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Productivity Improvement by Process Mapping in Sand and Casting Industry

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Abstract: This research paper presents a comprehensive investigation into the efficacy of process mapping as a means of enhancing productivity within the sand and casting industry. Through the meticulous analysis of current state maps and the strategic development of future state maps, this study identifies and addresses inefficiencies in foundry operations, offering practical suggestions for the integration of new technologies, reduction of takt time, and alleviation of bottlenecks. Additionally, employing methodologies such as Time Study with Process Improvement, Rapid Upper Limb Assessment (RULA) analysis, and Rejection Analysis, this research provides a multifaceted approach to process optimization. By synthesizing empirical findings and industry insights, this paper not only underscores the importance of process mapping in enhancing efficiency but also offers actionable strategies to streamline operations and elevate productivity within the sand and casting sector.
Keywords: Process Mapping, Value Stream Mapping, Foundry Operations, Productivity Improvement, Rejection Analysis, **Bottleneck Identification**

I. INTRODUCTION

Industrial engineering is a multidisciplinary field that focuses on optimizing systems and processes within various industries to maximize efficiency, productivity, and quality. Combining principles from engineering, mathematics, and social sciences, industrial engineers analyse complex systems involving people, materials, information, equipment, and energy to improve overall performance. They employ techniques such as process optimization, workflow design, and resource management to streamline operations, reduce costs, and enhance competitiveness. Industrial engineers play a crucial role in areas such as manufacturing, logistics, healthcare, and service industries, where they design efficient production processes, develop supply chain strategies, and implement quality control measures to meet customer demands effectively. Their expertise in problem-solving, data analysis, and project management enables them to drive continuous improvement initiatives and innovation, ultimately contributing to the success and sustainability of organizations in today's dynamic and competitive business environment. A Value Stream Map (VSM) is a powerful Lean manufacturing tool utilized in industrial engineering to visually depict and analyse the flow of materials and information within a process from start to finish. It enables organizations to identify value-adding steps, as well as non-value- added activities that contribute to waste and inefficiencies. By mapping out the current state of the value stream, including processes, inventory levels, lead times, and information flow, VSM facilitates a comprehensive understanding of the existing operational landscape. This insight allows teams to pinpoint areas for improvement and develop strategies to streamline processes, reduce cycle times, minimize inventory, and optimize resource utilization. Additionally, a future state Value Stream Map is often created to illustrate the ideal state of operations, serving as a roadmap for implementing continuous improvement initiatives and achieving operational excellence.

II. COMPANY PROFILE

Siddasankalp Casting, Maharashtra in here all types of Steel Castings is being manufactured by using the synergy of skilled man power & fully fledged machinery. Besides a manufacturer, they are also steel casting suppliers based in India, they have a complete setup to manufacture castings of reliable quality that will exactly meet with Customer specifications. They manufacture Cylindrical Sleeve, Brake Drum, Pulleys, Hub Housing.

III. PROBLEM STATEMENT

The sand and casting industry faces challenges stemming from inadequate visibility and understanding of the production process, resulting in inefficiencies, delays, and suboptimal resource utilization. Issues such as material flow management, lead time reduction, and maintaining consistent product quality persist due to the absence of a structured approach for analysis and optimization.

Bottlenecks, excessive inventory, and inconsistent workflow synchronization hinder productivity and increase costs, making it challenging to meet customer demands and remain competitive. Implementing Value Stream Mapping (VSM) is essential to address these challenges by visualizing, analysing, and improving the production process effectively.

IV. OBJECTIVE

1) The primary objective is to identify and visualize current inefficiencies and bottlenecks within the sand and casting production process to understand areas for improvement.
2) Identify and reduce non-value-added activities and unnecessary delays throughout the production process to minimize cycle times and increase throughput.
3) Identify opportunities to reduce costs, such as inventory holding costs, overtime expenses, and rework costs, through process optimization and waste reduction.
4) Develop standardized work procedures and best practices to ensure consistency, reliability, and repeatability in production operations.
5) Evaluate and address ergonomic concerns within the production process to enhance worker safety, comfort, and efficiency, thereby reducing the risk of injuries and improving overall productivity

V. METHODOLOGY

1) Defining the scope of the value stream, encompassing all processes involved in transforming raw materials into finished casted components. This includes activities such as sand preparation, moulding, melting, casting, finishing, and inspection.
2) Collaborating with cross-functional teams to create a detailed map of the current state of the value stream. This involves capturing information on process steps, material flows, cycle times, inventory levels, and lead times using standardized symbols, icons.
3) Analysing helps to identify opportunities for waste reduction and process improvement.
4) Gathering quantitative data on key performance metrics such as cycle times, lead times, defect rates, and resource utilization for each process step.
5) Designing an ideal future state for the value stream, incorporating improvements 3 bottlenecks identified during the analysis of the current state.

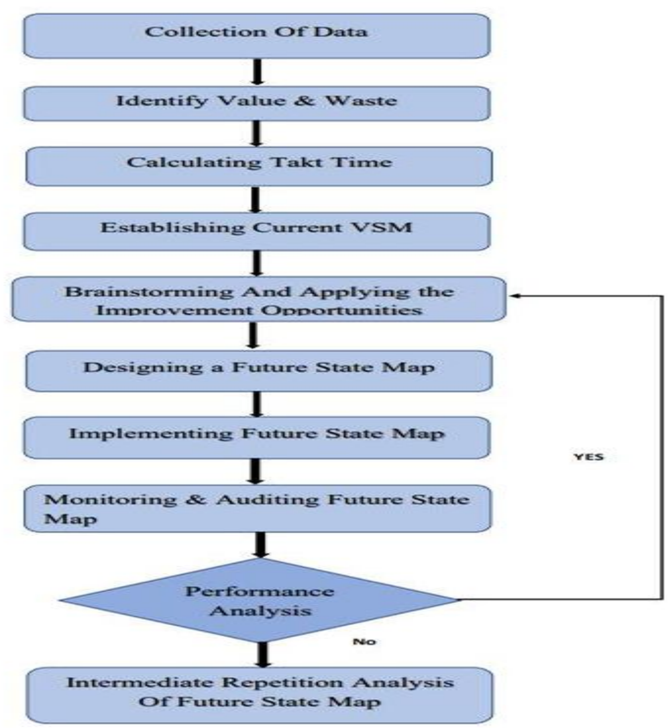

Figure 1 Methodology

VI. TAKT TIME CALCULATION

Table 1 Product & Quantity

Product	Current Demand (Per Year)
Cylindrical Sleeve	18000
Break drum, Wheels, Pulleys	7550
Hub and Housing	6500

Table 2 Product & Quantity for FY 24-25

Product	Current Demand (FY 2024-25)
Cylindrical Sleeve	40000

As cylindrical sleeve is in high demand thus, process mapping will be done for this particular product so that it meets the demand.
Takt time is a core concept in lean manufacturing, representing the maximum time allowed to produce one unit to meet customer demand. It is calculated by dividing available production time by customer demand. Takt time serves as a pacing mechanism, ensuring production matches customer demand, optimizing workflow, and guiding resource utilization. It helps in synchronizing processes, minimizing inventory, and reducing lead times, providing a basis for evaluating performance and identifying improvement opportunities.

- Working shift per day = 1
- Current production rate (FY 2023-2024) = 12631 Nos
- Working hours per shift = 8 hours
- Available time per shift = 480 minutes
- Tea break per shift = 2 breaks * 10 minutes = 20 minutes
- Lunch break per shift = 60 minutes
- Networking time per shift = [available time-(breaks +break down)] = 480-80 = 400 minutes
- Customer demand per Year= 40000 Nos (FY 2024-25)
- Customer demand per month= 3333 Nos
- Customer demand per day (1 shift) = 138 Nos
- Takt time = Available production time / Demand
- Total daily quantity required = 400/138
- Takt time = 3 minutes

The Takt time required to meet the customer demand is Calculated & found to be 3 minutes.
If the previous Takt Time which was 7.5 minutes for manufacturing 18000 unit of cylindrical sleeve will be used then it won't be possible to fulfill the demand of 40000 units

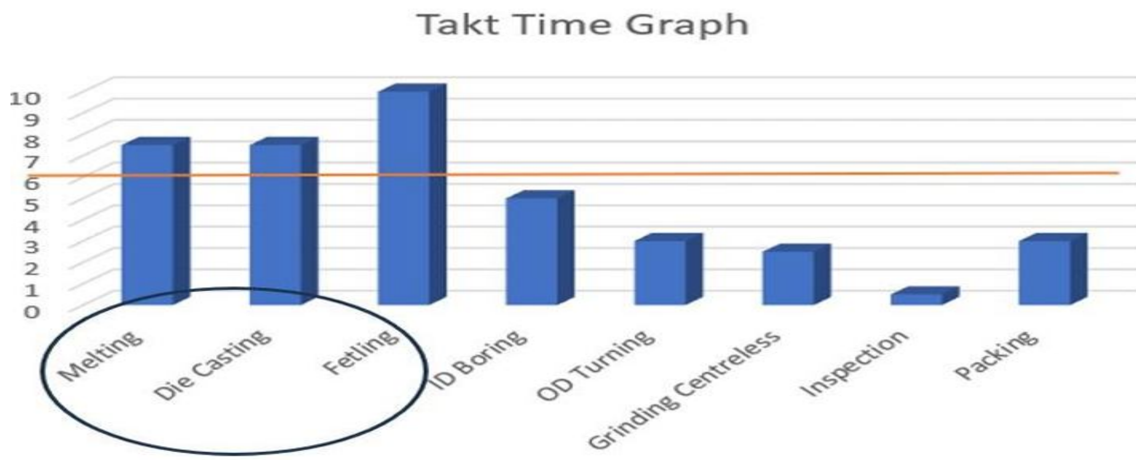

Figure 2 Bottleneck Identified

VII. CURRENT STATE MAP

After finding out task time, a value stream mapping of the current state as shown in Fig. 7, is created to identify areas for improvement and activities that spend the most non-value-added time (NVA). Current VSM shows that the task of copying, core collection, drag making and core insertion consumes NVA and this needs to be minimized. Here NVA is contributed by time spend on processes such as Melting, Sand Casting and Fettling.

Summary: • Bottleneck identification with the help of current state map

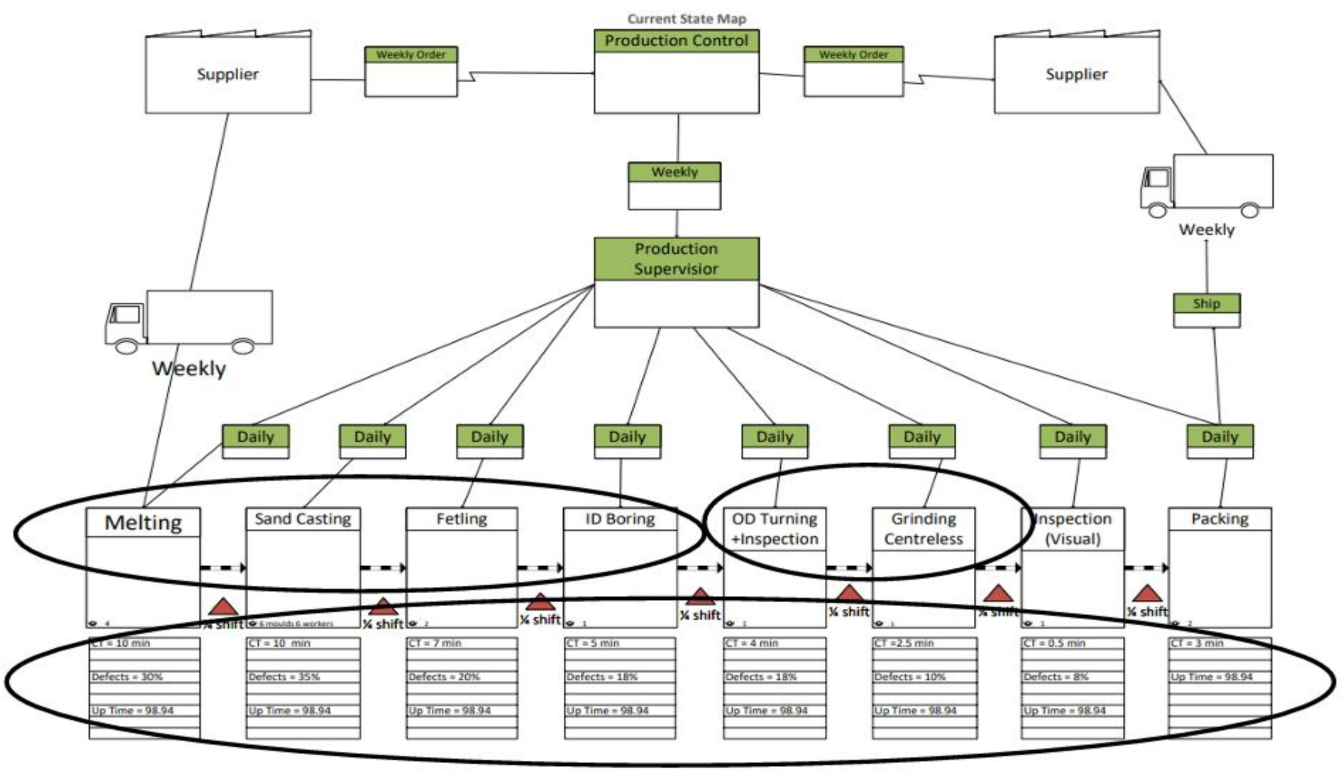

Figure 3 Current Value Stream Map

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VIII. UPTIME CALCULATION

- Uptime % = (Actual production time of a machine – Value added time / Availability time) * 100
- Actual production time of a machine: For a month = 26 days * 24 hrs. * 60 min = 43200.
- Value added time = 46 min (Calculated value) Uptime % = [(43200 - 442) / 43200] * 100 = 98.97 %

IX. SUGGESTIONS GIVEN TO IMPROVE CURRENT STATE MAP

Note: 5 suggestions were brought up to bring the processes under Takt time of 3 minutes

Figure 4 Multiheaded Centrifugal Die Casting Machine

Details:

These machines are designed and manufactured to meet the requirements of medium and large OEM producers of cylinder liner castings. They can produce single liners or multiple lengths depending on size and type. High profile wet and diesel liners are usually Produced in single pieces. Smaller automotive ow profile, wet or “cast in” block, these liners can be cast in lengths of four depending on the size. The multi-head machine offers a highly versatile alternative to tube type machine at low cost. Several versions are available to suit the production requirements and size of the castings. The machines are fully automated and can employ either wet or dry coating methods. One of the benefits of the multi-head is consistent production, the process variables are monitored and controlled at the critical points. These include pouring temperature and die temperature. The latest control and instrumentation technology is incorporated into the equipment. 13 Production rates are dependent on the wall thickness of the casting. Typically, a six head unit can consistently cycle at 45 seconds producing four-cylinder liners per casting, giving an hourly production rate of 320 liners. Machine on test prior to dispatch six, eight, ten or twelve head models are available with various options, subject to customer requirements. These machines can produce thin wall liners at a rate of one every 33 seconds. This simple to operate but robust design provides greater reliability without undue sophistication.

Main objective:

- Sand Moulding Process Elimination
- Multiple Liners in Die
- Manpower reduction

- Cycle time reduction
- Productivity Improvement
- Concentricity problem (Very less chances)

Table 3 Types of Multi-Head Casting Machine (Comparison)

Carousel	Typical Casting Size mm Min.	Typical Casting Size mm Max.	Typical Casting Size mm Length	Typical Casting Weights kgs	Approx. Cycle Times Subject To size	Nominal Rating KW
6 Head Compact	60	210	600	5-25	45 Seconds	50
6 Hed HD	100	350	700	20-75	50 Seconds	60
8 Head Compact	60	210	600	5-75	33 Seconds	60
8 Head HD	100	350	700	20-75	45 Seconds	70
10 Head	Details on Application					
12 Head	Details on Application					

Figure 5 Customized Lathe Machine with Mandrel (SPM)

Detail:

A special purpose lathe machine tailored for cutting cylindrical sleeves is engineered with precision and efficiency in mind. These machines typically feature a heavy-duty bed, carriage, and headstock assembly, ensuring stability and minimizing vibration during cutting operations. Equipped with specialized spindle configurations, such as multi-spindle setups, these lathes enable simultaneous cutting of multiple sleeves, thereby enhancing productivity and reducing cycle times. They employ advanced control systems for automated machining processes, allowing precise control over cutting parameters like speed, feed rate, and depth of cut. Tailored work holding devices, coolant systems, and tooling ensure accurate positioning, efficient chip evacuation, and prolonged tool life, essential for achieving the tight tolerances and surface finishes required in sleeve production. Moreover, these special purpose lathe machines often integrate automation capabilities, streamlining workflow coordination in high-volume production settings. Their robust construction, coupled with advanced control systems and specialized tooling, makes them indispensable for manufacturers seeking to optimize sleeve production processes.

Main objective:

- Raw Material Pipe cutting
- Productivity Improvement
- Manpower reduction
- Cycle time Reduction

Figure 6 CNC Machine

Detail:

CNC stands for computer numerical control and these machines play an important role in the manufacturing industry. These complex machines are controlled by a computer and provide a level of efficiency, accuracy and consistency that would be impossible to achieve through a manual process. Using CNC machine, the process of ID boring & OD Turning will be removed which will increase the productivity and the product can be manufacture under the calculated takt time.

Main objective:

- Elimination of Lathe Machine
- Cycle time reduction
- Set up time reduction

Figure 7 Shot Blasting Machine

Detail:

Shot Blasting Machine Manufacturers in India often use the term ‘Shot Blasting’ to define various processes such as Grit Blasting, Abrasive Blasting, Shot Peening and Media Blasting. While the process of Shot Blasting remains the same, a shot blasting machine may vary in capacity, size and structural design. A shot blasting machine makes use of a mechanical method of propelling abrasive using a centrifugal wheel to remove a layer of deposits and impurities from the surface of metal and steel products. 16 Shot blasting machine also have a dust collection system to prevent tiny particles, contaminant, dust particles etc. from escaping out of the machine into the surrounding. A dust collector connected with a Shot Blasting Machine prevents wastage of abrasives as well as prevents environment. As a leading manufacturer of Shot Blasting Machine in India, MGI manufactures highly reliable, low-cost shot blasting machine that are completely dust and pollution free. The capacity of each bare wheel goes from approximately 60 kg per minute up to 1200kg/min.

Main objective:

- Manpower reduction
- Productivity Improvement
- Cycle time reduction

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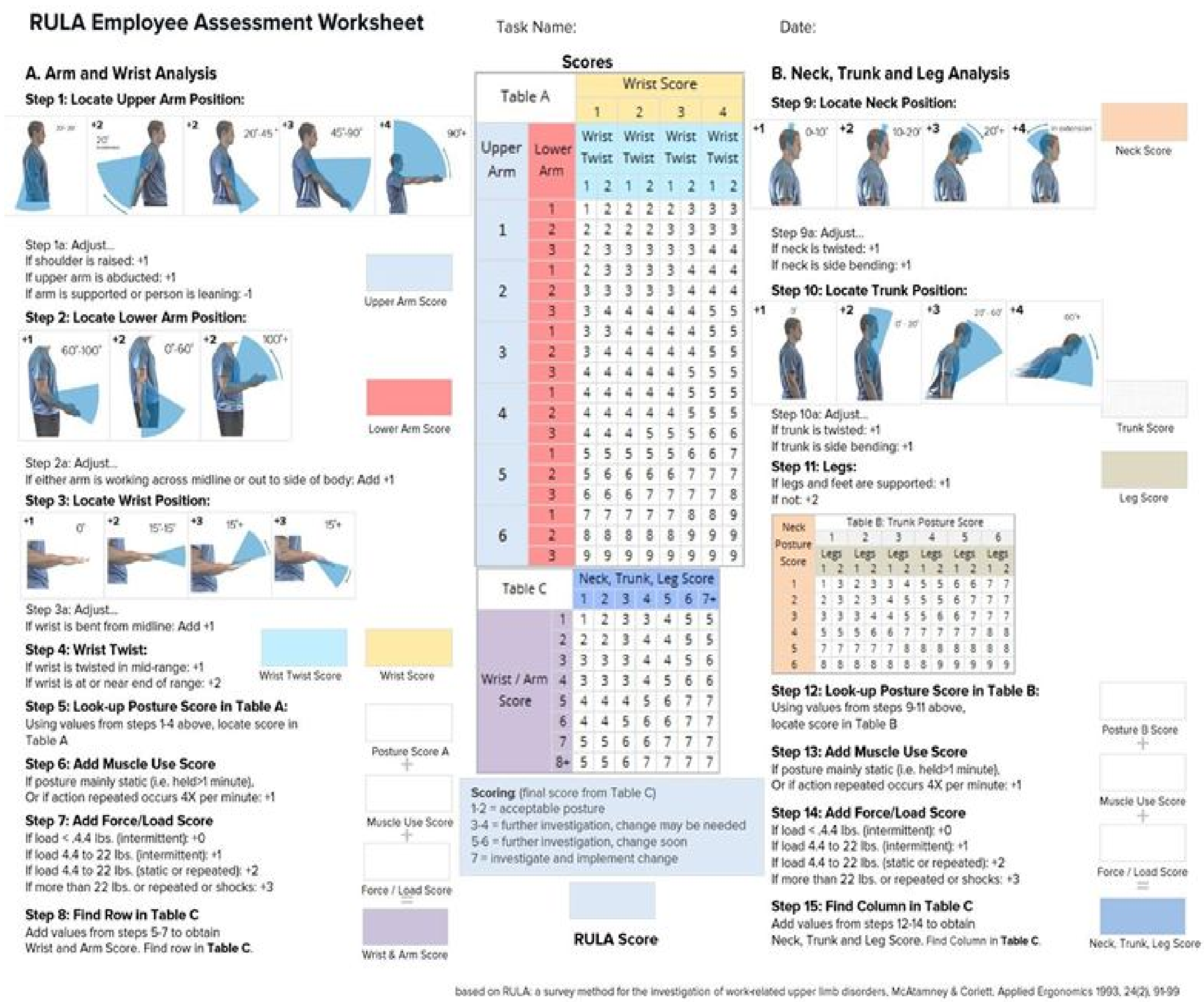

Figure 8 RULA Analysis

Detail:

As the workers working positions were risky, we proposed idea of RULA (Rapid Upper Limb Assessment) analysis which is a systematic ergonomic assessment method used to evaluate and analyses the risk factors associated with musculoskeletal disorders (MSDs) in the upper limbs and neck. Developed by Lynn McAnarney and Nigel Corlett in 1993, RULA aims to identify and mitigate ergonomic hazards that may contribute to discomfort, pain, or injury among workers who perform repetitive or prolonged tasks involving the upper body. 18 During a RULA assessment, an ergonomics specialist or trained observer observes a worker's posture and movements while performing their tasks. The assessment involves a step-by-step process of analysing various aspects of the worker's posture, such as the position of the arms, wrists, neck, and back, as well as the force exerted and the frequency of movements. Based on these observations, a RULA score is calculated, which indicates the level of risk associated with the observed postures and movements. The RULA assessment provides valuable insights into ergonomic hazards and helps prioritize interventions to improve working conditions and reduce the risk of MSDs. By identifying high- risk postures and activities, organizations can implement ergonomic solutions such as redesigning workstations, providing ergonomic tools and equipment, and implementing training programs to promote proper posture and movement techniques. Ultimately, RULA assessment contributes to creating safer and healthier work environments, reducing the incidence of work-related injuries and promoting employee well-being.

Main objective:

• Identify Risk Factors • Evaluate Postures • Quantify Risk Levels• Promote Worker Health and Safety

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X. TIME STUDY WITH PROCESS IMPROVEMENT

A. *Time Study Chart for Sand Casting*

The Sand casting, a widely used method for manufacturing metal components, involves several sequential steps: first, a pattern representing the desired part shape is created from materials like wood, metal, or plastic. Then, this pattern is placed in a two-part mould box (cope and drag), and fine sand is packed tightly around it to form a mould. After removing the pattern, the two halves of the mould are assembled, and a pouring basin and runner system are created in the cope half to facilitate metal flow. Molten metal is then poured into the mould cavity, allowed to cool and solidify, and finally, the mould is broken to reveal the cast metal part. Excess material is removed, and any necessary finishing operations are performed to achieve the desired final product.

Table 4 Activity Chart for Sand Casting

Sr no	Process	Time taken	○	□	⇨	D	△
	Preparing Casting Sand						
1	Collecting Sand		■				
2	Lifting Transporting to Machine				■		
3	Pouring sand in machine		■				
4	Waiting for the process					■	
5	Machine Processing Time		■				
6	Collecting Sand		■				
7	Transporting Sand				■		
	Melting Cast Iron						
1	Pouring Raw material		■				
2	Preheating Furnace		■				
3	Load in Furnace		■				
4	Waiting for melting					■	
5	Removing the melted iron		■				
6	Preparing the mould		■				
7	Transporting to moulding				■		
	Sand Casting						
1	Pouring Melted Material in mould		■				
2	Solidification		■				
3	Cooling		■				
4	Waiting to cool the furnace					■	
5	Mold Opening		■				
6	Collecting The Moulded Cylinders		■				
7	Cleaning the mold		■				
8	Transporting to Fetling process				■		
22			14	0	4	4	0

B. *Time Study Chart for Multi-Head Centrifugal Die Casting*

Centrifugal die casting entails several streamlined steps: first, the die or mould cavity is prepared to match the desired component shape and securely mounted within the centrifugal casting machine. Next, the metal alloy is melted to the appropriate temperature, degassed, and readied for casting. The machine is set up with the die positioned centrally, and parameters like rotation speed and tilt angle are adjusted. As the machine rotates, molten metal is poured into the spinning die, and centrifugal force evenly distributes it along the cavity walls, promoting complete filling and solidification. After cooling, the rotation halts, and the cast component is ejected from the die, subject to inspection for any defects or imperfections before additional finishing processes, if necessary. This process ensures efficient production of high-quality metal components with precise shapes and dimensions.

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Table 5 Activity Chart for Multi-Head Centrifugal Die Casting

Sr no	Process	○	□	⇨	D	△
1	Melting Cast Iron	■				
2	Collecting cast iron	■				
3	Transporting to furnes			■		
4	Putting cast iron in furnace	■				
5	Melting process	■				
6	Transporting to centrifugal casting machine			■		
7	Centrifugal Casting Process	■				
8	Removal of Casted Part from Die	■				
		6	0	2	0	0

C. Comparison of Sand Casting and Centrifugal Die Casting

Sand casting is a versatile metal casting process that involves creating a mould from compacted sand around a pattern, allowing for intricate designs and adaptability to changes in production requirements. This method is well-suited for producing complex shapes and parts in low to medium volume production runs. Sand casting offers relatively lower initial tooling costs compared to other casting methods, making it accessible for small-scale manufacturers. However, achieving precise dimensional accuracy and surface finish may require additional finishing processes such as machining or grinding. Centrifugal die casting, on the other hand, is a specialized casting process ideal for high-volume production of cylindrical or tubular parts, particularly using non-ferrous metals like aluminium and zinc alloys. In this method, a permanent metal mould is rotated at high speed while molten metal is poured into it. Centrifugal force ensures uniform distribution of the molten metal, resulting in excellent surface finish and dimensional accuracy. While centrifugal die casting offers rapid cycle times and high efficiency, it involves higher initial setup costs due to the expense of tooling (dies). Consequently, it is more commonly used in industries requiring large-scale production of parts with consistent quality and specifications.

Table 6 Comparison of Sand Casting and Multi-Head Centrifugal Die Casting

Status	Process	○	□	⇨	D	△
Before	Sand Casting	14	0	4	4	0
After	Centrifugal Die Casting	6	0	2	0	0

Note: Using Multi – Head Centrifugal Die Casting Machine helps to skip the unwanted steps to manufacture the sleeve And at the same time optimizing the manufacturing line.

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XI. RULA ANALYSIS

REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Limb Assessment) are ergonomic assessment tools widely used to evaluate the ergonomic risks associated with various work tasks. RULA focuses specifically on upper limb musculoskeletal disorders by assessing posture, force, and repetitive movements, while REBA extends this evaluation to include the entire body. Both tools aim to identify ergonomic hazards that could lead to discomfort, injury, or long-term musculoskeletal issues among workers. RULA analysis involves observing workers' postures and movements during a task, assigning scores based on the degree of risk associated with those postures, and then recommending corrective actions to reduce ergonomic risks. By examining factors such as joint angles, repetition, and force exertion, RULA helps identify high-risk activities and suggests interventions to minimize the likelihood of work-related injuries. The analysis typically involves trained ergonomic assessors who systematically evaluate various aspects of the task and provide recommendations tailored to improve ergonomics and reduce the risk of injury. Integrating RULA and REBA into workplace assessments can contribute significantly to improving occupational health and safety. By identifying and mitigating ergonomic risks, these assessments not only enhance worker well-being but also potentially increase productivity and reduce absenteeism due to work-related injuries. Moreover, by promoting ergonomic awareness and providing practical recommendations, organizations can create a safer and healthier work environment.

Note: RULA Analysis is done before inculcating suggestions and after inculcating suggestions and for analysis CATIA V5 and Manual RULA Assessment is done to get the safe RULA score.

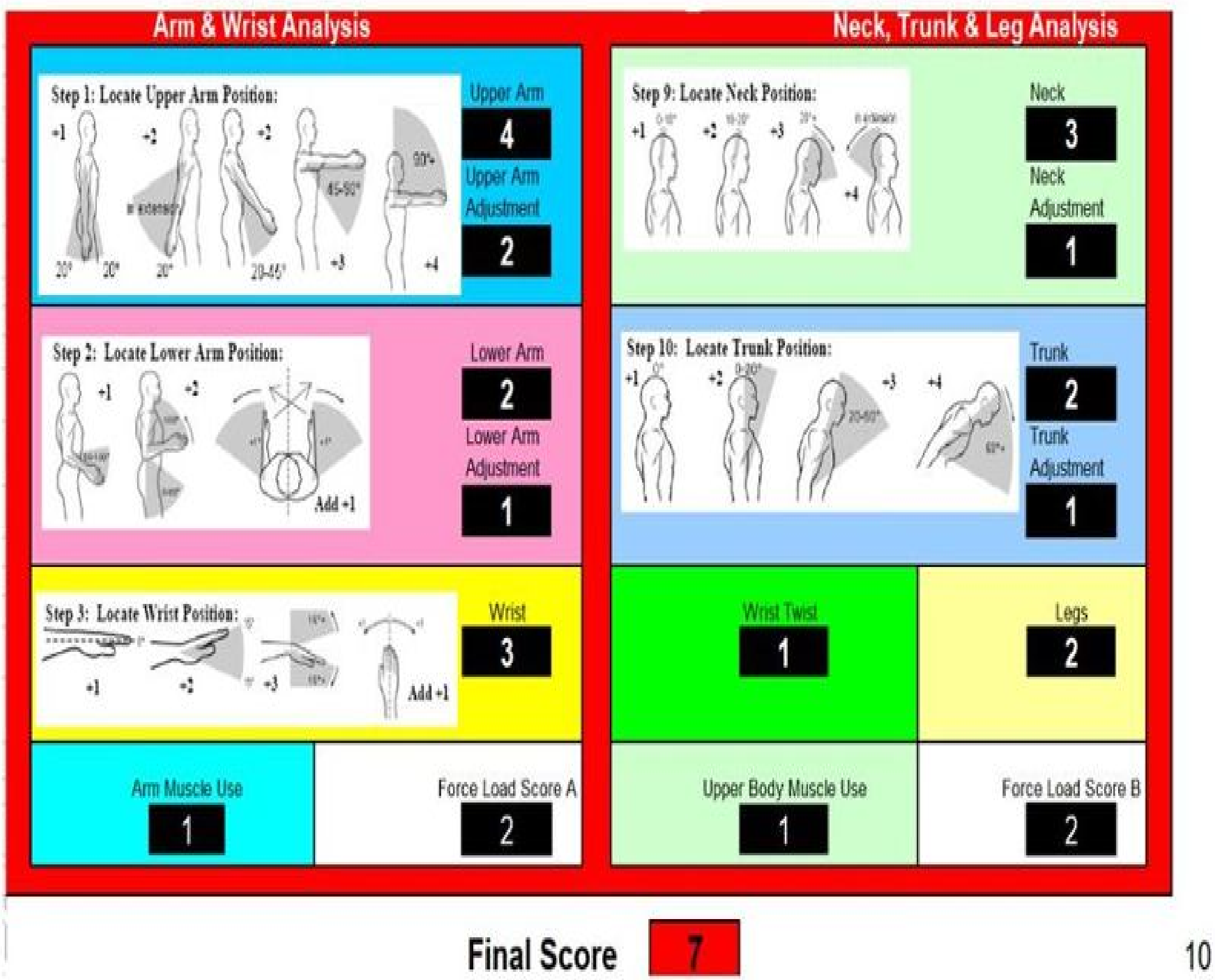

Figure 9 Manual Assessment Before Inculcating Suggestion

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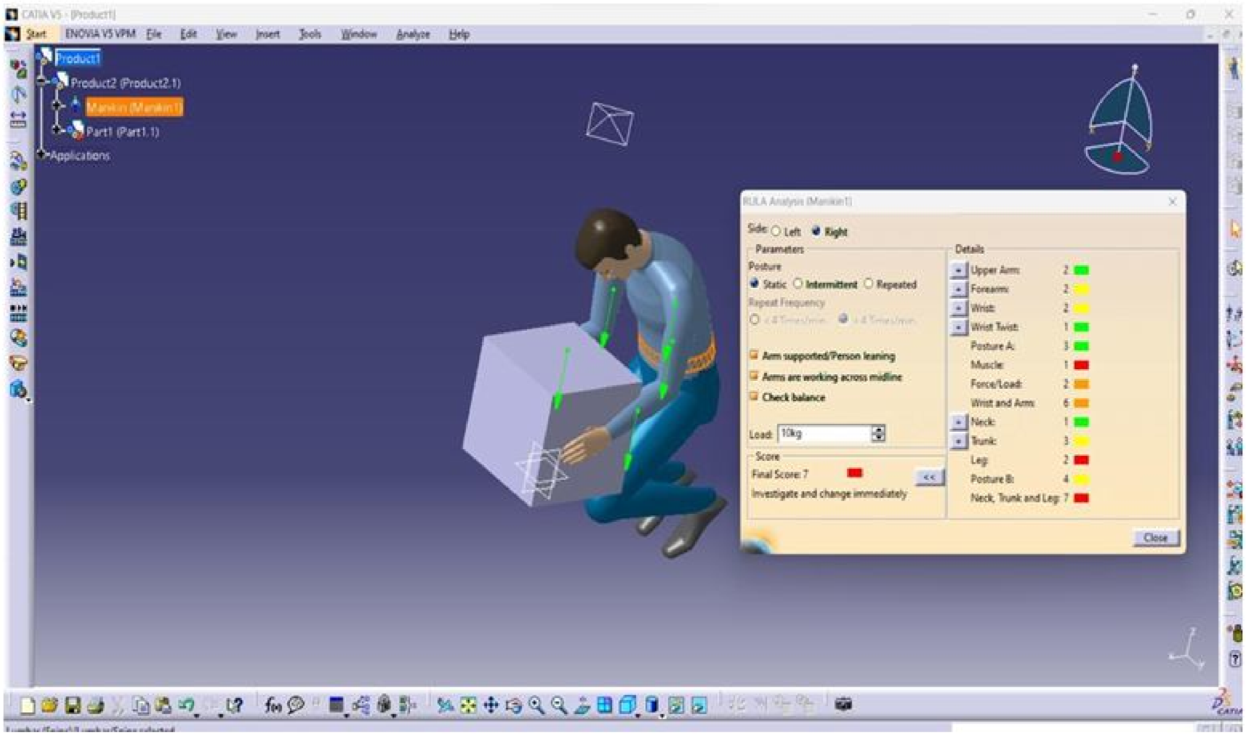

Figure 10 CATIA V5 Assessment Before Inculcating Suggestion

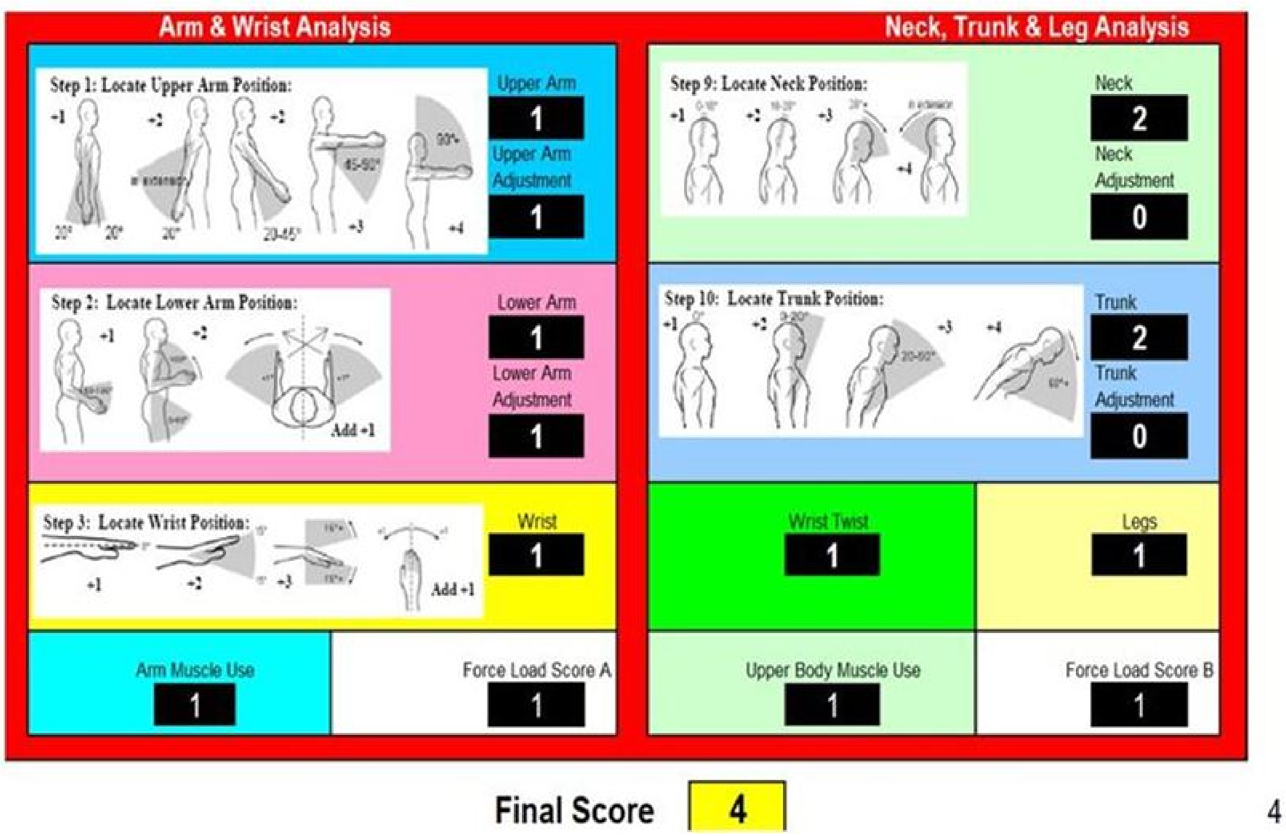

Figure 11 Manual Assessment After Inculcating Suggestion

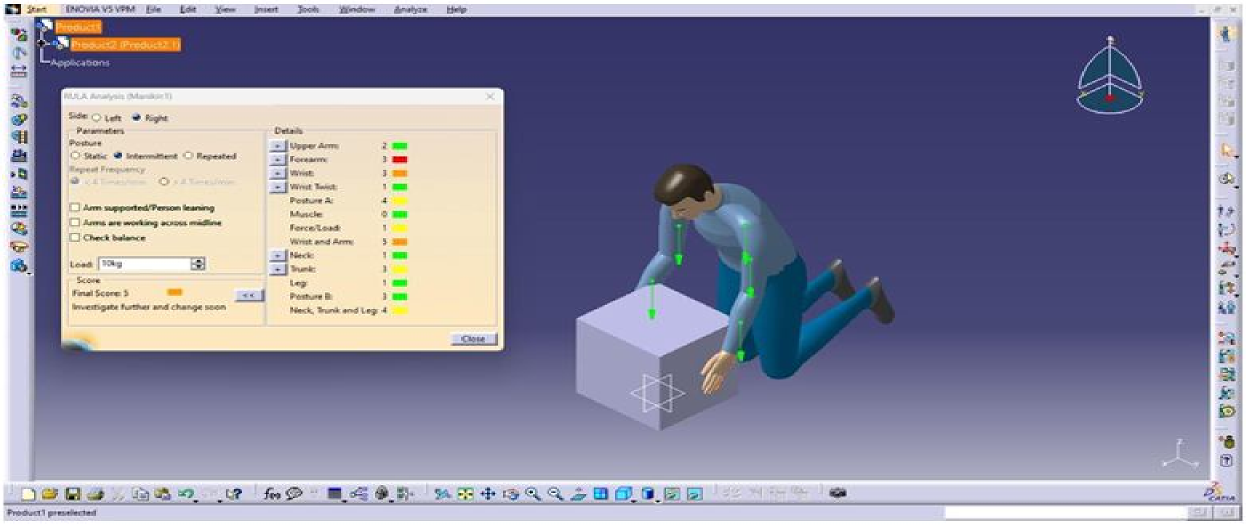

Figure 12 CATIA V5 Assessment After Inculcating Suggestion

Note: After inculcating suggestion the RULA score is successfully reduced to 4 which implies that the processes are risk free for workers to work in.

XII. REJECTION ANALYSIS (REPORT: OPTIMIZATION OF CYLINDRICAL SLEEVE PRODUCTION PARAMETERS)

A. Introduction: Rejection Analysis

In manufacturing, rejection analysis plays a critical role in identifying and mitigating defects to improve product quality and efficiency. Understanding the root causes of defects enables targeted interventions and process optimizations. This report focuses on applying Design of Experiments (DOE) techniques to analyse rejection rates in cylindrical sleeve production and optimize key parameters to reduce defects.

B. Design of Experiments (DOE)

DOE is a structured approach to systematically investigate and optimize process parameters affecting product quality and performance. By varying key factors and observing their effects on the output (defect rate in this case), DOE helps identify optimal parameter settings that minimize defects and improve overall productivity.

C. L9 Array Observation Table

1) Experimental Setup:

The following L9 array was used to study the effects of RPM (Revolutions Per Minute) and DOC (Depth of Cut) on defect rates in cylindrical sleeve production:

Table7 L9 Array

Run	RPM (Factor 1)	DOC (Factor 2)	Defect (%) per shift
1	25	0.1	10
2	30	0.1	12
3	35	0.1	15
4	25	0.16	8
5	30	0.16	7
6	35	0.16	5
7	25	0.2	13
8	30	0.2	9
9	35	0.2	11

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2) Observations:

_ • Based on the L9 array experiments, run 6 (35 RPM, 0.16 DOC) exhibited the lowest defect rate of 5%.

• This represents a significant improvement compared to other runs and indicates the effectiveness of this parameter combination.

3) Finalization of Parameters:

After analysing the experimental results, it is recommended to finalize the following parameters for cylindrical sleeve production:
• RPM (Revolutions Per Minute): 35 RPM • DOC (Depth of Cut): 0.16 • The combination of 35 RPM and 0.16 DOC resulted in a 50% reduction in defect rates compared to other parameter combinations. • These parameters provide optimal conditions for achieving the desired defect rate and improving overall production quality.

XIII. FUTURE STATE MAP

In the envisioned future state map, the process undergoes a significant transformation aimed at optimizing efficiency and streamlining operations. Through meticulous analysis and strategic planning, key improvements have been identified and integrated into the workflow to enhance productivity and minimize waste. Notably, steps have been taken to standardize processes and ensure consistent uptime across various stages of production. This is exemplified by the remarkable uptime rate of 98.94% consistently maintained throughout the entire production line, indicating a robust system resilient to downtime disruptions. Each component of the process, from melting and centrifugal die casting to shot blasting and CNC machining, operates seamlessly with minimal cycle times, underscoring the commitment to maximizing throughput and reducing lead times. Moreover, the future state map embodies a holistic approach to quality control and 19 customer satisfactions. By incorporating regular inspection checkpoints and rigorous quality assurance measures, the production line strives to deliver products of impeccable quality, meeting or exceeding customer expectations. This commitment to quality extends beyond the manufacturing process, encompassing meticulous packing procedures and timely shipping schedules to ensure that orders are fulfilled promptly and accurately.

• Inculcating above suggestions the cycle time has been reduced and the processes are under the takt time calculated.

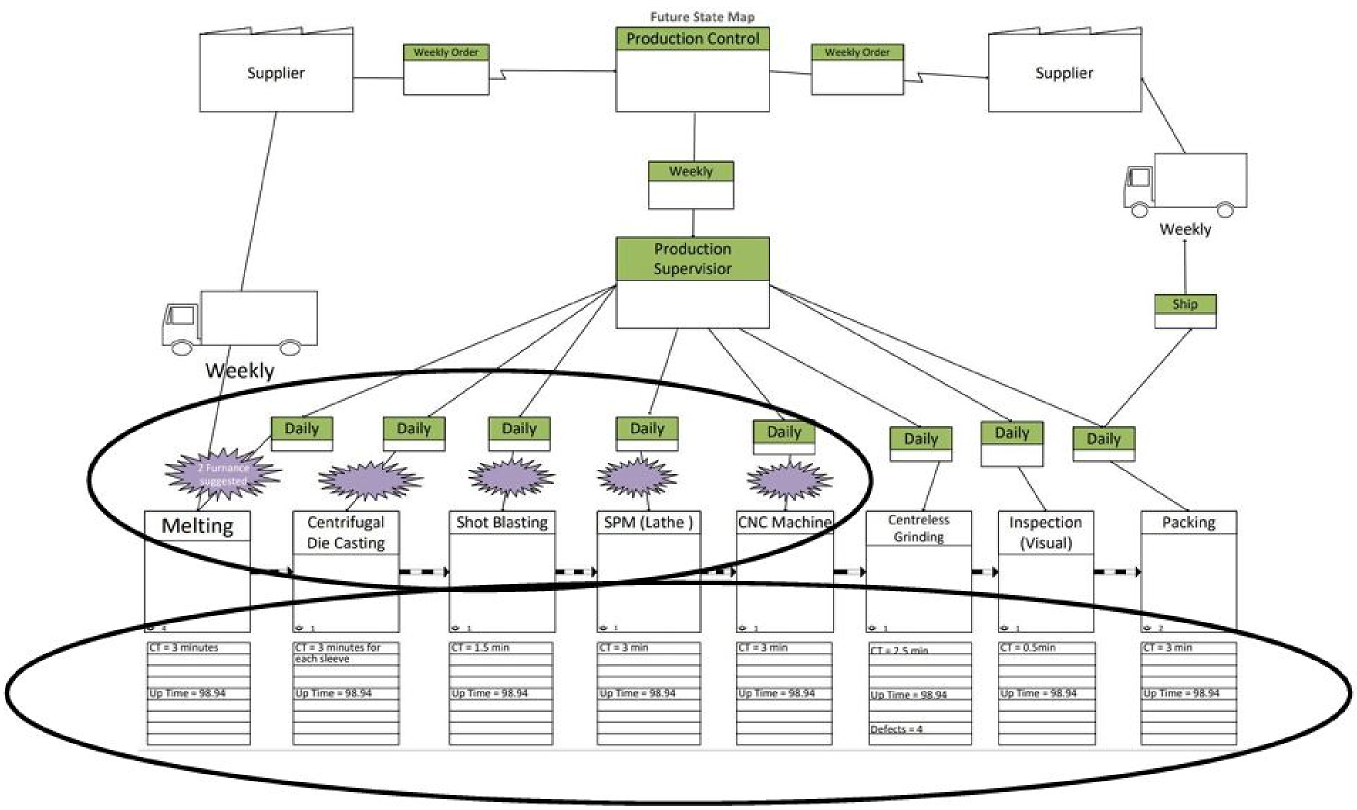

Figure 13 Future State Map

XIV. RESULTS AND DISCUSSIONS

From the analysis the following improvements are observed

A. Improved Productivity:

• Through concerted suggestions and strategic interventions, the industry will significantly achieve the goal of manufacturing 40,000 units of cylindrical sleeve for the year 2024 - 2025, marking approximate 218.3% increase in productivity.

• By leveraging advanced technologies and optimizing workflows, we've increased production volume allowing us to respond more swiftly to market demands.

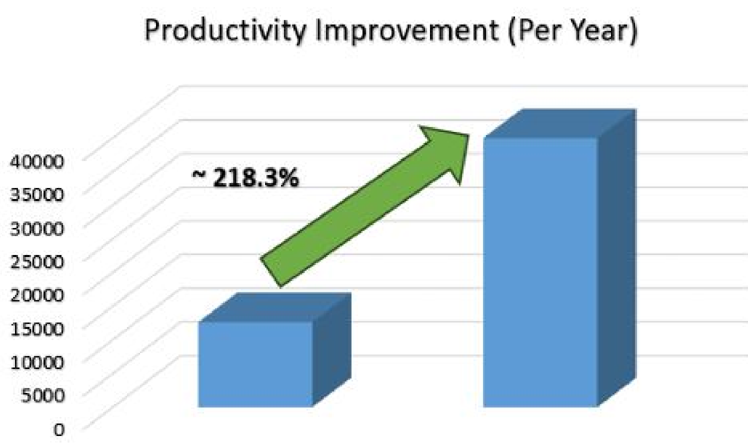

Figure 14 Output Optimization Graph

B. Streamlined Activities in Centrifugal Casting:

• Through meticulous analysis and process optimization, we have streamlined the activities involved in centrifugal casting and achieved approximate 57.1% reduction of steps.

• This reduction not only simplifies the operations but also minimizes the potential for errors, thereby enhancing overall efficiency and productivity.

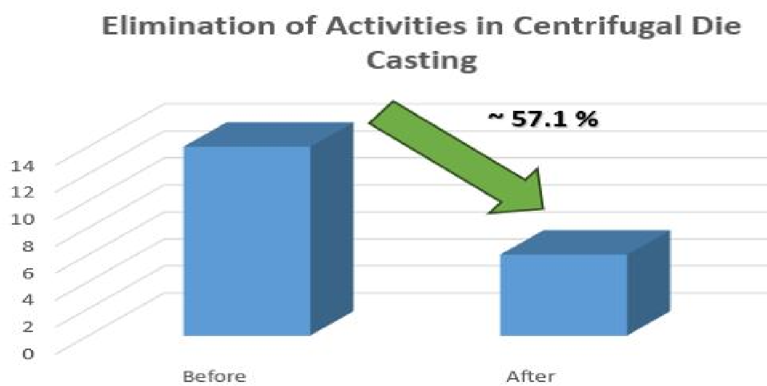

Figure 15 Task Eradication Graph

C. Enhanced Ergonomic Conditions with RULA Assessment:

• Prior to intervention the Rapid Upper Limb Assessment (RULA) score stood at 7 in CATIA software and also in doing manual assessment indicating potential ergonomic risks for workers. Following the implementation of suggested improvements, we successfully lowered the RULA score to 4, resulting in approximate 42.9% reduction.

• This signifies a notable enhancement in ergonomic conditions, ensuring the well-being and comfort of the workforce.

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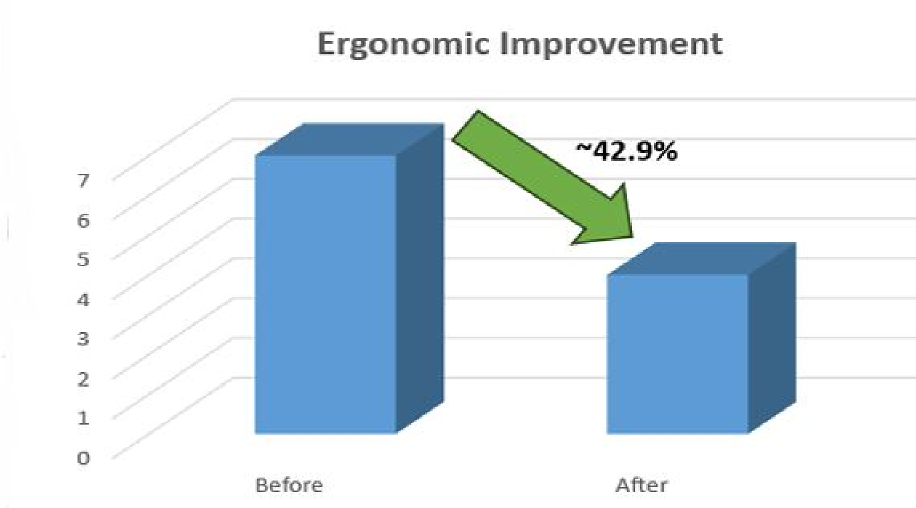

Figure 16 Ergonomic Optimization Graph

D. Reduced Rejection Rate:

• Through meticulous analysis and targeted interventions, we have successfully decreased the rejections of cylindrical sleeve and achieved approximate 50% reduction.

• It will improve the productivity and decrease the lead time.

Figure 17 Quality Assessment Graph

E. Optimized Manpower Utilization:

• By embracing efficiency-enhancing suggestions and optimizing workflows, we have achieved significant reduction in manpower requirements from 18 to 12 personnel, representing approximate 33.3% reduction.

• This optimized utilization of manpower not only reduces operational costs but also ensures that workforce is deployed in the most effective and productive manner possible.

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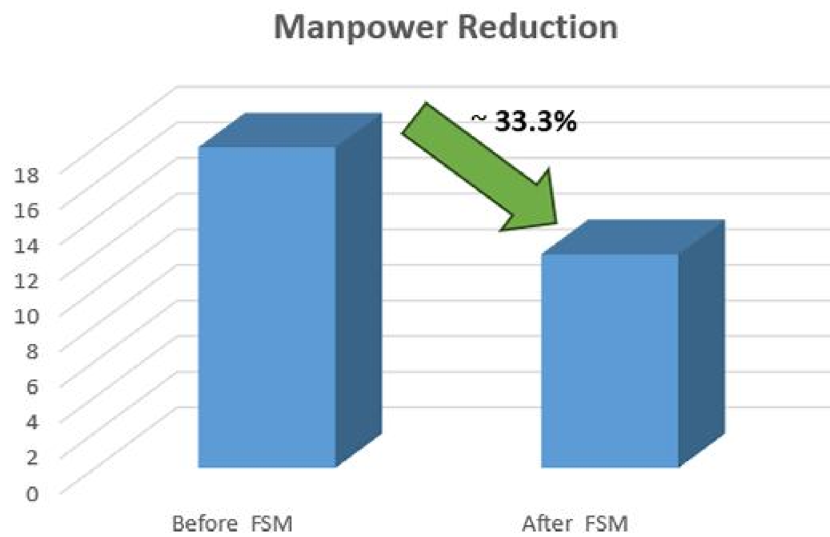


Figure 18 Workforce Downsizing Graph

XV. RESULTS AND DISCUSSIONS

A. *Conclusion:*

Value stream mapping tools can be used effectively in any kind of sectors as these are the world class manufacturing tools. The prime objectives of the project for using value stream mapping tools are as follows:

1) To use the tools in identifying, quantifying and minimizing major wastes in a foundry production line.
2) To quantify the variety of products generated at each manufacturing processes within the foundry line.
3) To formulate practical means of reducing the identified major wastes by reducing excess inventory, defects and unnecessary activities
4) The aim is to reduce lead time for process improvement.
5) To quantify by rank the seven wastes of lean within the foundry line.

The results of Process activity mapping shows increase of approximately 20% productivity compared to current process mapping. It is possible to reduce the chances of defects at the generic origin sources i.e., at melting, sand casting, fettling, IS Boring and OD turning and by controlling the melting parameters. In this study bottleneck product is identified. The key sources for internal scraps are identified and these are analysed and improvement is carried out in these areas. Also, there is 83% of manpower reduction which will certainly profitable for the company. After that future state quality filter map with findings are presented. Future state map revealed that if the company follows the future state map and optimize their production line then they could easily achieve their yearly target. It is however to be noted that there is a significant cost to carry out any required changes but the increased throughput against takt time will pay back for investment. Previously the RULA score was 7 which means that the worker's health factor was at risk upon revaluation after the implementation of suggestions, a notable improvement in ergonomic conditions was observed. The RULA score decreased from 7 to 4 which is 43% of improvement, reflecting a significant reduction in ergonomic risk factors. This improvement suggests a positive impact on the overall well-being and safety of employees, also the time study in sand casting process was approximately 73% which after adopting suggestion came down to approximately 39 % which is an significant number achieved for achieving the takt time.

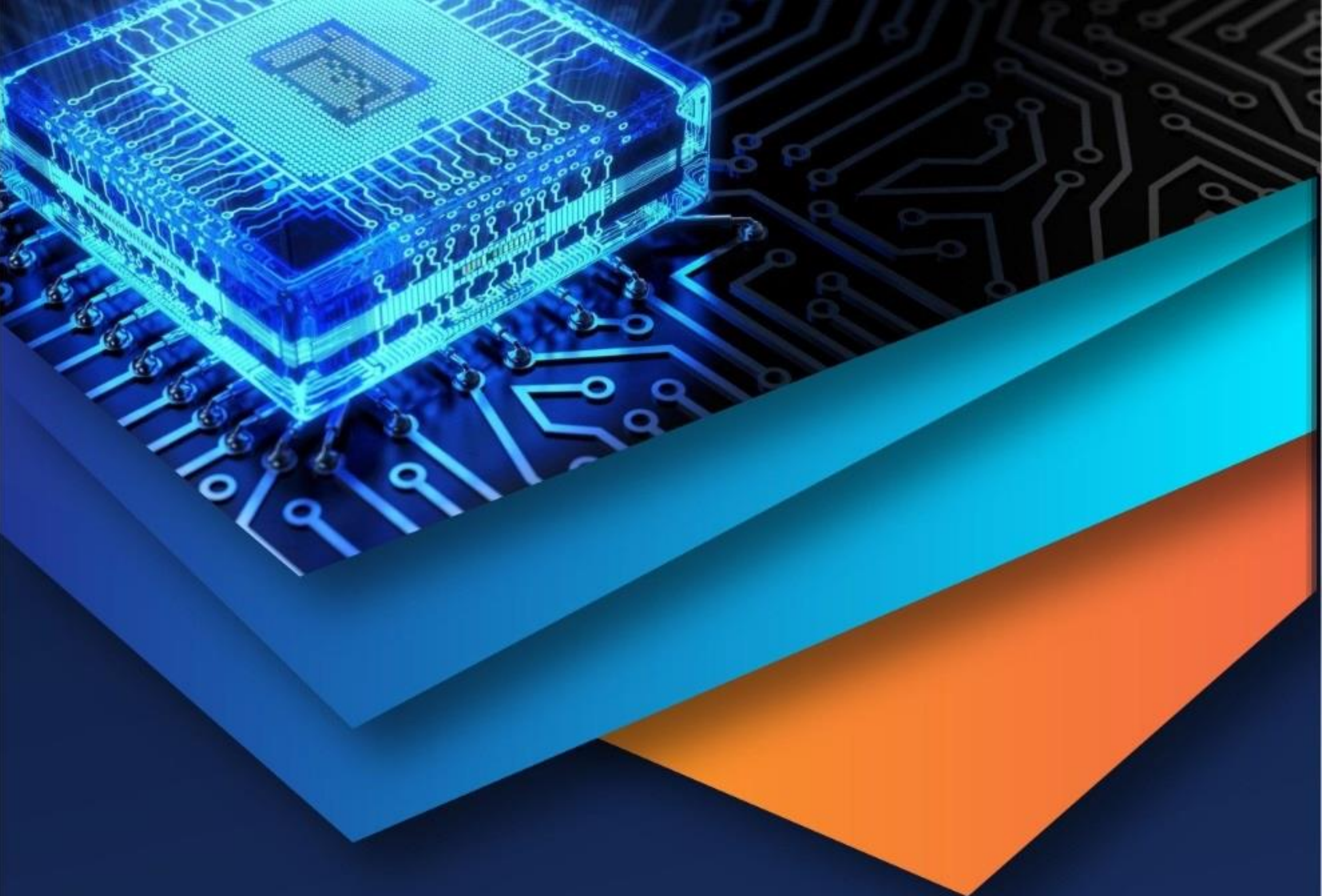
B. *Future Scope:*

The future of the sand and casting industry is characterized by a paradigm shift towards digitalization, sustainability, and innovation. Advanced technologies such as 3D printing, robotics, and IoT-driven monitoring systems are revolutionizing traditional casting processes, enabling higher precision, efficiency, and cost-effectiveness. Additionally, a growing emphasis on sustainability is driving the adoption of eco-friendly practices, including the use of recycled materials, cleaner production methods, and energy-efficient processes.

This dual focus on technology and sustainability not only enhances the industry's competitiveness but also aligns with global efforts towards environmental conservation and resource efficiency. Moreover, collaborative research initiatives and partnerships between industry players, academia, and government bodies are driving innovation and knowledge-sharing within the sector. These collaborations foster the development of new materials, casting techniques, and quality control measures, ensuring that the industry remains at the forefront of technological advancement. By leveraging these opportunities for digital transformation, sustainability, and collaboration, the sand and casting industry is poised for continued growth and resilience in the face of evolving market dynamics and regulatory pressures.

REFERENCES

[1] Belokar, R. M., Kharb, S. S., & Kumar, V. (2012). "An Application of Value Stream Mapping In Automobile Industry: A Case Study." International Journal of Innovative Technology and Exploring Engineering (IJITEE), 1(2), 231-236.
[2] Samad, M. A., et al. (2013). "Value Stream Mapping To Reduce Manufacturing Lead Time In A Semi-Automated Factory." Asian Transactions On Engineering, 2(6), 22- 28.
[3] Gracanina, D., Buchmeister, B., & Lalic, B. (2014). "Using Cost-Time Profile for Value Stream Optimization." Procedia Engineering, 69, 1225–1231.
[4] Rahani, A. R., & al-Ashraf, M. (2012). "Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study." Procedia Engineering, 41, 1727–1734.
[5] Al-Odeh, M., et al. (2014). "Value Stream Mapping: Recreating an Industrial Environment in an Educational Setting."\ Proceedings of The (2014) IAJC/ISAM Joint International Conference. ISBN: 978-1-60643-379-9.
[6] Sheth, P. P., et al. (2014). "Value Stream Mapping: A Case Study of Automotive Industry." Ijret, 2321-7308.
[7] Ali, R. M., et al. (2014). "Dynamic Lean Assessment for Takt Time Implementation." Procedia CRIP, 17, 577-581.
[8] Gohane, G. M., Bonde, A. S., & Sable, C. S. (2015). "Improvement of Productivity Using Value Stream Mapping." IJSRD - International Journal for Scientific Research & Development, 2(8), 1-5.
[9] Reddy, G. S., Lingareddy, H., & Jagadeeshwar, K. (2013). "Value Stream Mapping In A Manufacturing Industry." International Journal of Advanced Engineering Technology, 4(2), 20-23.
[10] Bose V, B., & Anilkumar, K. N. (2013). "Reducing rejection rate of castings using Simulation Model." Proceedings of International Conference on Energy and 41 Environment, International Journal of Innovative Research in Science, Engineering and Technology, 2(1), 589-597.
[11] Solding, P., & Gullandar, P. (2009). "Concepts for Simulation Based Value Stream Mapping." Proceedings of the 2009 Winter Simulation Conference, 2231-2237.
[12] Xia, W., & Sun, J. (2013). "Simulation guided value stream mapping and lean improvement: A case study of a tubular machining facility." Journal of Industrial Engineering and Management, JIEM, 456-476.
[13] Kumar, S. S., & Kumar, M. P. (2014). "Cycle Time Reduction of truck body assembly in an automobile industry by lean principles." Procedia Materials science, 5, 1853-1862.



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