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Analyzing Weekly Productivity Dynamics in Steel Fabrication Services Using the *Objective Matrix* (OMAX) Method Integrated with Root Cause Analysis

(Case Study: PT SWA)

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ABSTRACT

PT SWA is a steel fabrication service company operating in the construction sector, where productivity performance plays a critical role in meeting project schedules and cost targets. This study aims to measure weekly productivity levels in the steel fabrication process and to identify the dominant factors contributing to productivity fluctuations. The research employs the Objective Matrix (OMAX) method to quantify productivity performance using selected productivity ratios, which is then integrated with Root Cause Analysis (RCA) to identify the underlying causes of productivity decline. The results reveal significant weekly productivity dynamics during the ten-week observation period. Productivity increased during Weeks 1 and 2, with the highest improvement recorded in Week 2, achieving a productivity index of 190%. However, a continuous decline was observed from Weeks 3 to 10, with the lowest productivity index occurring in Week 8 at −78.33%. The analysis indicates that machine-related disruptions, substandard raw materials, and insufficient operator skills were the primary contributors to low-performing productivity ratios and overall productivity deterioration. The novelty of this study lies in integrating weekly OMAX-based productivity measurement with RCA to provide data-driven, actionable improvement insights within the context of steel fabrication services. The findings offer practical managerial implications, highlighting the importance of preventive maintenance planning, material quality control, and operator competency development to stabilize and improve productivity performance.

Keywords: *Productivity Measurement, Objective Matrix (OMAX), Root Cause Analysis, Steel Fabrication Services*

Introduction

Productivity performance plays a crucial role in steel fabrication service companies, as it directly influences project timelines, cost efficiency, and the ability to remain competitive in the construction sector[1], [2]. PT SWA, a company operating in construction and steel fabrication services, conducts project-based production activities that are highly dependent on the effective use of labor, machinery, materials, and work methods [3], [4]. In such an environment, productivity levels tend to fluctuate over short periods, making continuous and detailed evaluation essential for identifying operational inefficiencies and performance bottlenecks.

Although productivity measurement has been widely discussed in the literature, many previous studies have focused on manufacturing industries with stable production systems or have relied on aggregate monthly or annual performance indicators[5]. This approach provides limited insight into short-term productivity dynamics, particularly in steel fabrication services, where operational conditions vary from week to week due to changes in workload, resource availability, and project complexity [6]. Furthermore, while the Objective Matrix (OMAX) method is commonly used as a quantitative tool to evaluate productivity based on multiple performance ratios, its application is often limited to performance measurement without being explicitly linked to systematic problem diagnosis [7]. At the same time, Root Cause Analysis (RCA) is frequently employed as a qualitative technique to identify the sources of operational problems. Yet, it is rarely integrated with productivity indices derived from weekly operational data [8].

This study addresses these limitations by applying the Objective Matrix (OMAX) method to measure weekly productivity levels in the steel fabrication process at PT SWA and integrating the results with Root Cause Analysis (RCA) to identify the underlying causes of productivity decline [9]. The novelty of this research lies in its emphasis on weekly productivity dynamics and in the integration of quantitative OMAX results with RCA-based diagnosis, enabling a more comprehensive understanding of productivity fluctuations in steel fabrication services

[10]. By linking low-performing productivity ratios to specific root causes, the study provides a structured basis for formulating data-driven improvement strategies [11].

The primary objective of this research is to evaluate the weekly productivity performance of steel fabrication activities at PT SWA, identify the productivity ratios with the most significant influence on overall performance, and determine the root causes of productivity decline. Through this integrated analytical approach, the study is expected to offer practical managerial insights for improving productivity, stability, and efficiency, while also contributing to the limited empirical literature on productivity measurement in project-based steel fabrication service industries.

Research Methods

This study adopted a single-case study design to evaluate productivity performance in steel fabrication services at PT SWA. The analysis was conducted using weekly operational data collected over a ten-week observation period, allowing the research to capture short-term productivity dynamics that are typically overlooked in aggregate assessments [12]. Data were obtained from both primary and secondary sources. Primary data were collected through direct field observations and semi-structured interviews with relevant personnel to understand operational conditions and identify potential factors influencing productivity. Secondary data were obtained from company production records, including weekly production output, total fabricated weight, defect inspection results, machine power information, and total working hours [13].

Productivity measurement was performed using the Objective Matrix (OMAX) method. OMAX was selected because it enables productivity assessment through multiple performance ratios that represent key operational dimensions in fabrication activities. In this research, four productivity ratios were defined based on a combination of literature review and field considerations, ensuring that the ratios reflected performance indicators that are operationally meaningful and routinely documented at PT SWA. Each ratio was assigned a weight (20%, 35%, 30%, and 15%) to reflect its relative importance to overall productivity performance [14]. The weighting scheme was determined through expert judgment and internal operational priorities, as discussed with company personnel, and aligned with the practical relevance of each ratio in influencing project performance. The OMAX calculation process involved determining the performance value for each ratio each week, translating each performance value into a level score using predetermined reference ranges, and then computing a weighted productivity score. The weekly productivity index was subsequently generated to evaluate productivity changes relative to the baseline period, enabling the identification of weeks with notable increases or declines [15].

To complement the quantitative measurement, Root Cause Analysis (RCA) was used to identify the causes of productivity deterioration. RCA was applied by linking weeks and ratios with low OMAX scores to operational evidence gathered from observations and interviews. Potential causes were categorized using the commonly applied 4M framework Man (human factors), Machine, Method, and Material to ensure systematic identification of underlying issues. The integration of OMAX and RCA allowed the study not only to quantify productivity fluctuations but also to interpret them in operational terms and provide a basis for targeted improvement recommendations.

Results and Discussion

Weekly Operational Profile (August–October 2023)

This study used weekly production records from PT SWA over a ten-week period (August–October 2023). The dataset includes total production output (kg), defect inspection rate (%), number of workers, and total working hours per week. As summarized in Table 1, weekly output fluctuated sharply, ranging from 875 kg to 5,000 kg. Quality performance also varied, with defect rates ranging from 4% to 13%. Labor deployment changed from 2 to 7 workers per week, while working hours ranged from 80 to 280 hours. These variations indicate that productivity at PT SWA is shaped not only by output volume but also by weekly differences in quality outcomes and in the intensity of resource utilization.

Table 1. Weekly operational data for PT SWA (Week 1–Week 10, August–October 2023)

Descriptions	Total Production (Kg)	Inspection Defects (%)	Total Workers	Number of Working Hours / Week
Week 1	1500	9%	2	80
Week 2	3500	4%	5	200
Week 3	5000	12%	7	280

Week 4	1100	5%	2	80
Week 5	1350	13%	2	80
Week 6	975	10%	2	80
Week 7	875	8%	2	80
Week 8	1250	11%	3	120
Week 9	1800	7%	3	120
Week 10	1050	6%	2	80

(Total production, defect inspection rate, total workers, and weekly working hours.)

OMAX Productivity Index Results

OMAX was applied using four productivity ratios representing overall output performance, labor productivity, time-based productivity, and production effectiveness. Ratio values were translated into OMAX levels using a fixed scoring matrix, then aggregated into a weekly performance score using weighted scoring. To maintain academic conciseness, the detailed step-by-step calculations for each week are omitted; the scoring matrix and final weekly results are presented in Tables 2 and 3, respectively.

Table 2. OMAX scoring matrix for productivity ratios (Level 0–10)

Descriptions	Ratio 1	Ratio 2	Ratio 3	Ratio 4
Week 1	11.11	750.00	18.75	0.59
Week 2	25.00	700.00	17.50	1.43
Week 3	8.33	714.29	17.86	0.47
Week 4	20.00	550.00	13.75	1.45
Week 5	7.69	675.00	16.88	0.46
Week 6	10.00	487.50	12.19	0.82
Week 7	12.50	437.50	10.94	1.14
Week 8	9.09	416.67	10.42	0.87
Week 9	14.29	600.00	15.00	0.74
Week 10	16.67	525.00	13.13	1.09
Average Ratio (Levels 3)	13.47	585.60	14.64	0.91
Best Ratio (Levels 10)	25.00	750.00	18.75	1.45
Worst Ratio (Levels 0)	7.69	416.67	10.42	0.46

(Level 0 indicates the worst performance, Level 3 represents the average reference level, and Level 10 represents the target/best performance.)

The weekly productivity outcomes show intense volatility (Table 3). Productivity increased sharply in Week 1 (180%) and peaked in Week 2 (190%). After Week 2, the productivity index declined across most weeks, reaching its lowest value in Week 8 (−78.33%).

Table 3. Weekly OMAX performance score and productivity index (Week 1–Week 10)

Levels	Ratio 1	Ratio 2	Ratio 3	Ratio 4
10	25.00	750.00	18.75	1.45
9	23.37	726.48	18.18	1.41
8	21.72	703.00	17.59	1.31
7	20.07	679.52	17.00	1.21
6	18.42	656.04	16.41	1.13
5	16.77	632.56	15.82	1.11
4	15.12	609.08	15.23	1.01
3	13.47	585.60	14.64	0.91
2	11.55	529.29	13.24	0.76
1	9.62	472.98	11.83	0.61
0	7.69	416.67	10.42	0.46

Technical consistency applied: Week labels are standardized (e.g., Week 9, not "Wekk 9"), and decimal separators use dots (e.g., −78.33, 91.67).

Interpretation of Weekly Productivity Fluctuations

The productivity surge in Weeks 1–2 can be explained by a combination of relatively stable operations and favorable quality outcomes. Week 2, in particular, combined high output (3,500 kg) with the lowest defect rate in the dataset (4%), implying that the fabrication process achieved both throughput and quality simultaneously.

Operationally, this pattern is consistent with smooth machine performance, sufficient material availability, and effective alignment between workforce allocation and workload at the start of the observation period [16].

From Week 3 onward, productivity performance weakened, indicating that higher output volume alone did not guarantee productivity gains. Week 3 illustrates this clearly: although output was the highest (5,000 kg), the defect rate rose sharply to 12%, which likely increased rework, inspection failures, and wasted processing time. As a result, production effectiveness deteriorated, pulling the overall productivity index downward. The decline became more severe in Weeks 6–8, during which output decreased (975–1,250 kg) while time and labor resources were still being consumed. This mismatch reduced output per worker and per hour, resulting in extremely low OMAX scores and negative index values. The minimum productivity in Week 8 (−78.33%) reflects the combined effects of weak efficiency (labor- and time-based ratios) and reduced effectiveness [7].

Overall, the findings indicate that PT SWA's productivity volatility is driven by the interaction of (i) quality losses, (ii) equipment reliability and downtime, and (iii) inefficiencies in labor and time utilization. This explains why productivity fell substantially after Week 2 even when production volume remained high in certain weeks.

Integrating OMAX with RCA Findings

Root Cause Analysis (RCA) was conducted using a fishbone diagram and 5-Why analysis to diagnose the causes associated with low OMAX scores. Causes were organized under the 4M framework (Man, Machine, Method, Material) [17].

The integration of OMAX and RCA strengthens the interpretation by linking specific low-performing ratios and weeks to operational causes. The sharp deterioration in Weeks 6–8 is consistent with machine-related problems, such as breakdowns and jamming, which reduce adequate processing time and directly suppress output per hour and output per worker. In parallel, material-related issues likely contributed to elevated defect rates (e.g., 12% in Week 3 and 13% in Week 5), thereby lowering production effectiveness through rework and nonconforming output. In terms of human factors, insufficient operator skills can magnify both efficiency losses (e.g., slower processing, setup errors) and quality losses (e.g., defects), particularly when staffing is limited or workload changes abruptly. Finally, method-related weaknesses, such as inconsistent work procedures, inadequate process control, and weak discipline in inspection points, can amplify downtime and defect generation, further explaining the weekly volatility [18].

By linking quantitative OMAX outcomes to structured RCA diagnosis, the study provides a more precise causal explanation: productivity decline at PT SWA is primarily associated with equipment reliability issues, material quality inconsistencies, and human–method factors that jointly affect throughput efficiency and production effectiveness.

Managerial Implications and Improvement Recommendations

The combined OMAX–RCA results indicate that productivity improvements at PT SWA should prioritize interventions targeting the operational drivers most closely linked to low-performing ratios. Since the steepest declines were associated with weak efficiency ratios (output per worker and output per hour) and reduced effectiveness (defect-related losses), improvement programs should focus on machine reliability, material control, and operator capability [19].

First, PT SWA should implement scheduled preventive maintenance, supported by downtime recording and simple reliability indicators (e.g., jam frequency and duration of breakdown-related stoppages). This intervention directly targets efficiency ratios by reducing unplanned downtime, which suppresses output per hour and per worker, particularly under conditions similar to Weeks 6–8. Second, the company should strengthen material quality control by applying incoming inspection criteria and supplier feedback loops. Reducing raw material variability is expected to lower defect rates and improve production effectiveness, especially in weeks where defects are high, and rework erodes productivity (e.g., Weeks 3 and 5). Third, PT SWA should develop a structured operator training program that focuses on machine setup, handling procedures, and defect prevention. Skill improvement is expected to stabilize throughput, reduce errors, and improve the consistency of both efficiency and quality outcomes [20]. Finally, the company should standardize key work methods through concise operating procedures, clear inspection checkpoints, and routine coordination meetings, ensuring that method-related variation does not amplify machine and quality problems [21].

From a managerial perspective, these recommendations transform productivity measurement into a practical control system. Weekly OMAX monitoring can be used as a performance dashboard to identify early warning signals, while RCA provides a structured diagnosis for targeted corrective actions. This integrated approach supports faster decision-making, improves operational stability, and strengthens PT SWA's ability to meet project delivery requirements in steel fabrication services.

Conclusion

This study evaluated weekly productivity performance in steel fabrication services at PT SWA using the Objective Matrix (OMAX) method integrated with Root Cause Analysis (RCA). The results demonstrate that productivity at PT SWA fluctuated substantially every week during the ten-week observation period. Productivity improvements were observed in Weeks 1 and 2, with the highest increase recorded in Week 2, achieving a productivity index of 190%. After this initial improvement, productivity declined in subsequent weeks, reaching its lowest level in Week 8 at −78.33%. These findings indicate that productivity performance was unstable and strongly influenced by short-term operational conditions rather than by output volume alone.

Among the evaluated productivity ratios, the labor-based ratio, which represents the relationship between total production output and manpower, was identified as the most influential factor due to its highest weighting in the OMAX framework. The analysis further revealed that productivity decline was primarily associated with machine-related issues, inconsistent raw material quality and availability, and human-related factors such as insufficient operator skills and weak work discipline. The integration of OMAX and RCA enabled the identification of these causes by linking low-performing ratios and weeks to specific operational problems.

Despite providing valuable insights, this study has several limitations. First, the observation period was relatively short, covering only ten weeks, which may limit the generalizability of the findings across different project phases. Second, the research was conducted as a single case study at PT SWA, and the results may not fully represent productivity conditions in other steel fabrication service companies. Third, the study did not include a post-implementation evaluation of the proposed improvement strategies, as the recommendations were not yet implemented during the research period.

Future research is therefore recommended to extend the observation period to capture longer-term productivity patterns and seasonal effects. Comparative studies involving multiple projects or companies would also enhance the external validity of the findings. In addition, future studies should evaluate the effectiveness of implemented improvement measures by comparing productivity performance before and after intervention. Such research would strengthen the empirical basis for integrated OMAX–RCA approaches to productivity management in steel fabrication services.

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