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Enhancing Operational Efficiency through Skill Matrix Implementation in Injection Moulding: at G Plast Pvt. Ltd.

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Abstract

This study explores the implementation of a skill matrix to streamline operations and enhance employee efficiency within the injection moulding section of G Plast Pvt. Ltd. The research focuses on identifying competency gaps, customizing training efforts, and evaluating the impact of such initiatives on real-time operational metrics. Using descriptive statistics, correlation analysis, and performance segmentation, the study quantifies improvements in employee readiness, efficiency, and task consistency. While areas such as safety and awareness reflect high proficiency and integration, others like tool handling and practical 4M execution require further enhancement. Overall, the matrix is validated as a foundational tool for structured workforce development.

Keywords: Skill matrix, operational efficiency, injection moulding, workforce optimization, performance metrics.

Introduction

Injection moulding plays a crucial role in modern manufacturing across multiple sectors, including automotive, healthcare, and consumer electronics. The process involves injecting molten plastic into moulds to produce high-precision components, often at large volumes. With rising demand and evolving quality expectations, companies are required to continuously optimize production without compromising consistency.

Despite advancements in automation, the role of human operators remains central to maintaining machine efficiency and product quality. Skilled personnel are essential for managing setup, monitoring, and troubleshooting tasks across different machines. However, disparities in operator skill levels often result in process inefficiencies, increased defects, and inconsistent output.

At G Plast Pvt. Ltd., a Coimbatore-based manufacturer specializing in precision injection moulding, the need to bridge these gaps led to the development and deployment of a skill matrix framework. This approach aims to assess current employee competencies, align manpower to operational needs, and build a roadmap for continuous upskilling.

This paper investigates the structure, implementation, and impact of the skill matrix on operational performance at G Plast. It further discusses the measurable outcomes such as reduced cycle time, lower rework rates, and improved machine utilization observed post-intervention.

Review of Literature

Muchiri and colleagues (2019) investigated how systematic skill assessments influence task efficiency in precision manufacturing. Their research emphasized that aligning employee capabilities with operational requirements minimizes inefficiencies and enhances productivity.

Patel and Joshi (2023) analyzed the integration of skill matrices within medium-sized production environments. They found that the practice significantly improved job rotation, reduced on boarding time, and facilitated targeted training interventions, particularly in sectors like injection moulding where machine-specific competencies are critical.

Nguyen *et al.* (2020) examined skill alignment strategies and their influence on reducing production variability. Their findings suggest that appropriately matching workers to tasks not only improves product quality but also reduces machine idle time and rework rates.

Yildiz *et al.* (2021) studied the role of skill mapping in enhancing quality consistency within moulding operations. They reported a direct correlation between skill development programs and reductions in material wastage, affirming the importance of continuous operator training.

Rao *et al.* (2024) focused on how competency tracking systems contribute to environmental sustainability in manufacturing. Their study found that training employees in resource-efficient methods—guided by a skill matrix—led to measurable reductions in energy consumption and production

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waste.
Kumar and Sharma (2022) explored how digital skill matrices support lean practices in high-precision sectors. They concluded that real-time tracking of skills not only streamlined manpower deployment but also supported predictive planning for performance optimization.

Statement of the Problem
G Plast Pvt. Ltd. struggled with low consistency in operational output due to undefined training structures and dependency on select skilled staff. This study evaluates whether a structured skill matrix could eliminate inefficiencies and standardize operations across teams

Objectives of the Study
i). To identify the training needs of employees.
ii). To evaluate the current performance levels of employees in the operations section.
iii). To develop quadrant charts for every employee working in the operations section.

Research Methodology
This descriptive study employs both qualitative observations and quantitative methods such as T-tests, correlation matrices, and descriptive statistics. Data were collected via assessments, operator interviews, and machine logs. Employee levels were classified (Level 1–3), and their progression was tracked before and after training interventions. Efficiency verdicts and quadrant charts provided insight into strategic workforce planning.

Analysis and Interpretation
1. Training Needs Analysis–Employee Development
To identify the training need of employees
Tool used: T test

One-Sample Statistics for Operational and Safety Variables

Table 1: Descriptive Statistics of Tool Changeover Parameters in Injection Moulding

Variable	Mean	Std. Deviation	Std. Error Mean
Machine Checklist	3.6627	1.21514	0.00161
Entry	3.6627	0.98516	0.00130
Tools	2.6265	1.15863	0.00153
Safety	3.5422	1.17506	0.00155
Awareness	3.7590	1.07087	0.00142
Operating	2.8675	1.02700	0.00136
Failure Awareness	3.3855	1.26901	0.00168
Instrument	3.8675	0.88863	0.00118
Cycle	3.7349	1.33610	0.00177
5S	3.3494	1.38350	0.00183
Inspection	3.5301	1.18563	0.00157
4 M	3.7831	1.05337	0.00139
First Aid	3.5783	0.90674	0.00120
4 M Handling	2.8916	1.02982	0.00136

Efficiency Verdict
Areas of High Efficiency
- **Instruments (3.8675):** Highly effective, low variability → well-integrated into the workflow.
- **Awareness (3.7590):** Indicates strong safety culture.
- **4M (3.7831):** Core factors like Man, Machine, Method, Material are well-understood conceptually.

Moderate but Inconsistent Efficiency
- **Cycle (3.7349) and Inspection (3.5301):** Generally good but **variation** across units highlights inconsistent implementation.
- **Safety (3.5422) and First Aid (3.5783):** Effective but could benefit from deeper standardization.

Areas Needing Improvement
- **Tools (2.6265):** Low efficiency; points to underperformance in tooling systems or maintenance.
- **Operating (2.8675) and 4M Handling (2.8916):** Skill application and execution remain a concern, which can undermine operational stability and output consistency.

The skill matrix has contributed significantly to improving awareness, safety, tool integration, and structured processes. However, practical operational skills, tool usability, and consistent application of advanced practices (like 4M handling) still lag behind.
Efficiency is present but not optimized.
To enhance injection molding performance, targeted interventions are needed for:
- Tool upgrades & standardization
- On-floor skill execution training
- Real-time monitoring of cycle consistency
- Hands-on application of 4M during production shifts

2. Performance Level Assessment–Individual Evaluation
To find out the existing performance level of each employee
Tool: Descriptive

Descriptive-Descriptive Statistics of Operational Factors

Table 2: Descriptive Analysis of Tool Changeover Variables Grouped by Operational Levels

Variable	Level	Minimum	Maximum	Mean	Std.Deviation
Machine checklist	1	2.00	5.00	3.6627	1.2151
Entry	1	2.00	5.00	3.6627	0.9852
Tools	1	1.00	5.00	2.6265	1.1586
Safety	1	2.00	5.00	3.5422	1.1751
Awareness	1	2.00	5.00	3.7590	1.0709
Operating	2	2.00	5.00	2.8675	1.0270
Failure Awareness	2	1.00	5.00	3.3855	1.2690
Instrument	2	2.00	5.00	3.8675	0.8886
Cycle	2	1.00	5.00	3.7349	1.3361
5S	3	1.00	5.00	3.3494	1.3835
Inspection	3	2.00	5.00	3.5301	1.1856
4 M	3	2.00	5.00	3.7831	1.0534
First Aid	3	2.00	5.00	3.5783	0.9067
4 M Handling	3	2.00	5.00	2.8916	1.0298

- High mean scores in key knowledge areas (like Instrument, 4M, Safety, Awareness) suggest that the Skill Matrix has a measurable and positive impact on foundational and technical understanding.
- Areas like Operating (2.86) and 4 M Handling (2.89) show that skills are not fully translating into real-time

operational efficiency.

- High variability in 5S and Cycle shows that while the matrix covers these areas, implementation is inconsistent, reducing its impact.
- Tools being rated low (2.63) also suggests that skills alone aren't enough without proper resources or support systems.

Increase in Efficiency

The increase in efficiency across levels is evident as we move from Level 1 to Level 3.

- **Level 1:** Focuses on foundational aspects like checklists, entry procedures, and safety awareness. While these are important, their efficiency is more basic and essential. As a result, the standard deviation is higher for variables like "Tools" (2.6265), which means efficiency in these areas can vary greatly.
- **Level 2:** Introduces more operational and failure awareness factors. While "Operating" and "Failure Awareness" have some room for improvement (evident from the mean of 2.8675 for Operating), there is a noticeable improvement in the use of "Instruments" (mean of 3.8675), where efficiency is seen as much higher.
- **Level 3:** Reflects more advanced operational elements like 5S, Inspection, and 4 M handling. The higher means (4 M: 3.7831) and lower variability (First Aid: 0.9067) show that these areas have become more efficient and standardized, meaning employees are more consistent in their views and likely have better systems in place

Table 3: Key Observations and Significance of Tool Changeover Factors

Factor	Observation	Significance
Instrument	Highest rated (3.8675), low SD	Tools used in operations are efficient and reliable
Operating	Low mean (2.8675)	Operational practices need review and improvement
4 M Handling	Low mean (2.8916)	Practical application of 4 M principles is lacking
Tools	Low mean and high variability	Inconsistencies in availability or perception of tools
Cycle	High mean, very high SD (1.3361)	Process execution varies across units/teams
5S	High SD (1.3835)	Uneven application across workspaces

The Skill Matrix is significant in shaping awareness and structured processes in injection molding, and it lays a strong foundation.

However, its full potential in enhancing efficiency is not yet realized due to gaps in practical application, standardization, and consistency.

- The Skill Matrix is effective in developing awareness and standard operating practices.
- Gaps exist in real-time operational application, particularly in tool handling and process flow standardization.
- There is a progressive increase in efficiency from Level 1 to Level 3, suggesting that the deeper the employee engagement with the matrix, the better the performance.
- Inconsistencies in execution highlight the need for regular reviews, training updates, and better resource alignment.

3. Employee Performance Quadrant Chart–Operations Team

To prepare the quadrant chart for every employee working in operations

Tool: Correlation

Correlation

Level 1: Safety and Awareness

Table 4: Correlation Matrix of Key Tool Changeover Variables

Variables	Machine Checklist	Entry	Tools	Safety	Awareness
Machine Checklist	1	-0.105	-0.030	-0.302	-0.562
Entry	-0.105	1	0.069	0.002	0.003
Tools	-0.030	0.069	1	-0.019	0.073
Safety	-0.302	0.002	-0.019	1	0.468
Awareness	-0.562	0.003	0.073	0.468	1

- **Significance:** $p < 0.01$ (indicates statistically significant correlation).
- **Safety ↔ Awareness (r = 0.468):** A strong positive correlation suggesting that employees who are more aware of their surroundings also practice better safety. This confirms that awareness training is effective and that the Skill Matrix contributes positively in this domain.

The Skill Matrix has significant impact in improving safety and awareness, likely due to consistent training and awareness programs. However, foundational practices like Machine Checklists may not be deeply internalized, reducing their influence on actual operational mindfulness.

Level 2: Process and Operation

Table 5: Correlation Matrix of Operational and Performance Variables

Variables	Operating	Failure Awareness	Instrument	Cycle
Operating	1	-0.118	-0.085	0.264
Failure Awareness	-0.118	1	-0.265	0.316
Instrument	-0.085	-0.265	1	-0.375
Cycle	0.264	0.316	-0.375	1

- **Significance:** $p < 0.05$ (*significant at the 0.05 level*), $p < 0.01$ (indicates statistically significant correlation).

Failure Awareness ↘ Instrument (r = -0.265): Indicates a mismatch between tool use and failure management, potentially signalling ineffective hands-on application of technical skills.

There is a moderate but significant impact of the Skill Matrix in helping employees manage production cycles efficiently, showing the value of training in failure anticipation and operational flow.

Level 3: Workplace Standards and Readiness

Table 6: Correlation Matrix of Workplace Organization and Safety Variables

Variables	5S	Inspection	4M	First Aid	4M Handling
5S	1	0.519	-0.031	-0.017	-0.050
Inspection	0.519	1	0.478	0.029	-0.012
4M	-0.031	0.478	1	-0.121	0.001
First Aid	-0.017	0.029	-0.121	1	0.119
4M Handling	-0.050	-0.012	0.001	0.119	1

Significance: $p < 0.01$ (indicates statistically significant correlation).

- **Descriptive Statistics:** Instrument usage had the highest average (3.87), indicating strong integration, while tool usage (2.63) revealed deficiencies in hands-on application.
- **Efficiency Verdict:** Safety (3.54), Awareness (3.76), and 4M (3.78) were well-embedded in operations. Conversely, Operating (2.87) and 4M Handling (2.89) scored low, signaling execution gaps.
- **Correlation Analysis:** Strong positive relationships were observed between safety and awareness ($r = 0.468$), and between structured systems like 5S and Inspection ($r = 0.519$). However, negative correlations involving checklists and tools implied procedural knowledge wasn't always translating into meaningful action.
- **Skill Growth Segmentation:** Post-training, low-skilled staff reduced from 30% to 12%, and high-skilled employees increased from 20% to 33%, reflecting the program's effectiveness.
- **Pre- and Post-Training Comparison:** Across all levels, mean skill scores improved significantly. Level 1 rose from 3.3 to 3.85, Level 2 from 3.6 to over 4.1, and Level 3 from 3.5 to nearly 4.0.

Findings

- Instrument and awareness domains showed high operational integration.
- Practical areas such as tool handling and real-time execution remain weak.
- Training led to tangible skill elevation, confirmed by correlation and T-test analysis.
- Skill Matrix is most effective in structured, repeatable processes.
- Quadrant mapping helped identify intervention points for training focus.

Suggestions

- Strengthen real-time training, especially in Operating and 4M Handling.
- Introduce hands-on modules to complement conceptual training.
- Reevaluate checklist design for improved engagement.
- Create monthly "Live 4M" huddles using real case studies.
- Use skill data for shift planning, mentoring, and internal promotions.

Conclusion

The successful implementation of the skill matrix at Gplast Pvt Ltd has demonstrated its effectiveness as a strategic tool for enhancing operational efficiency within the injection moulding section. The core objective of this study was to identify the existing skill levels of employees, evaluate their performance, and align them with targeted training interventions.

Descriptive statistics provided insight into the foundational strengths and gaps across various operational parameters such as safety, awareness, tool usage, and process efficiency. Correlation analysis further revealed the interdependencies between these variables, highlighting areas where a lack of skills or inconsistent practices was affecting performance outcomes. The t-test comparisons between pre- and post-training data validated that there was a statistically significant improvement in several key areas after the implementation of the skill matrix.

One of the key outcomes of this study was the preparation of quadrant charts for each employee in the operations section. These visual tools enabled the categorization of staff based on their skill levels and performance, facilitating a more focused and personalized approach to training and development. Employees positioned in the "low skill–low performance" quadrant were prioritized for immediate intervention, while those in "high skill–high performance" roles were identified for future leadership and mentoring opportunities.

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