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A FORMAL ANALYSIS THE IMPLEMENTATION OF THE THEORY OF CONSTRAINTS (TOC) ACROSS FOUR PRODUCTION SYSTEM MODELS: MICRO-ENTERPRISES, AGRICULTURE, FOOD PROCESSING, AND MANUFACTURING

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Abstract

In the application of the Theory of Constraints (TOC) as an approach to increase production capacity, operational efficiency, and profitability in various business sectors, ranging from Enterprises, Micro, Small, and Medium (MSMEs) to large-scale industries. In general, each research object has major obstacles (bottlenecks) that hinder production flow, such as limited machine capacity, long process time, and unbalanced production trajectory. The implementation of TOC is carried out through five core stages, namely identification of constraints, exploitation of constraints, subordination to other resources, evaluation, and continuous repetition of the improvement process. Various studies show that solutions such as adding machines, increasing working hours, reorganizing production flows, and optimizing scheduling are able to increase throughput, lower operational costs, and improve the fulfillment of market demand. The implementation of TOC has also been proven to be able to increase profits, both through production cost efficiency and increasing production capacity that is more in line with demand. Overall, this series of studies proves that TOC is an effective, applicative, and relevant approach to be applied to various types of businesses in order to achieve more optimal and sustainable operational performance.

Keywords: Theory of Constraints, Efficiency, Bottleneck, Profitability

INTRODUCTION

In the development of industries and MSMEs, companies are required to be able to optimize their production processes in order to meet demand effectively and efficiently. However, in practice, many companies face various production constraints that hinder operational performance, such as limited machine capacity, unbalanced processing times, and bottlenecks at certain workstations. This situation is evident in the various studies referenced in this study.

In a study on Gampong-Owned Enterprises (BUMG) Malacca, it was found that there was an imbalance in capacity between the mixing station and the pelleting station which caused material accumulation and production delays (F. Syiam 2021). Similar conditions also occur in Sari Asih Chips MSMEs, where the process of cassava cutting, comring printing, and frying is an obstacle point that limits the ability of MSMEs to meet market demand (G. Hamidah 2025). Other research on PT. Perkebunan Nusantara X (PTPN X) Tjoekir Sugar Factory, shows that obstacles related to machinery and process efficiency cause high production costs and low

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manufacturing cycle effectiveness (Inayati 2028) . Meanwhile, Teh Karya Tani MSMEs face obstacles in the winding and packaging process, which has an impact on the low percentage of market demand fulfillment compared to the total existing demand (S. Bahri 2022)

The implementation of TOC becomes relevant in that context because it provides a systematic approach to identifying, analyzing, and addressing the most inhibiting production constraints. With its five main stages, TOC helps companies determine improvement priorities, select effective alternative solutions, and ensure continuous performance improvement. Through the study of these various studies, it can be seen that TOC not only increases production capacity, but also increases cost efficiency and profitability. Therefore, the implementation of TOC is one of the important strategies for MSMEs and industries to increase competitiveness in a dynamic market.

METHODOLOGY (Material and Method)

The methodology of this study was compiled to analyze the application of TOC based on four references that have different production process characteristics, namely BUMG Malacca (animal feed industry), Sari Asih Chips MSMEs (snack industry), PTPN X Tjoekir Sugar Factory (large-scale manufacturing industry), and Teh Karya Tani MSMEs (agricultural industry). Although they come from different sectors, these four references have the same problem pattern: the existence of capacity imbalances that create bottlenecks. Therefore, the methodology of this study not only exposes the analysis techniques, but also compares how each study processes the data and applies the TOC to obtain relevant results.

Types and Approaches to Research

This study uses a descriptive-comparative approach, namely describing the flow of the production process in each reference and then comparing the constraint patterns and analysis methods used. A descriptive approach is used to describe the production process, machine capacity, process time, and output displayed in each file. Meanwhile, a comparative approach was used to find similarities and differences in how TOC is applied between industries, so that the research results are more analytically robust. This approach was chosen because:

1. BUMG Malacca has a mechanical and gradual production process.
2. Sari Asih Chips MSMEs have a manual process that relies heavily on labor.
3. PTPN X has a large-scale industrial process with more complete quantitative data.
4. Teh Karya Tani MSMEs have a semi-manual process with limited tools.

Research object

The object of this research consists of four production systems, as follows:

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1. BUMG Malacca:

The object is in the form of the animal feed production process starting from milling, mixing, to pelleting. The pelleting station capacity which is only able to process ±300 kg/h compared to the mixing process which is able to reach ±450 kg/h shows a significant capacity gap.

2. MSMEs Chips Sari Asih:

The object is in the form of the process of making comring chips which involves cutting (200 kg/day), printing (160 kg/day), and frying (120 kg/day). This data directly reflects the bottleneck at the frying station.

3. PTPN X Tjoekir sugar factory:

The object of the research includes a series of long processes ranging from sap extraction, evaporation, crystallization, playing, to packaging. The MCE value of 32% indicates that most activities are still non-value added.

4. MSMEs tea by farmers:

The object is the process of processing tea leaves, especially at the winding and packaging stages. The winding capacity of 25 kg/h and the packaging of 18 kg/h mark the existence of an imbalance of capacity.

Data collection techniques

Data were obtained entirely through a literature review of the four research references.

1. Run time(minutes/stations).
2. Machine capacity (kg/h).
3. Daily/weekly output.
4. Value-added vs non-value-added activities.
5. Operational costs (PTPN X only).

Research Flow

The research flow consists of:

1. Data collection from four files.
2. Describe the production flow of each object.
3. Identify bottlenecks based on capacity and process time.
4. Compare the types of constraints between industries.
5. Analyze using TOC stages.
6. Develop an interpretation of improvements based on the results of the analysis.
7. Deduce the relationship between constraint patterns between references

RESULT AND DISCUSSION

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The results of the analysis of the implementation of TOC are based on four research references, namely BUMG Malacca, MSMEs Kechipik Sari Asih, PTPN X Tjoekir Sugar Factory, and MSMEs Tea Karya Tani. The analysis was developed by comparing the constraint patterns, production capacity, and effectiveness of repairs made on each object. This discussion focused on how TOC helps improve the efficiency of the production flow through systematic identification and handling of bottlenecks.

Results of Identification of Production Constraints

Based on the analysis of the four references, it was found that each industry, both medium and MSME, has different bottlenecks, but the impact is similar on the smooth production process. At BUMG Malacca, bottlenecks occurred at the pelleting station due to lower engine capacity than other stations. Sari Asih Chips MSMEs experienced a bottleneck in the frying process whose capacity was not able to keep up with the production volume from the previous stage. In contrast, PTPN X Tjoekir Sugar Factory does not have a bottleneck in the form of one specific station, but faces many non-value added activities such as waiting times and goods movements that cause a low MCE value, which is 32%. The Teh Karya Tani MSMEs have a bottleneck in the packaging process because the capacity of the equipment is smaller than the daily production needs.

Comparative Analysis of Capacity and Production Flow

The comparative analysis of production capacity across various industrial scales highlights a consistent operational challenge, namely the imbalance of capacity between interconnected stages within the production system. Although large-scale industries such as PTPN X exhibit a more complex structure compared to MSMEs, the fundamental issue remains identical: the misalignment of process capacities that disrupts production continuity. This capacity mismatch leads to inefficiencies, prolonged lead time, accumulation of work in process (WIP), and increased operational costs. Consequently, achieving optimal synchronization among processes becomes a central concern in enhancing productivity and maintaining competitiveness.

In the case of BUMG malacca, a significant disparity exists between the mixing process (±450 kg/hour) and the pelleting stage (±300 kg/hour). This gap indicates that the pelleting station operates below the required capacity to sustain the output generated by prior processes. The resulting imbalance causes a buildup of material inventory before the pelleting station, leading to increased waiting times and reduced throughput. Such inefficiencies highlight the critical need for capacity balancing to ensure smooth material flow and minimize production delays.

For the Sari Asih Chips MSME, the discrepancy between the cutting process (200 kg/day) and the frying process (120 kg/day) demonstrates that the latter acts as the primary bottleneck. The

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slower processing rate at the frying stage results in the accumulation of semi finished materials, which not only slows down the entire production cycle but also risks affecting product quality. Prolonged waiting times before frying may alter the moisture content and texture of raw materials, thereby influencing the final product's consistency.

Similarly, the Teh Karya Tani MSME experiences a capacity constraint between the rolling process (25 kg/hour) and the packaging process (18 kg/hour). The lower capacity at the packaging stage forms a bottleneck that hinders production continuity and extends overall lead time. When the final stage operates below the required throughput, it limits the enterprise's ability to increase production volume despite the availability of capacity in earlier processes. This condition underscores the significance of evaluating downstream processes carefully, as constraints often emerge in the final stages where product value has already accumulated.

Across all cases examined, the presence of capacity imbalance is evident regardless of industry scale. This finding reinforces the importance of applying capacity planning and TOC based approaches to identify, analyze, and mitigate bottlenecks. By addressing these constraints, industries and MSMEs can achieve a more streamlined production flow, reduce non value added activities, and enhance overall production efficiency.

The Effectiveness of Implementing TOC on Each Object

The analysis indicates that the implementation of the TOC has made a substantial contribution to enhancing operational efficiency across all observed cases. In general, the TOC framework effectively directs organizational attention toward the processes that function as the primary constraints, allowing improvement efforts to be executed in a more targeted, systematic, and impactful manner. As a result, organizations experience notable increases in throughput and reductions in waiting time throughout the production flow.

At BUMG Malacca, the application of TOC by identifying the bottleneck at the pelleting station proved effective in reducing the persistent accumulation of materials that had previously hindered production continuity. By concentrating on optimizing the capacity of the pelleting process, through workflow adjustments and better alignment of production rhythms, the enterprise achieved more stable output levels. These improvements also contributed to shorter inter process waiting times and better utilization of machine capacity, ultimately supporting a smoother and more consistent production flow.

For the Sari Asih Chips MSME, TOC was implemented by reassessing frying durations and restructuring production schedules to align more closely with the actual capacity of the frying station. These adjustments substantially improved the enterprise's ability to meet market demand, as the process previously functioning as the main constraint could now operate in

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harmony with upstream production stages. Furthermore, reducing the accumulation of semi-processed materials helped prevent declines in product quality that could occur when raw materials remain idle for extended periods before further processing.

At PTPN X, constraints were not associated with a single production station but rather with the prevalence of non value added activities that negatively affected overall efficiency. Through the TOC approach, the company successfully identified and addressed sources of inefficiency such as excessive waiting times, unnecessary product movement, and suboptimal process flow. Eliminating these non-value-added activities resulted in a significant improvement in the MCE, demonstrating a higher proportion of value-added time within the overall production cycle.

In the Teh Karya Tani MSME, TOC efforts were concentrated on the packaging process, which served as the primary capacity limitation. By extending working hours at the packaging stage and aligning its workflow with earlier production processes, the enterprise achieved a substantial increase in throughput. These improvements helped reduce delays in fulfilling customer orders and enhanced the MSME's ability to manage daily production volumes more efficiently. Improved synchronization among processes also minimized product accumulation at the final stages of production, enabling a reduction in lead time.

Overall, the findings from all examined objects reaffirm that TOC is an effective method for improving production efficiency in both large scale industries and MSMEs. By prioritizing the identification and management of the primary constraint, organizations can optimize workflow, enhance resource utilization, and achieve sustainable improvements in operational performance.

Summary of Result

Table 1. Summary of the Study Literature

Research Object	Jenis Bottleneck	Capacity Constraints	Dampak Bottleneck	Fixes with TOC
BUMG Malacca	Pelleting	300 kg/h	Build-up on previous processes	Adjustment of working hours & capacity building recommendations
Scarlet Witch	Frying pan	120 kg/day	Output delays & unmet demand	Workflow balancing & frying time optimization
PTPN X Tjoekir	Aktivitas non-value added	MCE 32%	Long production cycle & high cost	Reduction of non-value added activities & refinement of the flow
Farmer Tea	Packaging	18 kg/h	Limited output & distribution delays	Capacity adjustment & increase in operating hours

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From the four research objects, it can be seen that TOC provides a consistent framework for dealing with various types of production constraints. Although the characteristics of the process are different. heavy machinery, manual production, large industry, and processed agriculture. TOC remains effective because its main principle focuses on improving workflows, not on the entire process at once. This is in line with the general conclusion that efficiency improvements do not have to be done thoroughly, but simply by optimizing the most restrictive stations. Thus, TOC has proven to be adaptive and can be an important reference in the preparation of process improvement strategies in various industrial sectors.

CONCLUSION AND SUGGESTION

Conclusion

Based on the analysis of the implementation of the TOC, it can be concluded that each MSME examined exhibits different bottlenecks within its production process; however, all experience similar impacts in the form of reduced production capacity and the inability to meet market demand optimally. Through the TOC stages; comprising constraint identification, exploitation of existing resources, subordination of other processes, evaluation, and the repetition of the improvement cycle. MSMEs are able to determine effective solutions for addressing their primary operational barriers.

The implementation of various alternatives, such as extending working hours, investing in additional machinery, and reorganizing production flows, has been shown to increase throughput, reduce non value added activities, and lower operational costs. Consequently, the application of TOC contributes positively to enhancing production capacity, improving process efficiency, and ultimately increasing the profitability of the enterprise.

Moreover, the consistent results across different case studies reinforce the applicability and robustness of TOC as a methodological framework for diagnosing and resolving core operational constraints. Its structured, iterative nature not only supports immediate performance enhancement but also encourages a long-term culture of continuous improvement. Therefore, TOC stands as a valuable analytical tool for future academic inquiry and for practical implementation within small-scale industries seeking sustainable operational advancement.

Suggestion

1. To maintain the effectiveness of production capacity improvements, companies need to implement the TOC cycle continuously. This approach ensures that any emerging constraints can be promptly identified and addressed appropriately.

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2. Based on the findings from UMKM Keripik Sari Asih, we emphasize that *"the restructuring of process flows and the strengthening of capacity measurements at each workstation must be prioritized to prevent the recurrence of bottlenecks in the cutting and frying processes."*

3. In response to the research results on UMKM Teh Karya Tani, we recommend that *"any investment in new machinery should be accompanied by adequate workforce preparedness and long-term demand analysis, ensuring that the increase in production capacity is not merely temporary."*

4. Referring to the case of BUMG Malaka, we assert that *"the use of overtime should only serve as a short-term solution; the company needs to consider adding machinery to avoid dependence on extended working hours."*

5. Based on the findings at the Tjoekir Sugar Factory, we suggest that *"the application of the Manufacturing Cycle Efficiency (MCE) indicator should be expanded to more comprehensively identify non–value-added activities and enhance production cost efficiency."*

REFERENSI

F. Syiam, (2021)*"Implementation of the Theory of Constraints for Increasing Production Capacity and Profit in Teh Karya Tani MSMEs" Proceedings of The 12 th Industrial Research Workshop and National* Seminar Bandung.

G. Hamidah and P. N. (2025) Application of Theory of Constraints (TOC) to Increase Production Capacity and Company Profit (Case Study on MSMEs of Sari Asih Chips *Indonesian Accounting Literacy Journal*, vol. 5, no. 2, pp. 124–138.

Inayati and D. Wahyuningsi (2018) *Theory of Constraint (TOC) Approach in Improving Production Cost Efficiency (Study at PT. Nusantara Plantation X Tjoekir Sugar Factory Diwek Jombang Regency, East Java Province).*

S. Bahri and Khairul Anshar (2022) *Application of the Theory of Constraints Method for Floating Fish Feed Production at BUMG Malacca"* National Seminar, Faculty of Engineering, Malikussaleh University in 2022.