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Research Paper

An Analysis of Factor Affecting the Effectiveness of Steel Structure Fabrication at PT Jagat Baja Prima Utama, Indonesia

Vincentius Ivan Ghandi[1], Lalu Mulyadi[2*], Erni yulianti[3]
[1,2,3] *(Master Program of Construction Management, Postgraduate Program, Institut Teknologi Nasional, Malang, Indonesia)*
Corresponding Author: Lalu Mulyadi

ABSTRACT : *Steel structure fabrication plays a strategic role in construction supply chains because it determines the readiness, quality, and timeliness of structural components before erection on site. This study analyzes the factors affecting the effectiveness of steel structure fabrication at PT Jagat Baja Prima Utama, Indonesia. Six operational factors are examined: workforce competency, material availability, fabrication equipment, production management, technical documents, and work environment. A quantitative explanatory survey was conducted using a saturated sample of 28 employees directly related to fabrication activities. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The measurement model met the requirements of convergent validity, discriminant validity, and internal consistency reliability, with Cronbach's Alpha ranging from 0.899 to 0.928, Composite Reliability ranging from 0.919 to 0.941, and AVE values above 0.50. The structural model shows strong explanatory power, with an R-square value of 0.742 and a Q-square value of 0.428. All six factors have positive and significant effects on fabrication effectiveness. Production management is the dominant factor with the highest path coefficient (0.294), t-statistic (3.115), p-value (0.002), and effect size (0.210). These findings indicate that fabrication effectiveness is mainly determined by the ability of the company to integrate workers, materials, equipment, technical information, and workshop conditions into a controlled production flow. The study recommends strengthening production planning, scheduling, work-package readiness, material readiness, technical document control, and competency-based training as the main strategies for improving fabrication effectiveness.*

KEYWORDS: *Construction management, steel structure fabrication, production management, fabrication effectiveness, PLS-SEM..*

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I. INTRODUCTION

The construction industry is a strategic sector that supports infrastructure development, industrial growth, public facilities, and building projects. Within this sector, steel structures are increasingly used because they offer strength, durability, speed of construction, and adaptability for complex project requirements. Steel components can be manufactured in workshops before delivery to project sites, allowing construction processes to become more controlled and efficient when the fabrication stage is well managed [1,2].

Steel structure fabrication is not a simple manufacturing activity. It involves cutting, drilling, fitting, welding, assembly, quality inspection, finishing, and delivery preparation. Each activity depends on the readiness of labor, materials, equipment, technical documents, and production coordination. Errors at the fabrication stage may create rework, schedule delay, material waste, equipment idle time, and quality problems during erection. Therefore, the effectiveness of the fabrication process is a critical determinant of project performance [3,4].

In practice, fabrication companies often face operational disturbances such as late material delivery, equipment downtime, inconsistent workmanship, unclear shop drawings, weak coordination, and inefficient workshop flow. These disturbances show that fabrication effectiveness cannot be explained by a single factor. It is formed by the interaction of human resources, physical resources, technical information, and managerial control. A fabrication system may have adequate machinery and skilled workers, but the output will remain suboptimal when work priorities, material readiness, or drawing status are not synchronized with production schedules [5,6]. The operational problems are summarized in Table 1.

Table 1. Operational problems affecting steel fabrication effectiveness

Factor	Common Problem	Operational Impact
Workforce competency	Measurement errors, incorrect reading of drawings, inconsistent welding quality	Rework and reduced product quality
Material availability	Late material delivery, insufficient stock, materials not in accordance with specifications	Production delay and idle time
Fabrication equipment	Machine downtime, equipment failure, inadequate production capacity	Lower productivity and output
Production management	Suboptimal scheduling, weak coordination, ineffective production control	Resource waste and work delays
Technical documents	Unclear shop drawings, late revisions, incomplete specifications	Fabrication errors and rework
Work environment	Ineffective workshop layout, low safety discipline, poorly organized work area	Reduced productivity and higher accident risk

PT Jagat Baja Prima Utama is a company engaged in engineering, fabrication, and construction, with a main activity in structural steel fabrication. As a company operating in a competitive construction industry environment, it needs to ensure that fabrication work is completed according to quality, time, and cost requirements. The operational complexity of the company makes it relevant as a case for examining how several internal factors affect steel fabrication effectiveness.

Previous studies have examined productivity and performance in construction and fabrication environments. They indicate that labor competency, material supply, equipment reliability, lean production, digital fabrication, and management systems influence construction manufacturing performance [10-18]. However, many studies still focus on particular variables separately. There remains a need for an integrated empirical model that simultaneously examines workforce competency, material availability, fabrication equipment, production management, technical documents, and work environment as determinants of fabrication effectiveness.

Based on this research gap, this study aims to analyze the effect of six operational factors on the effectiveness of steel structure fabrication at PT Jagat Baja Prima Utama. The study also identifies the dominant factor and translates the statistical findings into managerial implications for improving fabrication performance. Theoretically, the study contributes to construction management and operations management literature by explaining fabrication effectiveness as the result of an integrated production system. Practically, the findings provide a basis for prioritizing improvement programs in a steel fabrication workshop.

II. LITERATURE REVIEW

2.1. Effectiveness of Steel Structure Fabrication

Effectiveness refers to the ability of an organization or process to achieve intended results. In the context of steel structure fabrication, effectiveness is not limited to the volume of output produced. It also includes the ability to meet production targets, comply with technical specifications, maintain product quality, reduce rework, control production time, use resources efficiently, and ensure smooth workflow. Thus, fabrication effectiveness reflects both the output achieved and the reliability of the production process that produces the output [5,8].

Fabrication effectiveness is closely related to operations management. A fabrication workshop transforms steel materials, labor hours, technical drawings, machine capacity, and managerial decisions into finished structural components. The quality of transformation depends on planning, scheduling, coordination, process control, and the ability to respond to disturbances. In a project-based manufacturing environment, the effectiveness of this transformation is influenced by both repetitive production routines and project-specific requirements [6,9].

From a construction management perspective, the fabrication stage becomes a bridge between design and field installation. Errors in shop drawing interpretation, welding quality, dimensional accuracy, material identification, and production sequencing can affect construction performance at later stages. Therefore, fabrication effectiveness should be viewed as an integrated measure that connects quality management, production planning, material control, and project delivery [3,4].

2.2. Factors Affecting Fabrication Effectiveness

Workforce competency is a central factor in fabrication because workers directly interpret technical information, operate equipment, carry out fitting and welding processes, identify deviations, and solve problems on the shop floor. Competent workers can reduce measurement errors, improve consistency, and lower rework.

Prior studies on steel construction and fabrication show that workforce skill and technical capability are associated with productivity and efficiency [10,15].

Material availability refers not only to the existence of inventory but also to the readiness of materials for specific work packages. Steel materials must be available in the right quantity, quality, grade, dimension, identification, and time. Late or incomplete materials interrupt production flow and create idle time for workers and equipment. In fabrication systems, material readiness must therefore be integrated with production scheduling and technical document status [6,14].

Fabrication equipment provides the technical capacity needed for cutting, drilling, welding, lifting, and finishing. Equipment condition, availability, maintenance, and operational reliability affect the speed and continuity of production. Nevertheless, equipment capacity can only create value when supported by workers, materials, drawings, and schedules that are ready for production. For this reason, equipment should be assessed not only by ownership or quantity but also by its reliability and criticality in the flow of work [2,9].

Production management concerns the way the company plans, schedules, coordinates, monitors, evaluates, and controls fabrication activities. It determines how resources are assigned to priorities, how bottlenecks are identified, and how disturbances are handled. Production management is particularly important in fabrication environments because multiple jobs often compete for limited workshop space, material flow, machine capacity, and supervision [5,7].

Technical documents, such as shop drawings, specifications, connection details, work procedures, and revision records, function as the information input of fabrication. Incomplete, late, or unclear documents may result in waiting time, clarification requests, wrong fabrication, and rework. Effective document control ensures that only valid drawings are used in the workshop and that design changes are communicated to production, logistics, and quality control in a timely manner [3,4].

The work environment includes workshop layout, cleanliness, lighting, ventilation, material handling routes, workspace adequacy, safety, and supporting facilities. A good work environment supports movement efficiency, reduces safety risks, and helps workers concentrate on fabrication tasks. However, a good environment must be maintained continuously because increased work-in-process and material accumulation can quickly disrupt shop-floor mobility and safety [12].

2.3. Theoretical Framework

The theoretical framework of this study combines productivity theory, Resource-Based View, operations management theory, and the Theory of Constraints. Productivity theory explains that output is influenced by the quality and utilization of labor, materials, equipment, and managerial processes. Resource-Based View emphasizes that organizational resources create performance when they are valuable, organized, and difficult to substitute. Operations management theory explains the transformation of input into output through planning and control. Meanwhile, the Theory of Constraints highlights that system performance is limited by the weakest point or bottleneck in the production flow [5-7]. The conceptual relationship among variables is shown in Figure 1.

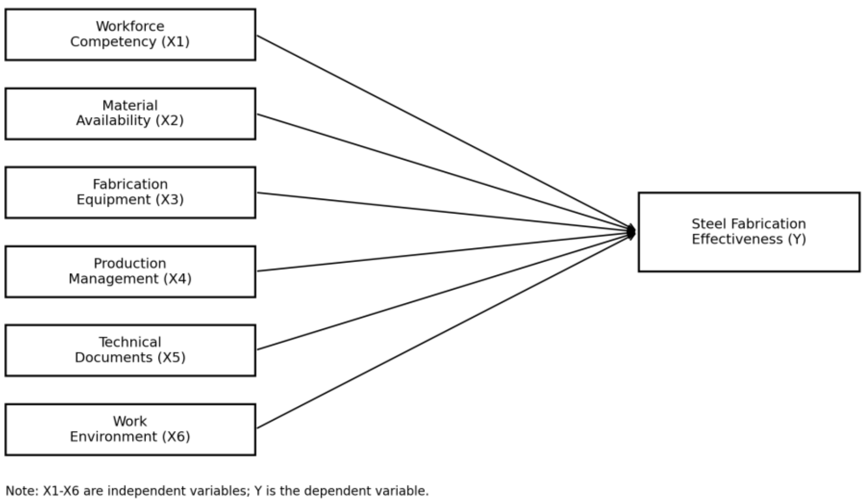

Figure 1. Conceptual framework of the study

Based on these perspectives, fabrication effectiveness is assumed to be influenced by six exogenous variables: workforce competency, material availability, fabrication equipment, production management, technical documents, and work environment. Each factor is expected to have a positive effect on fabrication effectiveness. The study also expects that one of these factors will become more dominant because fabrication performance depends not only on resource availability but also on the capability to integrate those resources into a coherent production flow.

III. RESEARCH METHOD

This study used a quantitative explanatory design to test the influence of several operational factors on steel structure fabrication effectiveness. The research was conducted at PT Jagat Baja Prima Utama, a company engaged in engineering, fabrication, and construction. The unit of analysis was employees who were directly involved in or closely related to fabrication activities, including production, fabrication, logistics, engineering, and quality control functions.

The population consisted of 28 employees who met the relevance criteria for the study. Because the population was limited and all members were accessible, the study used a saturated sampling technique. The respondent profile consisted of production personnel, fabrication workers, logistics personnel, engineering staff, and quality control staff. In terms of work experience, all respondents had at least one year of exposure to the company's fabrication process, and more than half had worked for more than three years. This profile supports the relevance of the responses because the questionnaire required practical knowledge of shop-floor processes.

The research instrument was developed as a Likert-scale questionnaire. The model consisted of seven reflective constructs: workforce competency, material availability, fabrication equipment, production management, technical documents, work environment, and fabrication effectiveness. Each construct was measured using eight indicators, resulting in 56 indicators in total. The indicators covered technical understanding, material readiness, equipment reliability, production planning, document control, workplace condition, and effectiveness outcomes such as quality, timeliness, productivity, resource efficiency, and smooth workflow. Table 2 summarizes the operationalized variables and indicators.

Table 2. Research variables, definitions, and indicators

Variable	Operational Definition	Main Indicators	Scale
Workforce competency (X1)	Employees ability to perform fabrication work according to technical standards.	Technical knowledge; procedure understanding; equipment operation; work-standard compliance; fabrication experience; drawing reading; problem solving.	Likert
Material availability (X2)	Availability of materials according to production needs in terms of quantity, time, and specifications.	Schedule compliance; material sufficiency; specification conformity; material quality; inventory control; supplier reliability.	Likert
Fabrication equipment (X3)	Readiness and capability of equipment to support structural steel fabrication.	Equipment availability; machine condition; capacity; reliability; maintenance; production technology.	Likert
Production management (X4)	Ability to plan, schedule, coordinate, control, and evaluate production activities.	Production planning; scheduling; coordination; supervision; performance evaluation; capacity utilization.	Likert
Technical documents (X5)	Quality and availability of technical information used during fabrication.	Document completeness; clarity; accuracy; timely distribution; revision control; accessibility.	Likert
Work environment (X6)	Workplace conditions that support safety, comfort, movement, and productivity.	Workshop layout; safety; cleanliness; lighting; ventilation; material movement.	Likert
Fabrication effectiveness (Y)	Success in achieving structural steel fabrication targets.	Product quality; time performance; productivity; cost efficiency; rework minimization.	Likert

Data analysis was carried out using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS. The analysis consisted of descriptive statistics, measurement model evaluation, discriminant validity evaluation, structural model evaluation, hypothesis testing through bootstrapping with 5,000 subsamples, and dominant factor analysis. Convergent validity was assessed using Average Variance Extracted, internal consistency reliability was assessed using Cronbach's Alpha and Composite Reliability, discriminant validity was assessed using Fornell-Larcker and HTMT criteria, and the structural model was assessed using VIF, R-square, Q-square, path coefficients, t-statistics, p-values, and effect size f-square. The analysis procedure is summarized in Figure 2.

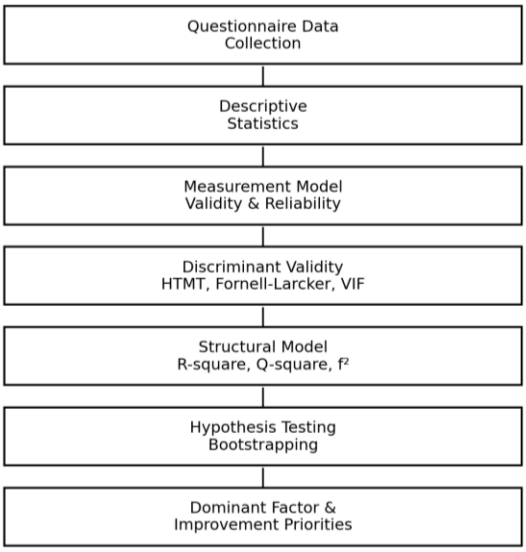

Figure 2. Research analysis procedure

The decision criteria used in the analysis were as follows: AVE should be greater than 0.50, Composite Reliability and Cronbach's Alpha should be above 0.70, HTMT should be below 0.90, VIF should be below 5.00, and a hypothesis is considered significant when the t-statistic is greater than 1.96 and the p-value is less than 0.05. These criteria were applied to ensure that the interpretation of the structural relationships was supported by acceptable measurement quality and model adequacy.

IV. RESULT AND DISCUSSION

4.1. Descriptive Results

Table 3. Respondent characteristics

Category	Group	n	%
Unit work	Production	9	32.14
Unit work	Fabrication	8	28.57
Unit work	Logistics	6	21.43
Unit work	Engineering	3	10.71
Unit work	Quality Control	2	7.14
Work experience	1-3 years	13	46.43
Work experience	3-5 years	8	28.57
Work experience	> 5 years	7	25.00
Education	Senior/Vocational High School	12	42.86
Education	Diploma III	7	25.00
Education	Bachelor/S1	9	32.14

The descriptive analysis shows that all constructs were perceived to be in the high category. The highest mean was obtained by the work environment (4.085), followed by fabrication equipment (4.027), technical documents (3.978), fabrication effectiveness (3.978), production management (3.929), workforce competency (3.906), and material availability (3.879). This result indicates that the company generally has positive operational conditions, but the relatively lower score of material availability suggests that material readiness remains an important area for improvement.

Table 4. Descriptive statistics of research constructs

No.	Construct	Code	Indicators	Min.	Max.	Mean	Std. dev.	Category
1	Workforce competency	X1	8	3	5	3.906	0.617	High
2	Material availability	X2	8	2	5	3.879	0.689	High
3	Fabrication equipment	X3	8	2	5	4.027	0.714	High
4	Production management	X4	8	2	5	3.929	0.572	High
5	Technical documents	X5	8	3	5	3.978	0.699	High
6	Work environment	X6	8	2	5	4.085	0.681	High
7	Fabrication effectiveness	Y	8	3	5	3.978	0.384	High

The difference between descriptive condition and structural contribution is important. A high mean does not necessarily indicate that a factor is the most influential determinant of effectiveness. For instance, the work environment obtained the highest mean, but its substantive contribution in the structural model was the smallest. Conversely, production management did not obtain the highest descriptive mean, yet it became the strongest predictor of fabrication effectiveness. Therefore, improvement priorities should be determined not only from mean scores but also from path coefficients and effect sizes.

4.2. Measurement Model Evaluation

The measurement model met the requirements for convergent validity and reliability. All constructs had AVE values above 0.50, ranging from 0.589 to 0.664. This indicates that each construct was able to explain more than half of the variance of its indicators on average. Composite Reliability values ranged from 0.919 to 0.941, and Cronbach's Alpha values ranged from 0.899 to 0.928. These results demonstrate adequate internal consistency and show that the indicators reliably measured their respective constructs.

Table 5. Construct reliability and validity

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE	Decision
Workforce competency	0.908	0.912	0.926	0.612	Valid and reliable
Material availability	0.903	0.909	0.922	0.598	Valid and reliable
Fabrication equipment	0.914	0.920	0.930	0.625	Valid and reliable
Production management	0.928	0.935	0.941	0.664	Valid and reliable
Technical documents	0.919	0.924	0.934	0.640	Valid and reliable
Work environment	0.899	0.905	0.919	0.589	Valid and reliable
Fabrication effectiveness	0.922	0.929	0.936	0.648	Valid and reliable

Discriminant validity was also achieved. The Fornell-Larcker evaluation showed that the square root of AVE for each construct was higher than its correlations with other constructs. In addition, all HTMT values were below 0.90, with the highest value remaining clearly below the accepted threshold. These findings indicate that the seven constructs measured different empirical concepts, even though they are operationally connected in the fabrication system.

The inner VIF values ranged from 1.850 to 2.450, all below the threshold of 5.00. Thus, the model did not show critical multicollinearity among the exogenous variables. This result allows each path coefficient to be interpreted as the relative contribution of the corresponding factor to fabrication effectiveness.

4.3. Structural Model and Hypothesis Testing

The structural model demonstrated strong explanatory and predictive power. The R-square value for fabrication effectiveness was 0.742, meaning that 74.2% of the variance in fabrication effectiveness was explained by workforce competency, material availability, fabrication equipment, production management, technical documents, and work environment. The remaining 25.8% may be explained by other factors outside the model, such as project complexity, customer changes, supplier performance, digitalization level, or project-specific characteristics. The Q-square value was 0.428, indicating that the model had predictive relevance. Table 6 summarizes model quality and effect size values.

Table 6. Structural model quality and effect size

Indicator / Factor	Value	Interpretation
R-square of fabrication effectiveness	0.742	Strong explanatory power
Q-square of fabrication effectiveness	0.428	Predictive relevance
f^2: production management	0.210	Medium
f^2: workforce competency	0.145	Small to medium
f^2: material availability	0.118	Small to medium
f^2: technical documents	0.105	Small to medium
f^2: fabrication equipment	0.088	Small
f^2: work environment	0.062	Small

Bootstrapping results show that all six factors had positive and significant effects on fabrication effectiveness. Workforce competency had a path coefficient of 0.245, t-statistic of 2.412, and p-value of 0.016. Material availability had a path coefficient of 0.198, t-statistic of 2.054, and p-value of 0.040. Fabrication equipment had a path coefficient of 0.162, t-statistic of 1.985, and p-value of 0.047. Production management had a path coefficient of 0.294, t-statistic of 3.115, and p-value of 0.002. Technical documents had a path coefficient of 0.185, t-statistic of 2.103, and p-value of 0.036. Work environment had a path coefficient of 0.214, t-statistic of 2.338, and p-value of 0.019. The hypothesis testing results are presented in Table 7.

Table 7. Hypothesis testing results

Hypothesis	Relationship	Path coefficient	t-statistics	p-values	Decision
H1	X1 → Y	0.245	2.412	0.016	Supported
H2	X2 → Y	0.198	2.054	0.040	Supported
H3	X3 → Y	0.162	1.985	0.047	Supported
H4	X4 → Y	0.294	3.115	0.002	Supported
H5	X5 → Y	0.185	2.103	0.036	Supported
H6	X6 → Y	0.214	2.338	0.019	Supported

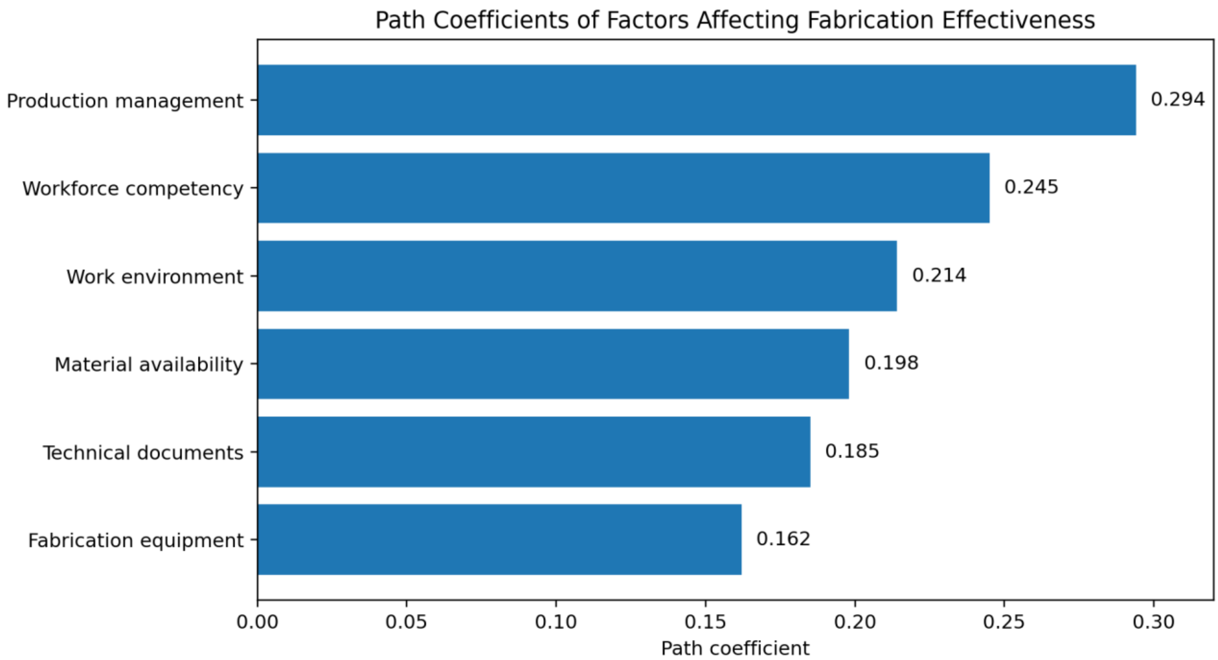

Figure 3. Path coefficients of factors affecting fabrication effectiveness

Table 8. Ranking of factors affecting fabrication effectiveness

Rank	Factor	Mean	Path Coefficient	f²	p-values	Interpretation
1	Production management	3.929	0.294	0.210	0.002	Dominant factor
2	Workforce competency	3.906	0.245	0.145	0.016	High priority
3	Material availability	3.879	0.198	0.118	0.040	High priority
4	Technical documents	3.978	0.185	0.105	0.036	Medium priority
5	Fabrication equipment	4.027	0.162	0.088	0.047	Targeted monitoring
6	Work environment	4.085	0.214	0.062	0.019	Maintain condition

The direction of all path coefficients was positive. This means that improvements in each operational factor are associated with improved fabrication effectiveness. However, the magnitude of the relationships differs. The highest path coefficient belongs to production management, followed by workforce competency, work environment, material availability, technical documents, and fabrication equipment. This pattern suggests that the effectiveness of fabrication is influenced not merely by the presence of resources but by how those resources are coordinated and controlled.

4.4. Dominant Factor and Managerial Interpretation

Production management emerged as the dominant factor. It had the highest path coefficient (0.294) and the highest effect size (0.210), making it the only factor with a medium effect. This finding implies that planning, scheduling, coordination, monitoring, capacity control, priority setting, and response to disturbances are the most important levers for improving steel structure fabrication effectiveness at PT Jagat Baja Prima Utama.

The dominance of production management can be explained by its integrating function. Competent workers, available materials, reliable equipment, valid drawings, and a good work environment will not automatically produce effective output when jobs are not planned, sequenced, and coordinated properly. Production management connects these resources into a production flow. It determines which work package should be processed, whether material and drawings are ready, which equipment is needed, how bottlenecks should be addressed, and how actual progress is compared with production targets.

From the perspective of the Theory of Constraints, the results indicate that the main limitation in fabrication effectiveness may not always be a physical resource such as a machine or labor quantity. Managerial constraints, such as inaccurate scheduling, delayed decisions, unsynchronized material readiness, excessive work-in-process, and weak response to disturbances, can also restrict throughput. Therefore, the first improvement priority should not automatically be adding more machines or workers, but strengthening the managerial system that controls the flow of work.

Workforce competency ranked second in terms of contribution. This indicates that workers remain a critical determinant because they translate drawings and procedures into physical components. Competency improvement should be targeted toward shop drawing interpretation, fit-up accuracy, welding quality, equipment operation, problem solving, quality awareness, and standard work compliance. Training outcomes should be evaluated through operational indicators such as rework rate, first-pass acceptance, repair rate, and problem-resolution time rather than only the number of training hours.

Material availability requires particular attention because it had the lowest mean score while still exerting a significant influence. Material readiness should be distinguished from inventory availability. A material can be present in the warehouse but not ready for production when it is not properly identified, does not match the required specification, is inaccessible, or has not been allocated to a specific work package. Therefore, material readiness should be integrated with production scheduling and drawing status.

Technical documents also influence fabrication effectiveness because they are the information basis for fabrication work. Invalid drawings, late revisions, incomplete details, and slow clarification responses may generate waiting time or rework. The company should strengthen document control by ensuring drawing readiness before production, confirming revision distribution, withdrawing obsolete documents, monitoring request-for-information aging, and integrating engineering information with material planning and production control.

Fabrication equipment had the smallest path coefficient, although its effect remained significant. This result should not be interpreted as equipment being unimportant. Instead, it suggests that equipment conditions were perceived as relatively good in the studied company. The managerial implication is that equipment should be maintained through preventive maintenance based on criticality, downtime tracking, and capacity monitoring. Investment in additional machinery should be justified by evidence of equipment-related bottlenecks rather than by general assumptions.

The work environment obtained the highest descriptive mean and a significant path coefficient. This indicates that the workshop environment supports fabrication effectiveness and should be maintained. Housekeeping, material handling routes, lighting, ventilation, workspace order, and safety practices must be sustained, especially when workload increases. Safety should also be treated as part of production effectiveness because accidents can stop work, reduce productive hours, and disrupt schedules.

4.5. Practical Improvement Model

Based on the findings, the proposed improvement approach places production management at the center of integration. The company should implement production readiness checks before work packages enter the schedule. These checks should confirm material readiness, drawing readiness, workforce readiness, equipment availability, and quality requirements. Work packages that are not ready should not be forced into production because doing so can increase idle time, rework, and schedule changes.

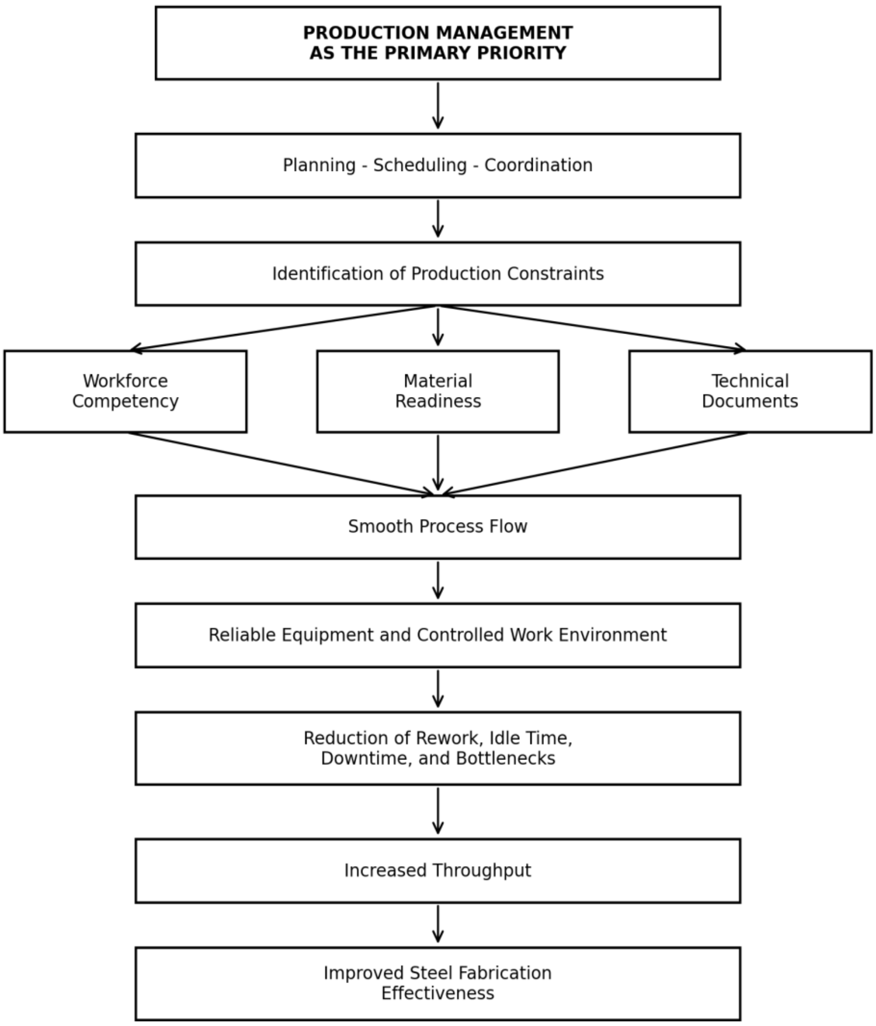

Figure 4. Recommended model for improving steel fabrication effectiveness

Table 9. Managerial improvement priorities

Priority Area	Recommended Action
Production management	Strengthen production readiness checks, weekly and daily scheduling, work-in-process monitoring, and constraint control.
Workforce competency	Improve training in drawing reading, welding/fitting standards, machine operation, and technical problem solving.
Material readiness	Integrate material control with production schedules, monitor critical materials, and improve supplier coordination.
Technical documents	Validate shop drawings, control revisions, speed up distribution, and ensure document accessibility at the workshop.

Priority Area	Recommended Action
Equipment and work environment	Prioritize preventive maintenance for critical equipment and maintain safe, clean, and efficient workshop layout.

Production control should also include weekly and daily priority setting, work-in-process limits at critical stages, visual production control, and routine constraint identification. Coordination meetings should focus on the main obstacles, responsible persons, corrective actions, and deadlines for resolution. This approach will make production meetings function as a control mechanism rather than merely a progress reporting forum.

The expected impact of the improvement model is the reduction of rework, idle time, downtime, material waiting time, and bottlenecks. By reducing these disturbances, the company can improve throughput, enhance schedule adherence, and strengthen the effectiveness of steel structure fabrication. The model also helps management prioritize improvement actions based on empirical evidence rather than intuition alone.

V. CONCLUSION

This study concludes that workforce competency, material availability, fabrication equipment, production management, technical documents, and work environment all have positive and significant effects on the effectiveness of steel structure fabrication at PT Jagat Baja Prima Utama. The structural model explains 74.2% of the variance in fabrication effectiveness and has predictive relevance, indicating that the six operational factors form a strong empirical model for understanding fabrication effectiveness.

Production management is the dominant factor affecting fabrication effectiveness. It has the highest path coefficient, the strongest statistical significance, and the largest effect size. This finding shows that the main issue in improving fabrication effectiveness is not simply the availability of individual resources, but the company’s capability to integrate those resources into a controlled production flow.

The managerial implication is that PT Jagat Baja Prima Utama should prioritize strengthening production planning, scheduling, coordination, monitoring, work-package readiness, work-in-process control, and constraint management. Workforce competency, material readiness, and technical document control should also be improved because they directly support the production flow. Equipment reliability and the work environment should be maintained through preventive maintenance, housekeeping, material handling control, and safety management.

The study is limited to one company and uses cross-sectional questionnaire data from 28 respondents. Future research should combine perception-based data with actual shop-floor indicators such as tonnage output, productive labor hours, rework rate, welding repair rate, equipment downtime, material waiting time, schedule adherence, and fabrication lead time. Comparative studies involving several steel fabrication companies and longitudinal designs are also recommended to examine whether the dominant constraints change over time.

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