen or any person

5.4 Type and condition of job

Routine: Done by usual/ regular method of procedure.

Non Routine: Unusual/non-regular method of procedure.

Normal Condition: Risks converted to tolerable condition by way of engineering control or by using PPE.

Abnormal Condition: Deviation from normal condition, which requires immediate attention.

Emergency Condition: Hazards and Risks, which are contained or mitigated by invoking emergency procedures.

5.5 Evaluation of Occupational Hazards & Associated Risks to Health and Identification of Significant Occupational Health Hazards & Risks

Probability of occurrence

Severity rate

Hierarchy of controls

Table 1 Probability of Occurrence

Rating	Description	Examples of Description
5	Almost certain	Event occurs often and constant exposure to hazard. Very high probability of damage.
4	Likely	Event might probably occur and known history of occurrence. Frequent exposure to hazard. High probability of damage.
3	Possible	Event could occur at some time and history of single occurrence. Regular or occasional exposure to hazard. Moderate probability of damage.
2	Unlikely	Event is not likely to occur and known occurrence. Infrequent exposure to hazard. Low probability of damage.
1	Rare	Event may occur occasionally and no reported occurrence. Rare exposure to hazard. Very low probability of damage.

Table 2 Severity Rate

RATING	INJURY/ERGONOMICS ISSUES	NOISE	TEMPERATURE/HEAT	FUMES/VAPOUR & GASES	DUST
1	First aid cases	51 to 74dBA	Frequent Perspiration at work	Odour, itching	Sneezing, cough
2	Minor injury/Cuts, Return back to work within 24	75 to 84dBA	Heat Stroke (Mental or psychological strain or transient Heat Fatigue)	Suffocation, Respiratory tract damage, Eye irritation Sneezing, Temporary Headache	Prolonged exposure / Temporary Headache, eye or respiratory tract irritation
3	injury, Fracture, Back/Lumbar pain, Exceed more than 24 hours to return	85 to 94dBA	Heat Exhaustion (Unconsciousness or Fainting , Eye disorder , Nausea & vomiting)	Unconsciousness, Faint or collapse, Vomiting	Unconsciousness, Faint, Eye disorder , Vomiting
4	Laceration, Permanent Damage, Burn injury	95 to 104dBA	Heat Cramps, Throbbing Headache, Sweating/ perspiration	Prolonged exposure , Chronic Respiratory failure or other occupational diseases	Major Health impact which leads to chronic Respiratory
5	Fatal or Death	>=105dBA	Heat Stroke / Exhaustion lead to death or permanent damage	Over exposure which may lead to immediate death	Over exposure which may lead to immediate death

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Table 3 Other Conditional Criteria to Evaluate the Risk

a	The combined score (multiplication) is calculated for each Hazard. If the score is 6 or less then it is considered as **Acceptable risk Area /Activity.** If the score is above 6 it is considered as **Unacceptable risk Area/Activity.**
b	In addition to this any of the risk having severity / probability rating as "4" or 5 will also be considered as **Unacceptable risk Area/Activity.**
c	All legal issues related to work are identified, listed and considered for all maintaining required controls.

VI. METHODOLOGY

6.1 Corrective action and Preventive action (CAPA):

Steel plant has a program for PII (Personal Identifiable Information) reporting, each department are required to report the safety violation which they happen to observes in the workplace. PII reporting includes all the unsafe act, unsafe behaviour, unsafe condition, near miss incident, notable incident and all major and minor incident on a regular basis. This PII reporting are then complied into a monthly Corrective and Preventive action (CAPA) report. To conduct the Behavioral Based safety survey, a minimum of 10 percentage of the workers were to be selected and surveyed and if it happens that the10 percentage of the workforce excluding the officers and managers comes out to be less than 100 members than at least 100 workers were to be surveyed along with the all the officers and managers to needs to be surveyed. Since Manna factory total workforce is more than 1000, so its 10 percentage would be 100 workers so keeping that in mind top 100 violators were selected after conducting a detail analysis of Corrective and Preventive (CAPA) report for the year 2021-2022.

Current study in a plant has total of 7 managers and 28 officers so the total candidate pool for the survey came out to be 165. Everyday pool for survey was decided as per the availability of the employee and the survey was conducted. The BBS survey sheet consists of set of behaviour which all the employees expected to follow. Keeping those behaviour in mind few sets of questions were designed and were asked to the candidate of the survey. Based on their response scoring was done for them.

Following marks were awarded to them like 100 for those whose response matches the requirement and are considered to follow those behavioural "always", 75 for those who "usually" follows those rule, 50 for those who follows mentioned rule "sometime" and finally 25 for those who "never or seldom" follows the mentioned behaviour. After survey is completed, the one who is conducting the behaviour needs to choose any one behaviour out of all the mentioned behaviourwhich has a scope of improvement, and he also needs to mention the reason for why that specific behaviour was selected, so that it gets highlighted and a corrective action plan can be developed for it.

6.2 DMAIC six-sigma approach:

The methodology adopted for this project is DMAIC. DMAIC is a six-sigma approach which is majorly used in the implementation programs in an organization

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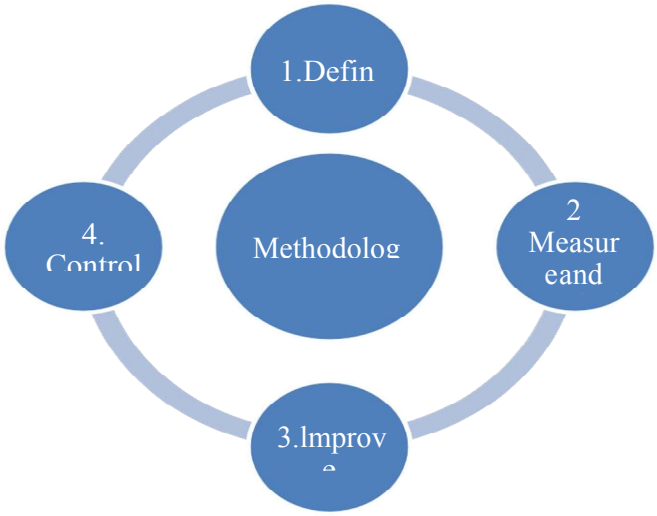
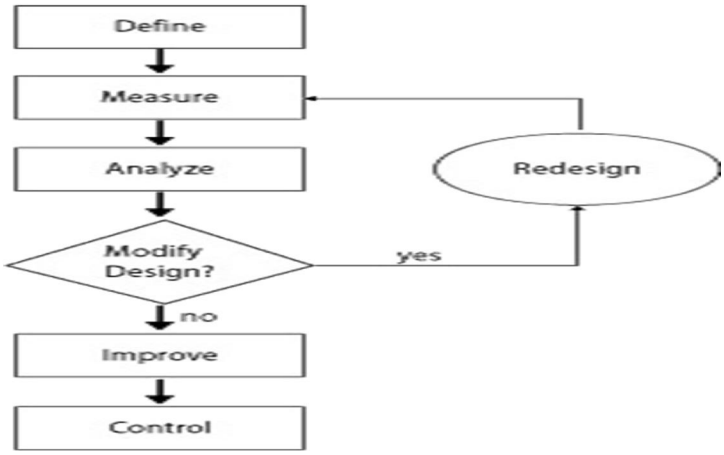


Figure 10: BBS Survey methodology

Table 11: Depicts Behavior Based Safety Implementation by DMAIC approach

Define	Aim and objective (Problem to be solved)
Measure and analyses	Prioritization of zones, Identification of area owners, conducting BBS survey, and identification of BBS gaps
Improve	Designation of appropriate action plan for the gaps identified and appropriate CAPA for the survey inferences.
Control	Area wise BBS check tracking



Flow Chart: 1 DMAIC Process

VII. TECHNIQUES IMPLEMENTED AND ANALYSIS

7.1 BBS Zoning

Once our work force reaches to their respective work stations the "Behavior Zoning" on the machines or the work stations is the second communication to the workers regarding the expected safe behaviors to be performed by them.

The "Behavior Zoning" is a concept of highlighting the risks on the machine and informing the work force the wrong methods to avoid and the correct method to carry out those riskyactivities.

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Three different ways are identified to perform the BBS zoning. They are:

- BBS Zoning
- Safety flag
- Ideal flight path

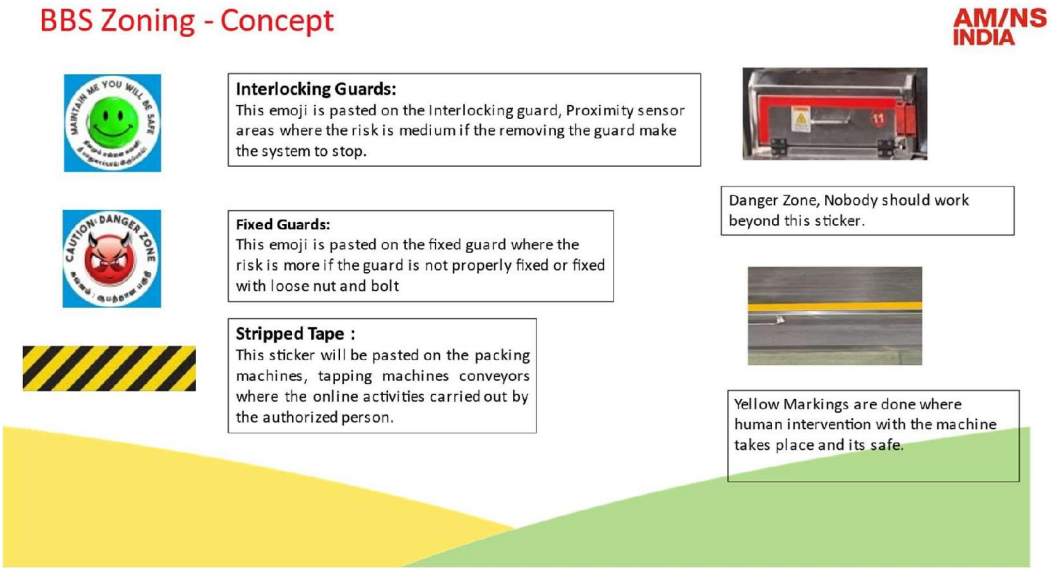

Figure 11: Stickers to represent BBS Zoning

Figure 12 : Sample Pictures of BBS Zoning on machines

7.2 Safety Flag:

Safety Flag when placed on any equipment describes that particular equipment is prone to accidents. It basically indicates that the particular equipment is dangerous to use, so by placing the safety flag the CL or the operator who is working with the equipment will be more cautious and this will help in reducing the chance of occurrence of accidents. In order to identify the Specific equipment's where previously the accidents have been occurred, I have referred the past 5 years accidents data of AM/NS which were mentioned in a safety alerts book. By critically examining them I have identified the below mentioned Equipment's as more dangerous.

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Fig 13: Sample image of safety flag

7.3 Ideal Flight Path:

Ideal Flight path is the concept of making all the different things/equipment's to be placed in a fixed path. The main objective of ideal flight path is to control the slips, trips in the workplace.

Below mentioned are Ideal flight paths identified in the mixing, forming and oven, Packing, S&F and RM store areas.

7.4 BBS Training & Orientation Program

Benefit of Implementing Behaviour Based Safety Training at Workplace: -

Improve employee health and welfare.

Increase job satisfaction.

Improve employee retention rates.

Lower or eliminate cost of worker's compensation claims.

Reduce costs related to employee medical leave and absenteeism.

Extreme Focus on efficiency and capturing and delivering value

7.5 Outcomes of Behaviour Based Safety Training: -

Self-assessment and introduction to safe work ethics.

Determinate how Culture, experience and attitude affects behaviour.

Critical behaviour and safety discussion.

Benefits of Behaviour based safety program.

Kick-off activities and its effect at workplace.

Know about peer attitudes and unsafe conditions.

7.6 Following the identification of a hazard, evaluation of work practices and conditions must be undertaken so that effective prevention and control measures can be implemented. This should be considered an integral part of management's responsibilities. The following hazard and evaluation including their protection was evaluated in the company by doing proper analysis by me.

Evaluation

Monitoring

Exposer standards

Control measures

Elimination/substitution and process modification;

Engineering controls;

Administrative controls; and

Use of personal protective equipment.

Preventing physical injuries

Mechanically propelled vehicles or machinery should be inspected regularly, kept in efficient working order, and operated only by trained personnel.

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Maximum loads for winches, hoists, lifts and cranes should be clearly marked on the equipment. These maximum capacities must never be exceeded.

Contact between molten metal and water must be avoided. All ladles and other equipment used for handling metal should be completely dry before contacting molten metal.

Work areas should be checked regularly to ensure that good housekeeping practices are being followed.

Any defective equipment should be repaired immediately or removed from service.

Floors around furnaces should be of slip-resistant, non-combustible material, kept free of obstructions and cleaned regularly.

Operating instructions for each furnace should be clearly displayed in the furnace area and issued to the person responsible for the furnace.

Suitable protective clothing and equipment, including eye protection such as goggles, should be worn by furnace operators. This clothing and equipment should comply with the relevant Australian Standards.

Eye protection should be required in all metal cleaning/dressing areas and should comply with the relevant Australian Standard.

Barriers or other suitable shields against molten metal splashes should be installed where necessary.

Persons should be prohibited from entering furnace areas when the temperature exceeds 50°C, except in cases of emergency.

Foundries should be equipped with safety blankets, automatic emergency showers or hoses to extinguish burning clothing.

Adequate lighting should be provided in all working areas in accordance with
Australian Standard AS 1680.

When machinery or equipment is being cleaned or maintenance carried out, lock-out devices or procedures should be employed to prevent the starting of the equipment

Workers who cannot be protected against falls from heights in any other way should be protected by wearing approved safety harnesses and lifelines.

Self-contained breathing apparatus must be used in emergencies when high carbon monoxide concentrations are suspected.

Personal protective equipment-PPE

In certain circumstances, personal protection of the individual may be required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures. Personal protective equipment must be appropriately selected, individually fitted and workers trained in their correct use and maintenance. Personal protective equipment must be regularly checked and maintained to ensure that the worker is being protected

Education and training

All employees working with foundry hazards must be informed of the hazards and the precautions necessary to prevent damage to their health. Employees exposed to contaminants should be trained in appropriate procedures to ensure that they carry out their work so that as little contamination as possible is produced, and in the importance of the proper use of all safeguards against exposure to themselves and their fellow workers. Adequate training, both in the proper execution of the task and in the use of all associated engineering controls, as well as of any personal protective equipment, is essential. Employees exposed to contamination hazards should be educated in the need for, and proper use of, facilities, clothing and equipment and thereby maintain a high standard of personal cleanliness. Special attention should be given to ensuring that all personnel understand instructions, especially newly recruited employees and those with English- language difficulties, where they are known. Material safety data sheets should be obtained for all substances from the suppliers of such materials before handling. A management representative should be nominated as responsible for personal protective equipment supply, maintenance and training.

Health assessment

In some occupations, health assessment may form part of a comprehensive occupational health and safety strategy. Where employees are to undergo health assessment, there should be adequate consultation prior to the introduction of

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any such program. Where medical records are kept, they must be confidential. It is particularly valuable to be able to relate employee health and illness data to exposure levels in the workplace

VIII. RESULT, CONCLUSION AND RECOMMENDATION

8.1 Survey response (everyone):

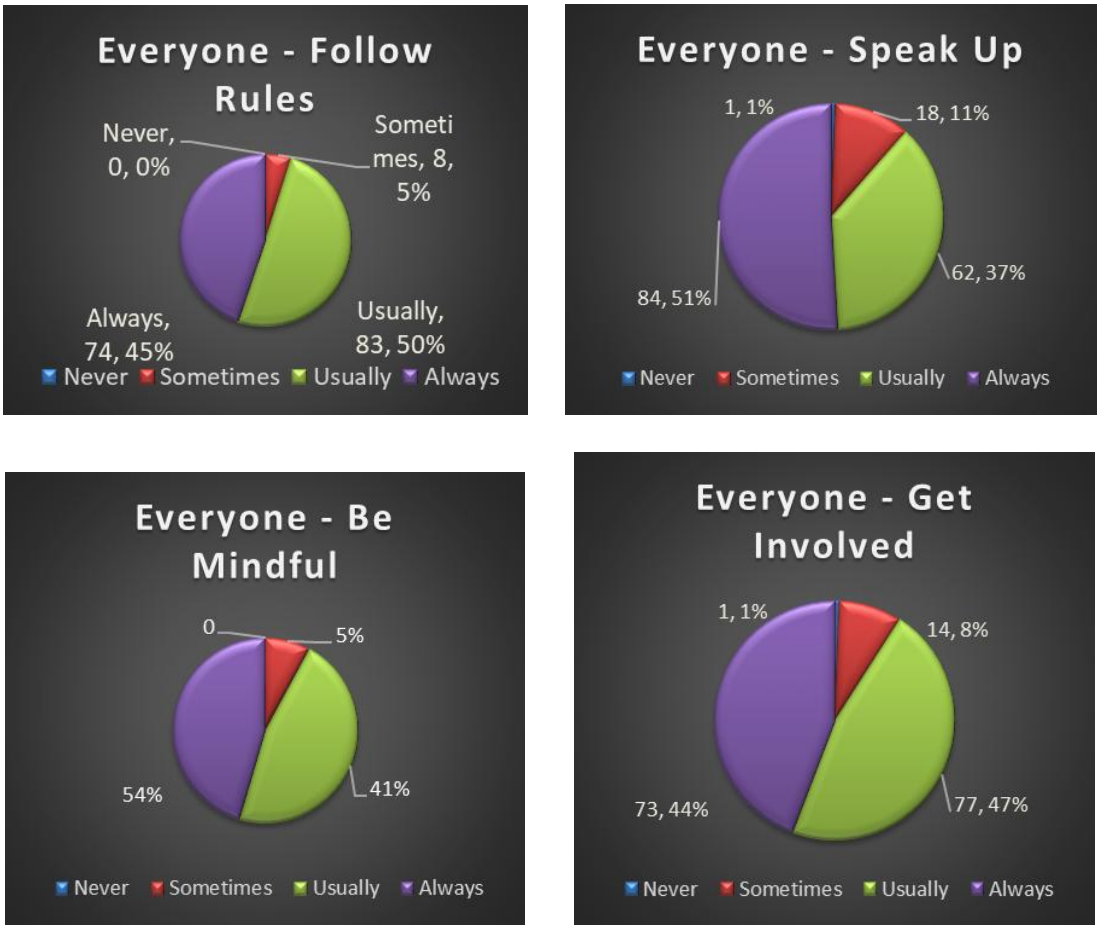

Fig 15: Survey response everyone

Under everyone category there are four expected behaviours such as follow rules, speak-up, be mindful and get involved. From the survey response it can be concluded that 45% of workers and operators always follow rules in their workplace but remaining 55% follow rules at times or occasionally. Under speak-up category 51% of the workers always communicate their problems and ideas to the immediate supervisor's, remaining 49% falls under the frequency of at-times and sometimes. Only % are always mindful in their job in site and only 18% are always involved in the team, 54% of workers are involved in the team only 46% of the time and remaining 44% of the workers involve in the team only 56% of the time in the workplace

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8.2 Survey response (supervisors):

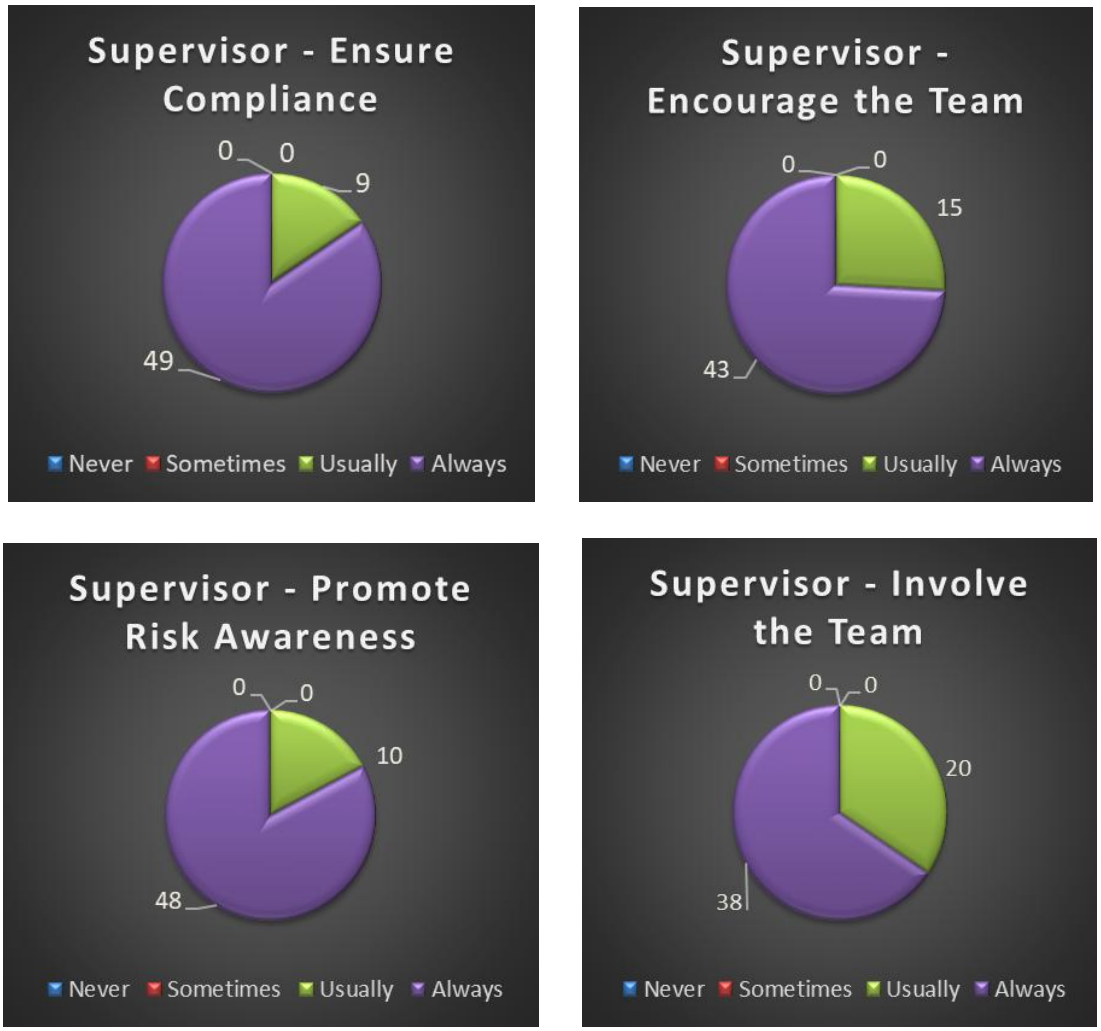

Fig 16: Survey response Supervisor's

Under supervisor category there are four expected Behaviours such as ensure compliance, encourage the team, promote risk awareness, and involve the team. Out of 58 only 9 supervisors are not able to adhere to the expected behaviours under ensure compliance. Supervisor's contribution in encouraging the team is only 43 of them motivate their team and remaining 15 of people are not able to motivate their team members always. Coming to the promoting the Risk awareness 48 Supervisors strictly follows and remaining 10 supervisors are not able to do always. Supervisor's contribution in involving the team is significantly lower when compared to all other as only 38 supervisors' follow out of 58.

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8.3 Survey response (manager's):

Fig 17: Survey Response Manager's

Almost all the managers are following the four expected behaviours Set high standards, Pro actively involve, communicates openly, Confront risk

8.4 BBS Maturity score and Inferences with CAPA and Timeline:

The BBS maturity score that was finally finalized and formulated is as follows,

	Standards	Behavior	Sample
Managers	Standards	Set High Standards	100%
	Communication	Communicate Openly	100%
	Risk Assessment	Confront Risk	100%
	Involvement	Proactively involve	86%
	Consolidated (For all behaviors)		96%
Supervisors	Standards	Ensure Compliance	84%
	Communication	Encourage the Team	74%
	Risk Assessment	Promote Risk awareness	83%
	Involvement	Involve the Team	66%
	Consolidated (For all behaviors)		77%

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Everyone	Standards	Follow Rules	45%
	Communication	Speak Up	51%
	Risk Assessment	Be mindful	45%
	Involvement	Get Involved	44%
	Consolidated (For all behaviors)		46%
		Maturity Score	**73%**
			Established

The Maturity score of Managers is the highest with a score of 96%, Maturity score of supervisors is around 77%, and the score of Contract workers and operators is least with only 46%.
The overall BBS Maturity score for the year 2023-2024 is 73%, which is 2% higher than the previous year's Maturity score.

8.5 Conclusion

BBS stands as a building block for implementation of safety pillar in an organization. This report focuses on enhancement of BBS in an organization. To enhance BBS in an organization a gap analysis on BBS is carried out. Gaps in a biscuit manufacturing industry are identified by prioritizing the zones. Packing, mixing, and oven Areas are identified as hazardous zones and it is followed by BBS survey to the people in hazardous zones. 7 managers, 58 officers, and 100 workers are surveyed. From the survey, the gaps are identified, and it is followed by suggesting the appropriate CAPA for each section of survey response. The suggested CAPA to cover the identified gaps in the BBS was extensively discussed with HR and plant manager and most of the CAPA was implemented till date

- The awareness level of senior operators and contract workers are good. For instance, a lady contract worker engaged in hygiene activity is aware of all the rules and procedures related to the cleaning activity. She explained the importance of height work permit for removing cobweb in the shop floor.
- Learning from their own experience is observed among the operators. They are aware of the consequences of not adhering to rules and procedures. For example, one of the operators had met with an injury two year ago. He lifted the wrapper roll under the running conveyor and he was suspended by the management for the unsafe act to avoid such incident in the future. Now he understands the purpose of the safety in the shop floor while conducting any activity.
- Most of the senior contract workers share their EHS learning and knowledge with the newly joined employees.
- Understanding of LOTO procedures is good among the maintenance team. Regular safety meetings are conducted by the maintenance team by the respective supervisor and managers.
- Though safety committee meeting and line safety monitor meeting are conducted, the workers are hesitating to share their opinion and suggestions related EHS issues.
- Supervisor's give importance to production and fails to take lead to resolve safety issues in their workplace.
- Significant growth can be observed by performing the BBS survey as we get the inferences from the individual worker.
- To enhance BBS in an organization a gap analysis on BBS is carried out. Gaps in a biscuit manufacturing industry are identified by prioritizing the zones.
- Packing, mixing, and oven area are identified as hazardous zones and it is followed by BBS survey to the people in hazardous zones. 7 managers, 58 officers, and 100 workers from these three zones are surveyed.
- From the survey, the gaps are identified, and it is followed by suggesting the appropriate CAPA for each section of survey response.
- Appropriate action plan to cover the identified gaps was made and it was extensively discussed with HR and plant manager and most of the CAPA was implemented till date.
- Behaviour coaching is done on the spot for the unsafe act, but the supervisor's fails to constantly follow up in checking their risk awareness level due to workload.

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8.6 Recommendation:

- Audio/Video module need to be prepared on contract workers activities/OCP/Critical behaviour/equipment specific and display during induction training and periodical training program.
- Number of authorized Officer for LOTOTO and PTW to be increased through continuous training program.
- Concerned department HOD need to encourage their team to stop the unsafe activity or life threatening.
- Conduct attractive events to improve active participants on monthly basis.
- Good behaviour needs to be analysed and thank you card need to be provided.
- On job training target need to be provided to the area officer and track on a weekly basis.
- Each department should analysis and prepared the OCPs prior to any incident take places.

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