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Strategy Alternatives to Increase Capacity: Study Case in PT Turmerica, an Herbal Extract Manufacturer

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ABSTRACT

The increased global demand for herbal extracts has made PT Turmerica need to re-evaluate its current output capacity. This study aimed to evaluate the most feasible and profitable business solution to solve the production capacity gap and meet the market demand through a combination of technical and financial analyses. Using the TELOS framework and Decision Tree Analysis, three strategic alternatives have been evaluated for consideration: A1 is to invest in a new concentrator machine; A2 is outsourcing; and A3 is extending working hours. From production data from 2023–2025 and expected market growth rates, it can be seen that the current production capacity of 161,915 kg/year is insufficient to meet future demand; the gap to be bridged is estimated to exceed 17% by 2027. The analysis found that the extractor machine was the main bottleneck in the extraction line, lowering throughput and increasing cleaning and maintenance time. A1 (investment in a new concentrator machine) is the most beneficial alternative, improving capacity by 35.1% as it speeds up extraction concentration, makes extract thickening unnecessary for the extractor, and prevents blockages. In contrast, both A2 (outsourcing) and A3 (additional working hours) have only increased capacity by 8.6% and 24.6%, respectively, with much higher operational risks and weaker long-term sustainability. Based on TELOS results, A1 offers the most feasible and profitable option according to decision tree analysis, which produces higher cash flow.

KEYWORDS *Herbal extracts; Capacity expansion, Herbal Extract, Decision Tree, TELOS framework, investment, Outsourcing, Additional Working Hours.*

INTRODUCTION

The global herbal industry has experienced remarkable growth over the past decade, supported by shifting consumer preferences toward natural, plant-based health solutions. According to Grand View Research (2024), the global herbal supplements market was valued at approximately USD 42.33 billion in 2024 and is projected to expand at a compound annual growth rate (CAGR) of 8.89% from 2025 to 2033. The growing demand for plant-based products is increasingly evident as consumers seek natural alternatives for health and well-being. The advantages of plant remedies, often rooted in empirical practices, contribute to their growing acceptance in modern medicine (Izah et al., 2024).

The expansion of the herbal market reflects a broader shift toward health consciousness and environmental sustainability, driven by increasing consumer awareness of the potential side effects of synthetic pharmaceuticals and a preference for holistic wellness approaches. From an industrial economics perspective, this market growth presents both opportunities and challenges for manufacturers, particularly in terms of scaling production capacity to meet escalating demand while maintaining product quality and cost efficiency. Capacity planning theory suggests that firms must align their production capabilities with market demand trajectories to sustain competitive advantage (Conejo et al., 2021; Pinedo, 2016). The failure to adequately address capacity constraints can result in lost market share, customer dissatisfaction, and diminished profitability. There was 83% consumer support for increasing the availability of natural medicine products in the market (Obahiagbon & Ogwu, 2024). In addition, the global plant-based market continuously develops, particularly in the fight against lifestyle diseases.

Indonesia stands out as a significant contributor to the global herbal sector, owing to its rich biodiversity and centuries-old tradition of herbal medicine, known locally as jamu

. The market for herbs and natural products in Indonesia is experiencing significant growth, driven by the increasing demand from consumers for holistic health solutions (Harfiani, Puspita, and Prabarini, 2025). However, the Indonesian herbal industry faces substantial operational challenges that constrain its growth potential. These include technological limitations in extraction processes, inadequate production infrastructure, and compliance requirements related to Good Manufacturing Practices (GMP) and halal certification (Purwaningsih et al., 2021). Specifically, many Indonesian herbal manufacturers operate with outdated extraction equipment that limits throughput, increases maintenance downtime, and reduces product yield efficiency (Sumarya et al., 2020). Furthermore, the lack of standardized production protocols and quality control mechanisms creates bottlenecks that prevent manufacturers from achieving economies of scale (Illian et al., 2021).

These operational constraints directly affect production capacity—the maximum output that a manufacturing system can produce under given technological and organizational conditions—which becomes a critical limiting factor when market demand exceeds available supply (Stevenson, 2018). In the context of PT Turmerica, these national-level challenges manifest as specific capacity limitations in the extraction line, where aging equipment and inefficient processes prevent the company from fulfilling growing market orders. Reports indicate many opportunities in agromedicine and functional foods for the Indonesian market, promoting economic growth and health benefits (Sihombing & Nugraha, 2025; Arwanto et al., 2022; Sumarya et al., 2020).

The rapid development of both the global and domestic herbal markets brings new challenges to manufacturers as markets grow larger and client expectations increase. Companies are increasingly compelled to enhance capacity and operational efficiency to sustain competitive advantage. PT Turmerica, an Indonesian manufacturer of herbal extract, despite the above advantages, is now facing capacity constraints to fulfill market demand. This creates operational problems for the company, as it relies on a limited number of extraction machines—all of which are already operating near their maximum efficient capacity, at 117% in 2027 (Internal Data of PT Turmerica, 2025).

With demand continuously increasing, this capacity restricts how the company can service orders and meet market requests with speed and dependability. Addressing production capacity issues must be strategic and multidimensional. Some alternatives include buying new extraction equipment, outsourcing to an external party or collaborating with other manufacturers, and adding working hours or adjusting shifts. However, the alternatives all have different financial, operational, and regulatory implications that should be studied diligently to stay aligned with the company's long-term business plan and capabilities.

PT Turmerica's efforts to optimize production capacity are critical for maintaining its position in the Indonesian herbal extract market. This study is significant due to the capacity limitation, which is one of the most important factors for the manufacturing company's effectiveness and profitability. Furthermore, these constraints commonly lead to underutilized resources and the inability of companies to fulfill market demand effectively. To respond to this challenge, a thorough analysis is required to understand their implications and to develop practical optimization strategies. Given these strategic options, this case study analysis focuses on identifying the most feasible and profitable strategy for PT Turmerica to expand its production capacity.

Several empirical studies have examined capacity expansion strategies across manufacturing contexts, yet significant research gaps remain. Ghamat et al. (2018) investigated optimal investment strategies in production machinery and found that capital investments in new equipment can yield substantial improvements in production capacity and cost efficiency, particularly when bottleneck operations are identified and targeted. Their analysis demonstrated that firms achieving the highest returns were those that strategically invested in technologies addressing specific production constraints rather than broadly upgrading all equipment. However, their study focused primarily on large-scale manufacturers in developed economies, leaving questions about the applicability of these findings to small and medium-sized enterprises (SMEs) in emerging markets, where capital constraints and risk aversion may limit investment capacity (Kilari, 2019).

In parallel, research on outsourcing as a capacity management strategy has revealed mixed outcomes. Sardar, Lee, and Memon (2016) demonstrated that outsourcing enables organizations to balance workload fluctuations without committing to fixed capital investments in machinery or additional labor. Their findings indicated that well-structured outsourcing arrangements could provide cost advantages while maintaining service quality, particularly for non-core production processes. However, subsequent research by Johnson and Haug (2021) and Kumar and Saini (2022) highlighted significant risks associated with outsourcing, including quality control challenges, supply chain volatility, and loss of internal process knowledge. These studies suggest that outsourcing may serve as a temporary or supplementary capacity solution but lacks the long-term scalability required for sustained growth.

The novelty of this research lies in its integrated, multidimensional approach to evaluating capacity expansion strategies within the Indonesian herbal extract manufacturing context. Furthermore, this study contributes to the literature by focusing specifically on the herbal extract industry, where production processes involving extraction, concentration, and quality control present unique capacity challenges not adequately addressed in generic manufacturing studies. The research also advances knowledge by examining capacity planning in an emerging market context (Indonesia), where institutional factors, regulatory requirements, and resource constraints differ substantially from developed economy settings.

This research aims to analyze current production performance and evaluate the capacity gap at PT Turmerica in meeting projected market demand, as well as assess and compare the feasibility and profitability of alternative strategies to recommend the most suitable solution. This research specifically focuses on analyzing and evaluating *alternative strategies alternative strategies* for capacity expansion at PT Turmerica. The alternatives include adding new extraction equipment; outsourcing production through third parties; and further extending hours of operation. The case study technique is adopted exclusively on PT Turmerica. The research draws on quantitative data with a scope on capacity optimization within the extraction process. However, it does not delve into downstream processes such as packaging, transportation networks, or post-production logistics. Capacity-related data is drawn from the latest historical file in 2024 with an update running to July 2025, while the forecasting analysis is performed using sales history and the company's financial targets for the period 2025–2029.

The scope of this research, therefore, is limited to PT Turmerica's internal operational environment. The data presented are qualitative, based on in-depth interviews, internal company documents, and direct field observations. As a result, the advice and results are most practical for PT Turmerica and may only partially apply to other companies. The company (Turmerica) name is a pseudonym for anonymization purposes and all numeric datapoints are altered while maintaining the original patterns and trends to protect sensitive business information.

METHOD

The study employed mixed-methods research design, integrating qualitative and quantitative approaches to evaluate capacity development strategies for PT Turmerica. It utilized cost-benefit analysis (CBA) to assess the economic viability of options such as in-house expansion, outsourcing, and adding labor hours, focusing on metrics like upfront investment costs, Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR). Data collection involved in-depth interviews with key internal stakeholders, ensuring a comprehensive understanding of operational capacity and strategic alternatives, alongside secondary data from production reports and industry literature. Each strategic alternative underwent CBA, utilizing key financial metrics, while a TELOS framework assessed feasibility through a structured questionnaire targeting technological, economic, legal, operational, and scheduling aspects. This comprehensive analysis aimed to determine the most viable strategy for enhancing PT Turmerica's production capacity while aligning with regulatory compliance and operational readiness.

RESULT AND DISCUSSION

Existing Capacity Analysis

The finding of current production capacity shows in the table 1, it is clear that the existing capacity of the production facility is still not optimal overall. Of the four main machines used, data shows that the Extractor, Mixer, FBD, and Milling are not balance in production output. The main bottleneck lies in the actual production capacity of the Extractor, which is only 161,915 kg/year, much lower than the Mixer (1,416,960 kg/year) or the FBD machine (944,640 kg/year). This condition limits the overall system's ability to achieve maximum production capacity.

Table 1. Existing Capacity

No	Machine	Effective Capacity (Kg/ Year)
1	Extractor	161,915
2	Mixer	1,416,960
3	FBD	944,640
4	Milling	354,240

The capacity used in this analysis is the effective capacity, which is the actual capacity that can be achieved considering actual operational conditions. The effective capacity calculation includes three-shift work, six days per week, and downtime due to routine maintenance. Based on observations, the extraction machine requires approximately 30 hours of maintenance every four days of operation. This time is necessary because clogging often occurs during the extraction process, requiring soaking, circulation, and thorough cleaning before the machine can be used again.

To address these constraints and increase effective capacity, Alternative 1 is proposed, which is the addition of a concentrator machine. This machine functions to assist in the concentration process of the extraction results, which can indirectly reduce the frequency and duration of cleaning on the extraction machine. With the concentrator, the extraction machine cleaning time is estimated to be reduced from 30 hours every four days to 30 hours every eight days. This increased efficiency is expected to increase available operating time, increase annual effective capacity, and reduce the potential for lost production time due to excessively frequent maintenance activities.

Table 2. Forecast Demand (Strong Growth)

Year	Demand	% utility (Extractor)
2026	158,422	98%
2027	190,106	117%
2028	205,315	127%
2029	246,378	152%
2030	266,088	164%

Table 3. Forecast Demand (Weak Growth)

Year	Demand	% utility (Extractor)
2026	114,398	71%
2027	124,568	77%
2028	126,337	78%
2029	128,131	79%
2030	129,950	80%

Table 2 provides forecast Sales Plan from 2026 to 2023. It is important to note that this demand projection was provided by the company's internal Marketing team, and therefore, the assumptions, methods, and detailed justification of the forecast are beyond the scope of this study. To reflect the possibility of market uncertainty, demand forecasts in this study are divided into two alternatives: strong growth and weak growth with probabilities respectively 0.54 and 0.46. With regard to herbal medicine export trend (Table 3) as representative indicators of the herbal extract market performance, it can be seen from their development trajectory that these two sectors exhibit an linear relationship. This assumption is confirmed by the observation that herbal medicine exports are determining the growth rate of related herbal products. Under a high growth scenario (p = 0.54), the demand will continue to rise at a faster rate. By contrast, the weak growth scenario (p = 0.46) paints a picture of more conservative expansion.

Table 4. Export Volume of Herbal Medicine, Aromatics and Spices of Indonesia

Year	Export in tons	Growth*
2012	222,875.90	Strong Growth
2013	291,872.10	Strong Growth

Year	Export in tons	Growth*
2014	366,337.70	Strong Growth
2015	367,243.90	Weak Growth
2016	295,491.00	Strong Growth
2017	316,198.60	Strong Growth
2018	329,005.10	Weak Growth
2019	315,444.90	Weak Growth
2020	273,370.20	Strong Growth
2021	293,368.10	Weak Growth
2022	274,609.80	Strong Growth
2023	289,390.30	Weak Growth
2024	263,824.80	Weak Growth

Source: Badan Pusat Statistik Indonesia, 2025

*Strong growth if the export volume increases from previous year, otherwise it is identified as weak growth

Based on the analysis of the existing production capacity and forecast sales plan, extractor machine will suffer from considerable capacity constraints in coming years. From table 4, it shows that in 2026 the utility rate of the extractor is rising to 98%, so that effective production capacity tends to be close to market demand limit. That leaves very small flexibility available to accommodate fluctuations in production demand or unanticipated plant downtime. In 2027, the utility rate is 117%, meaning that the current capacity can no longer match its needs for production unless either more capacity or other measures of efficiency are added. To make matters worse, the situation accelerates rapidly with plant utilization climbing to 127% in 2028, 152% in 2029 and reaching a full-blown crisis level of 164% by the year end of 2030 again with no investment taking place, which demonstrates an increasingly large disparity between production capacity available and anticipated demand.

This overutilization reveals a capacity bottleneck for manufacturing, which would gradually prevent the business from filling sales orders on time and may result in slow response to market demand, higher operation costs, and loss of opportunities. Without the intervention, there will be insufficient capacity from the production line to accommodate the forecast sales expansion which is expected to increase overall demand in 2026–2030. Thus, efforts for capacity increase through the addition of a new concentrator unit, outsourcing and additional working hours are strategically important.

New Capacity Simulation with Alternatives

Three options strategy have been evaluated to increase production capacity in PT Turmerica: (1) Purchase a new concentrator machine, (2) Outsourcing (Subcontract the extraction process) or (3) Extend the working hours by running the plant with Sunday shifts.

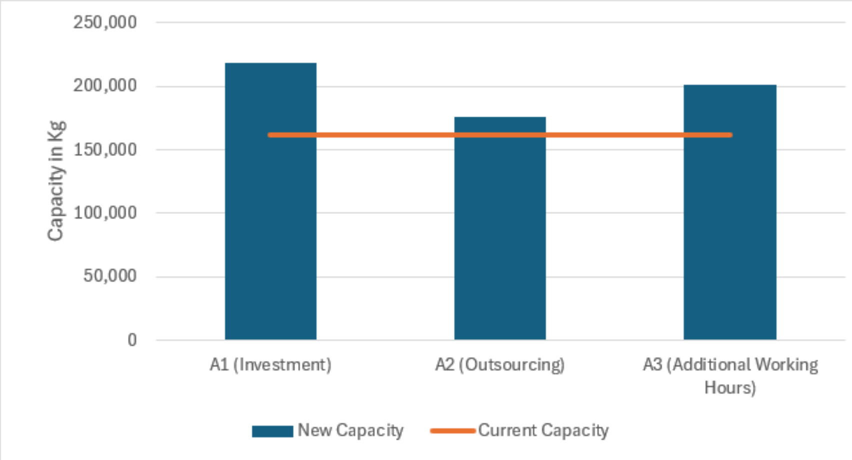

Figure 1. New Capacity Under 3 Different Alternatives

The analysis of production capacity alternatives at PT Turmerica demonstrates distinct differences in the potential impact of each strategy on output performance. Production capacity under existing conditions is 161,915 kg of herbal extract/year.

Table 5. New Capacity Improvement of 3 Alternatives

Alternative	New Capacity (Kg)	Current Capacity (Kg)	% Increase
A1 (Investment)	218,728	161,915	35.1%
A2 (Outsourcing)	175,885	161,915	8.6%
A3 (Additional Working Hours)	201,684	161,915	24.6%

Alternative 1 (Investment in New Concentrator Machine) offers the largest capacity increase, reaching 218,728 kg/year, an improvement of 35.1% (Table 5) over current production levels. This is a significant gain. At PT Turmerica, the extractor unit has become the biggest bottleneck in the entire extraction process. By investing in a new machine of concentrator, the company can greatly increase throughputs, by reducing maintenance and cleaning time, both of which currently contribute to downtime. The concentrator plays a vital role in concentrating the liquid extract after the extraction stage, thereby preventing clogging or over-thickening of the extract within the extractor. Although the investment necessitates a greater initial capital cost, financial metrics (NPV, IRR, BCR) and TELOS score show that the returns are good enough to be profitable on a strategic basis for the long run. However, according to strong growth demand in Table IV.2, this new capacity is not enough to meet projected demand in 2029. New options need to be considered such as adding new machine with facility area expansion.

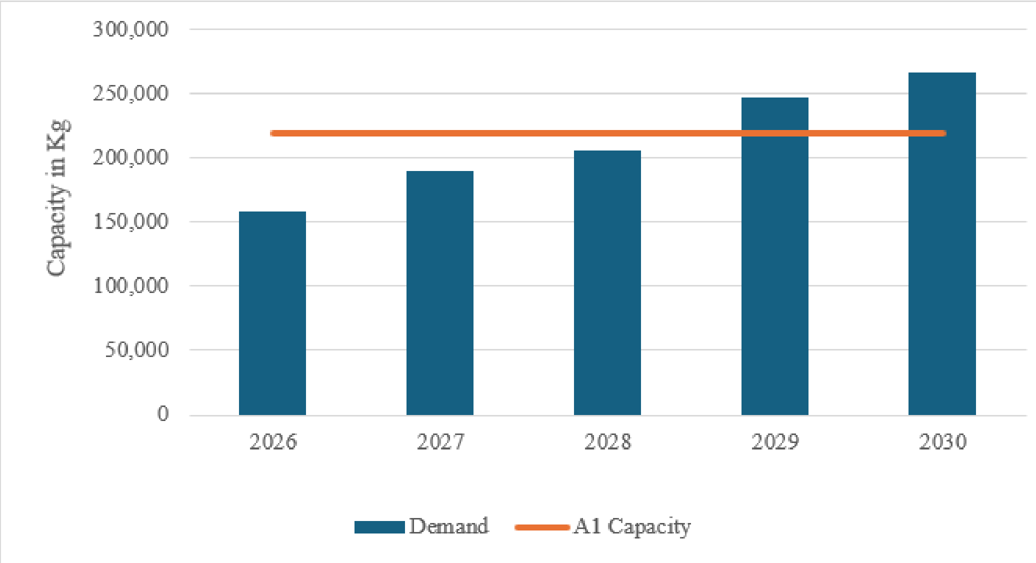

Figure 2. Demand and Capacity Under Alternatives 1

Alternative 2 (Outsourcing) provides a lower capacity improvement of 8.6%, to 175,885 kg/year. Even though outsourcing offers flexibility and saves initial investment, it realizes this small in capacity improvement and introduces several operational risks, including quality consistency, and third party timeline dependence. Moreover, since only one extract product can be outsourced, the increase in total capacity fails to meet production growth expectations. According to strong growth demand in Table 2, this new capacity only survive for year 2026 and will fail to meet demand in 2027. Therefore, whether as a short-term buffer measure or for temporary use only, it does not provide a real path of capacity expansion which can be sustained over time for PT Turmerica.

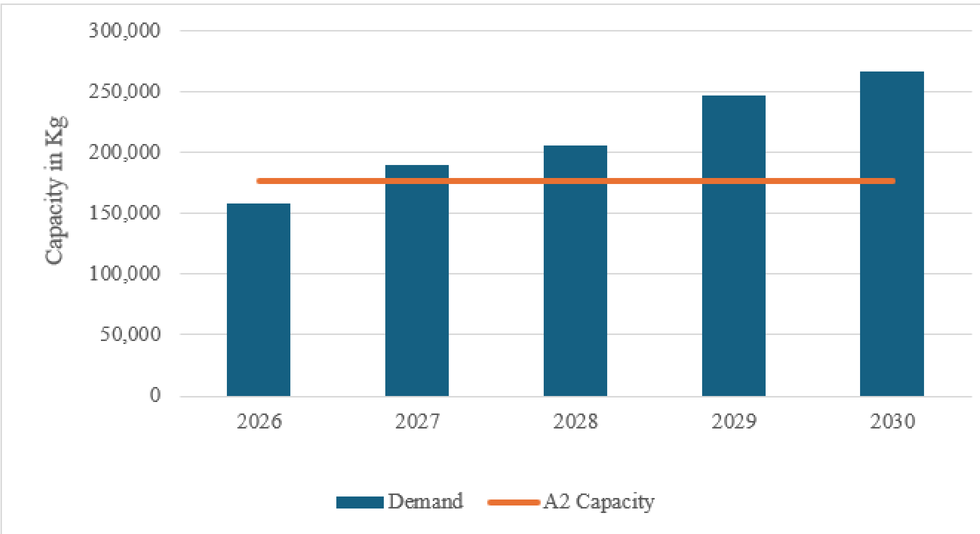

Figure 3. Demand and Capacity Under Alternatives 2

Alternative 3 (Additional Work Hours) pushes capacity up to 201,684 kg/year, up 24.6% from the current capacity. But this option needs three more new operators, makes costs roughly 4.5% higher. The potential risks of options include fatigue among staff, maintenance scheduling challenges and less service life for equipment. Furthermore, increasing working hours can be detrimental to employee welfare and compliance with regulations on labor practices if not properly handled.

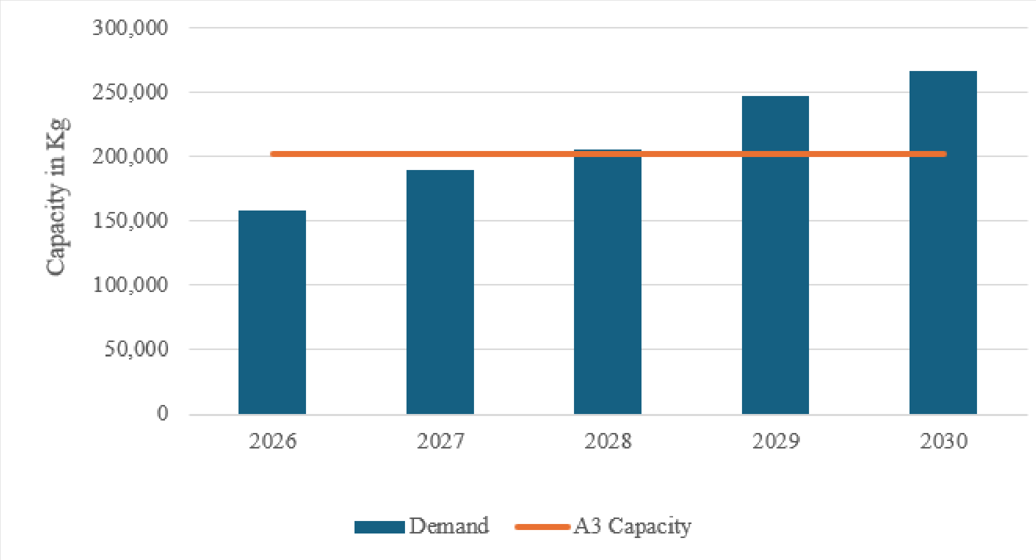

Figure 4. Demand and Capacity Under Alternatives 3

Cash Flow Simulation Using Decision Tree

The probabilities of the two future demands, high growth (0.54) and low growth (0.46), are included in a decision tree analysis to determine expected financial results for each strategy. The acquired expected values show that the investment strategy provides the highest payoff of IDR 24.36 billion and then increasing working hours' value equal to IDR 23.89 billion, followed by doing nothing with a value of IDR 22.97 billion, and outsourcing only IDR 19.37 billion in terms of payoffs. The results indicate that, if the conditions assumed hold, investing in new equipment is the best option to optimize plant capacity.

Decision tree is a vital tool for evaluating investment viability, integrating various components such as potential outcomes, probabilities, and associated risks. They simplify complex financial decision-making by providing a visual representation of alternatives and consequences, thereby facilitating a structured approach to risk assessment (Liu et al., 2017). The effectiveness of decision trees is evident in their ability to calculate expected monetary values, which can guide investors toward less risky investment strategies. Furthermore, decision trees are particularly valuable in the context of peer-to-peer (P2P) lending, where instance-based credit risk assessment aids decision making (Guo et al., 2016). Real-world applications demonstrate their versatility; For example, the decision tree framework has been employed in water resource planning amid climate uncertainties (Ray & Brown, 2015) and in assessing risks associated with renewable energy investments (Shimbar & Ebrahimi, 2020).

The first alternative is purchasing the new concentrator machine which will be installed at years end and pay off over a five-year period with to be financed with company policy, 12% interest. It offers great potential for a cost-effective and long-term expansion of capacity. By having own production assets, PT Turmerica can keep complete control of the quality process, integration and innovation as well as scale in efficiencies with each unit increment of volume increase. Additionally, residual machinery values post depreciation may enhance asset strength in the latter years.

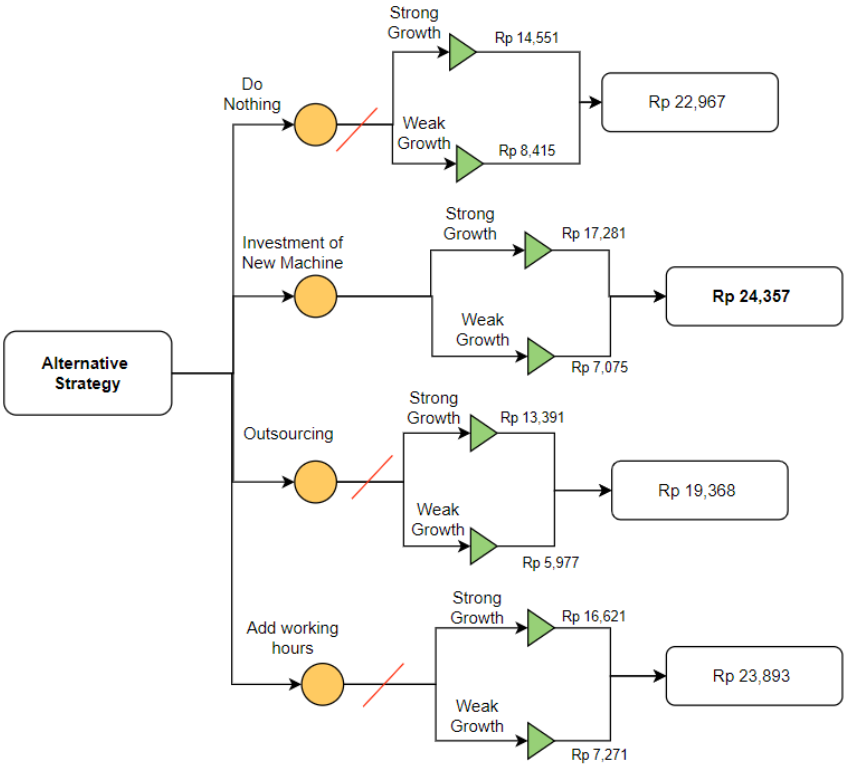

Figure 5. Decision Tree Analysis of three strategy option (value in million)

Subsequently, the investment strategy was further evaluated by financial indicators as Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit–Cost Ratio (BCR), under two scenarios for expected demand. Financial metrics were calculated since an investment cost (IC) of IDR 2,912,369,850, an interest rate (discount rate) of 12% (Company policy), and a five-year period in accord with the company's own financial policy.

Table 6. Present Value of Cash Flow – Investment New Machine Strong Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025	(2,912,369,850)	1.000	(2,912,369,850)
2026	6,969,793,435	0.893	6,223,029,853
2027	8,614,664,685	0.797	6,867,557,944
2028	9,582,952,996	0.712	6,820,956,658
2029	11,844,529,903	0.636	7,527,412,884
2030	13,175,855,064	0.567	7,476,334,011
		PV CF	32,002,921,500

Table 7. Present Value of Cash Flow – Investment New Machine Weak Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025	(2,912,369,850)	1.000	(2,912,369,850)
2026	4,687,681,541	0.893	4,185,429,948
2027	4,896,874,018	0.797	3,903,757,986

Year	Cash Flow	PV factor	PV of cashflow
2028	5,115,401,918	0.712	3,641,042,045
2029	5,343,681,844	0.636	3,396,006,417
2030	5,582,148,990	0.567	3,167,461,249
		PV CF	15,381,327,795

Table 8. Financial Metrix of New Machine Investment

Metrix	Weak Growth	Weak Growth
IC (IDR)	2,912,369,850	2,912,369,850
NPV (IDR)	15,381,327,795	32,002,921,500
IRR	164%	259%
BCR	5.28	10.99

In the case of strong demand, this investment produced a net present value of IDR 32,002,921,500 (Table IV.6), Table IV.8 shows an internal rate of return of 259%, and a cost-to-benefit ratio of 10.99. These results make it clear that this project is highly cost-effective, and more than justifies its cost of raising capital. An IRR of 259% says that the rate of return on this project is more than 20 times the minimum required of return. If there is strong market demand, this is very profitable. BCR ratio is greater than 1, as table IV.8 shows the BCR ratio is 10.99, which means that for every rupiah invested PT Turmerica will obtain roughly 10.99 rupiah in benefits. This performance thereby suggests that the investment not only recovers its total cost but also generates a strong surplus for reinvestment or shareholder value creation.

In contrast, under weak projected growth the NPV drops to IDR 15,381,327,795, the IRR falls to 164%, and the BCR sags to 5.28. But even as profitability diminishes in this market or demand scenario, all the above indicators is adequate from the perspective of the company's 12% discount rate. Because the NPV is positive and the IRR is tremendously higher than company's discount rate, this investment is still a financially positive one even if market conditions are in a weak scenario. A BCR of 1 or above (in this instance, 5.28) shows that this project may continue to produce net benefits even under reduced level of magnitude.

When compared to findings in the literature, the analysis appears consistent with the observation that heavily capitalized (and manufacturing-oriented) investments typically yield high returns when market prospects look bright but still generate good returns even under moderate conditions because of some efficiency gain and economies of scale (Pinedo, 2016, Stevenson, 2018). The big gap between the IRR and the discount rate indicates a considerable margin of safety; in other words, the possibility of losing money on this investment, while always present, is quite small. Moreover, this outcome aligns with the point made by De Neufville and Scholtes (2011) that engineering investments with built-in flexibility, like modules or scaleup systems, are likely to give positive returns in a variety of growth conditions.

The decision tree analysis has been a convenient approach of screening successful investment projects under uncertainty and accounting for expected outcomes over the different market states (Jacobs & Chase, 2015).

The second option is outsourcing. This option is designed to increase the available capacity by about 8.6% since only one type of extract is allowed to be outsourced to maintain confidentiality of process and formula of the product. This option has low capital costs and is a process which can be added quickly with output veering to the changing needs of the market but makes production cost increase 9%. Also, the company can offload some risks related to operation (e.g. machine failure and downtime) onto the outside vendor and concentrate its expertise on what it does best.

Table 9. Present Value of Cash Flow – Outsourcing Strong Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025		1.000	-
2026	4,950,317,843	0.893	4,419,926,646
2027	6,118,592,854	0.797	4,877,704,763
2028	6,806,322,691	0.712	4,844,606,052
2029	8,412,614,846	0.636	5,346,368,822
2030	9,358,192,755	0.567	5,310,089,890
		PV CF	24,798,696,172

Table 10. Present Value of Cash Flow – Outsourcing Weak Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025	-	1.000	-
2025	3,329,438,624	0.893	2,972,713,057
2025	3,478,018,243	0.797	2,772,654,849
2025	3,633,228,375	0.712	2,586,060,193
2025	3,795,364,915	0.636	2,412,023,018
2025	3,964,736,960	0.567	2,249,698,227
		PV CF	12,993,149,344

The result of outsourcing for increasing capacity is only worth IDR 19.37 million (Figure 5), so it has a lower total value than the "do nothing" option. This conclusion shows that even when markets are strong or weak, outsourcing does not bring any significant financial benefit. The main reason for the limited result is that outsourcing raises production capacity by only 8.6%. Thus, this increase is not enough to meet the expanding market demand or needs of a high-growth scenario. Long-term capacity limitations may result in a situation where demand exceeds supply and creates opportunistic loss. Moreover, outsourcing introduces extra production costs with an assumed 9% loss in overall profit margins. Other studies have also reported similar findings. They note that while outsourcing can provide short-term flexibility and lower capital outlays, over time it may lead to greater operational costs and dependence upon third parties (Kumar & Saini, 2022; Heshmati, 2019). Consequently, outsourcing can be seen as a conservative method suitable for urgent capacity bottlenecks but less appropriate in the longer-term or for high demand scenarios.

Additionally, the risk of this option is that it can lead to dependence on outsourcers, harder quality and process monitoring as well as added difficulties in managing contracts and coordination. Furthermore, the marginal gain in shipping capacity limits its strategic value. The views above are also consistent with findings from previous research where, bringing production back home Haider et al (2020), note that outsourcing increases short-term flexibility, but it may erode internal process capabilities and reduce strategic control. Optimal Outsourcing Strategies with Limited Capacity (Chakravarty, 2009) also posits that outsourcing should be applied as a supporting mechanism rather than the primary means to increase capacity, particularly when internal production is the key competitive core competence.

Table 11. Present Value of Cash Flow – Additional Working Hours Strong Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025	-	1.000	-
2026	5,952,177,029	0.893	5,314,443,776
2027	7,404,904,164	0.797	5,903,144,264
2028	8,319,636,346	0.712	5,921,752,820
2029	10,683,778,295	0.636	6,789,734,252
2030	12,075,480,541	0.567	6,851,951,954
		PV CF	30,781,027,066

Table 12. Present Value of Cash Flow – Additional Working Hours Weak Growth Scenario

Year	Cash Flow	PV factor	PV of cashflow
2025	-	1.000	-
2026	4,003,262,170	0.893	3,574,341,223
2027	4,209,204,204	0.797	3,355,551,820
2028	4,424,724,159	0.712	3,149,431,258
2029	4,650,254,964	0.636	2,955,321,099
2030	4,886,248,945	0.567	2,772,588,875
		PV CF	15,807,234,276

The third option is to increase the working hours through Sunday work, which is a low-capital cost, short-horizon capacity expansion option. Such a strategy would realize an overall capacity rise of 24% and require employing three new operators (three shifts) while increasing operational costs by 4.5%. Table 11 and Table 12 show that the payoffs are slightly higher compared to “do nothing” strategy, but lower than investment option. The approach improves productivity without taking a huge risk with new investments as the focus is on maximizing use of assets that already exist. Implementation can be implemented immediately, allowing the company to respond quickly to rising demand. Nevertheless, the increased work might result in worker fatigue, decreased morale and quality irregularity. There are additional costs related to the atypical nature of gates, shift premiums and potential scheduling overlaps which increase marginal costs. It is empirically validated by labor-intensive capacity management research where studies of Gunasekaran et al. (2015) and Stevenson (2018) note that extending hours of work, while a reasonable short-term response, can lead to a decline in longer term workforce productivity if practiced excessively. However, the tree decision analysis positions this strategy as second best parallel to the investment option and is marginally below the investment option, suggesting that it could be an effective interim approach while preparing for capital investment.

The analysis based on a decision tree highlights the trade-off between financial returns, operational flexibility and risk attitude. Although investing in new machines offers the highest return, PT Turmerica should consider its financing capability, market risk and long-term strategic expectations. The combination of decision tree analysis and TELOS analysis can combine to make a better assessment of future uncertainty that will provide a stronger foundation for strategy-to-act implementation.

TELOS Framework

TELOS framework was applied to analyze the feasibility of three alternatives for the capacity expansion of PT Turmerica: (A1) investment in a new concentrator machine, (A2) the outsourcing of part of the extraction process, and (A3) an extension of working hours. The result of assessment from Production Manager is shown in the table 13, from R&D Manager in table 14 and finally the total score shown in the table 15.

Table 13. Questionnaire answer from Production Manager

Indicator	**Weight**	**Scale**			**Score**		
		A1	**A2**	**A3**	**A1**	**A2**	**A3**
T1) Technology readiness	0.15	3	4	4	0.45	0.6	0.6
T2) Knowledge transfer	0.1	2	4	2	0.2	0.4	0.2
E1) Cash flow output	0.2	4	1	3	0.8	0.2	0.6
E2) Funding availability	0.15	4	4	4	0.6	0.6	0.6
L) Regulation compliance	0.1	4	3	3	0.4	0.3	0.3
O1) Resource readiness	0.15	4	4	1	0.6	0.6	0.15
O2) Resistance to change	0.05	4	3	2	0.2	0.15	0.1
S) Implementation time	0.1	3	4	3	0.3	0.4	0.3
Total Score					3.55	3.25	2.85

Table 14. Questionnaire answer from R&D Manager

Indicator	Weight	Scale			Score		
		A1	A2	A3	A1	A2	A3
T1) Technology readiness	0.15	4	4	4	0.6	0.6	0.6
T2) Knowledge transfer	0.1	3	3	3	0.3	0.3	0.3
E1) Cash flow output	0.2	4	1	3	0.8	0.2	0.6
E2) Funding availability	0.1	4	4	4	0.6	0.6	0.6
L) Regulation compliance	0.1	4	3	4	0.4	0.3	0.4
O1) Resource readiness	0.15	4	4	1	0.6	0.6	0.15
O2) Resistance to change	0.05	4	3	2	0.2	0.15	0.1
S) Implementation time	0.1	3	4	3	0.3	0.4	0.3
Total Score					3.8	3.15	3.05

Table 15. Summary of TELOS Score

Indicator	Weight	Scale			Score		
		A1	A2	A3	A1	A2	A3
T1) Technology readiness	0.15	3.5	4	4	0.525	0.6	0.6
T2) Knowledge transfer	0.1	2.5	3.5	2.5	0.25	0.35	0.25
E1) Cash flow output	0.2	4	1	3	0.8	0.2	0.6
E2) Funding availability	0.1	4	4	4	0.6	0.6	0.6
L) Regulation compliance	0.1	4	3	3.5	0.4	0.3	0.35
O1) Resource readiness	0.15	4	4	1	0.6	0.6	0.15
O2) Resistance to change	0.05	4	3	2	0.2	0.15	0.1
S) Implementation time	0.1	3	4	3	0.3	0.4	0.3
Total Score					3.7	3.2	3.0

This study covered eight important indicators - technology readiness level, learning spillover effect, operational cash flow performance, extra finance availability, compliance with rules and regulations, resources already in place, resistance to change, and time for application - and gave them weighted scores to work out the overall possibility of each item. Based on table 13, (A1=3.7; A2=3.2; A3=3.0), the new machine investment (A1) comes out as the most feasible option. The findings drive from its superior performance in operational cash flow output (4.0), compliance with rules and regulations, and resources already in place, indicating that this investment matches both financial and management strengths of the company. A high score in operational cash flow output (4.0) shows that despite the initial capital of IDR 2.9 billion, this remains justified giving returns from project financing– including an IRR of 259% BCR 10.99 under strong growth scenario–as well as payback times below two years. It agrees with the view put forward by Ssegawa and Muzinda (2021) that financial and operational viability are key signs of project sustainability when evaluated under popular benchmarks like TELOS. By comparison, the outsourcing strategy (A2) has a lower score: 3.2. even when it comes to tightness of budget and efficient means of development. Although outsourcing gets the best grades in technology readiness and implementation period, its operational cash flow point is low (1.0): outsourcing only increases production capacity by 8.6%, while also costing operators an extra 9%. According to Kumar and Saini (2022), outsourcing offers flexibility and short-term efficiency but leads to long-term profitability decline if cost savings are offset by dependence and reduced controls over the production process. The result validates Heshmati (2019) who found that firms linking outsourcing with strategic alignment as well as physical location could have reduced capabilities for innovative creation and indeed below-average investment returns.

In contrast, strategy (A3) of increased working hours fetched a total score of just 3.0. With this option of developing the plant's production capacity company can perform up to 24%, but it suffers severely on resource readiness (1.0) and high resistance to change (2.0) due to labor fatigue, the need for additional operators, and potential compliance risks in extended working schedules. As a result, this can raise compliance issues in terms of not only security but also employment. This result is supported by Krzywdzinski (2021), who pointed out that adding labor periods leads to temporarily greater output but poses sustainability and productivity risks over time, particularly in labor-intensive industries.

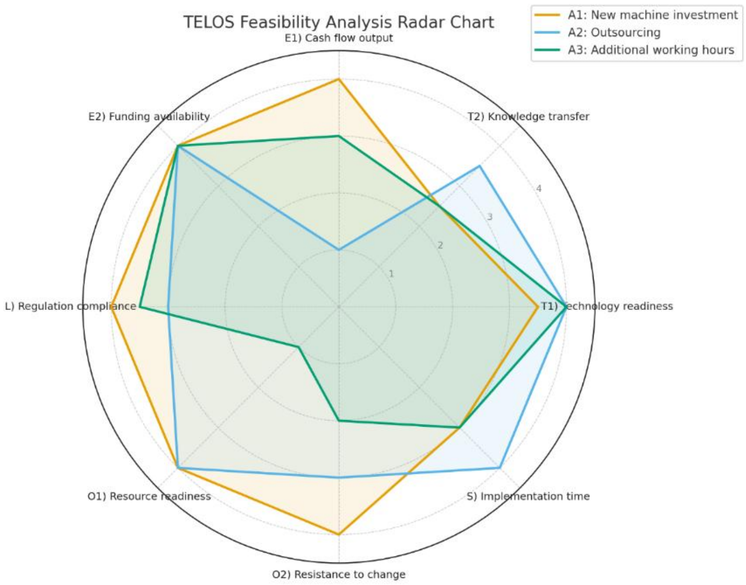

Figure 6. TELOS Feasibility Radar Chart

Figure 6 shows that investment alternative (A1) has the most potential for feasibility, balancing technological adoption with return on investment and operating capacity. This suggests that there is an interdependence between technology and economics (Ssegawa and Muzinda, 2021). Both outsourcing (A2) and extending hours of labor (A3) have lower initial barrier, but lack long-term scalability and potential revenue required to sustain PT Turmerica's growth targets.

Business Solution

Integrating both quantitative results (Decision Tree) and qualitative data (TELOS), the most feasible and profitable business solution for PT Turmerica is to invest in a new concentrator machine. This option offers the most profitable return and most feasible startegy, making it sustainable in the long run. It is also consistent with PT Turmericas strategic target of strengthening its own production scale and reducing reliance on outside partners.

While outsourcing and extending hours of operation still remain possible in the short-run, they do not have adequate financial performance or expandability. So, based on the comprehensive analysis, a new machine is recommended as the best option to break through the bottleneck of capacity problems and help support PT Turmerica's market development strategy in herbal extract industry.

CONCLUSION

The research found that PT Turmerica's current production capacity is insufficient to meet projected market demand, with a 17% capacity deficit expected by 2027 if no expansion occurs, mainly due to bottlenecks at the extractor machine. Three strategies were evaluated: investing in a new concentrator machine (A1), subcontracting production (A2), and extending operating hours (A3). Investment in the new concentrator showed the highest expected monetary value (IDR 24.36 billion), strong financial metrics (NPV of IDR 32 billion, IRR of 259%), and the best feasibility rating based on technology readiness and cash flow, making it the most profitable and feasible option. Alternatives A2 and A3 were less favorable due to dependency risks and regulatory challenges. The study concludes that A1 offers the most sustainable approach for improving production efficiency and competitiveness while maintaining compliance. Future research should explore capacity expansion effects on downstream operations like packaging and distribution to provide a more holistic view of scaling production.

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