Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AN15.20250487
Published: February 18, 2025

Manufacturing Location Analysis for Automated Fare Collection Hardware

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Abstract

In today's dynamic global market, choosing the optimal manufacturing location is critical for competitiveness, efficiency, and rapid product delivery. This study assesses the manufacturing location for Hardware V for Company X, comparing China and Malaysia based on cost, quality, and strategic business impact. Methodologies used include analysis of Total Cost of Ownership (TCO), Return Material Authorization (RMA), SWOT and PESTLE, Analytic Hierarchy Process (AHP), Hofstede's Cultural Dimensions, Net Present Value (NPV), and stakeholder feedback. Malaysia emerged as the preferred choice in six out of nine key decision factors. Findings revealed a 4% cost reduction, a 1% decrease in defect rates, and a projected 23% growth in business opportunities compared to China. While China demonstrated strengths in cultural compatibility and supply chain robustness, Malaysia's advantages in lower operational costs, enhanced quality control, and strategic alignment with Company X's goals in the Automated Fare Collection (AFC) sector positioned it as the optimal location. Selecting Malaysia strengthens Company X's profitability, product quality, and stakeholder satisfaction in a competitive market landscape.

Keywords

Manufacturing Location Decision, Contract Manufacturing, Total Cost of Ownership, Product Quality, and Strategic Business Impact.

1. Introduction

1.1 Background

Company X is a subsidiary of a publicly listed company and operates seven offices worldwide. It focuses on improving public transportation systems and specializes in Automated Fare Collection (AFC), ticketing, and smart transportation technology. One of its main products, Hardware V, streamlines fare collection, enhances passenger flow, and generates valuable transit data (Welp Magazine 2024). Production is outsourced to contract manufacturers (CMs) for cost efficiency and technical expertise in alignment with the electronics industry practice (MFG 2024). Initially produced in China, Hardware V's manufacturing shifted to Malaysia in 2022. Company X's management believes this move increased costs but also improved product quality whilst customer relationships, brand reputation, or market share remain unchanged. However, these assumptions unvalidated by data pose risks for Company X. It is critical for Company X to evaluate these assumptions and guide strategic decision-making on its production location to maintain its competitive advantage in the VUCA global landscape.

1.2 Objectives

This study is guided by the following three objectives. The first objective is to conduct a Total Cost of Ownership (TCO) analysis of outsourcing the production of Hardware V in China and Malaysia, considering all relevant costs, with quantitative analysis. The second objective is to analyze data to determine which location, China or Malaysia, produces a better quality of Hardware V with fewer rejects from end customers and to assess the ease of doing business

and managing CM, weighing the pros and cons of each manufacturing location. The third objective is to determine if the origin of Hardware V will affect Company X's footprint in the global AFC industry.

1.3 Scope of this Study

Company X provides end-to-end logistics and installation services for some customers, which can influence the total cost of Hardware V. However, this study will focus solely on factory gate costs, covering expenses incurred until the product leaves the manufacturing facility, excluding transportation, delivery, and after-sales costs, as illustrated in Figure 1. Using quantitative and qualitative methods, the study offers a comprehensive assessment to guide Company X's strategic decision on the optimal production location for Hardware V.

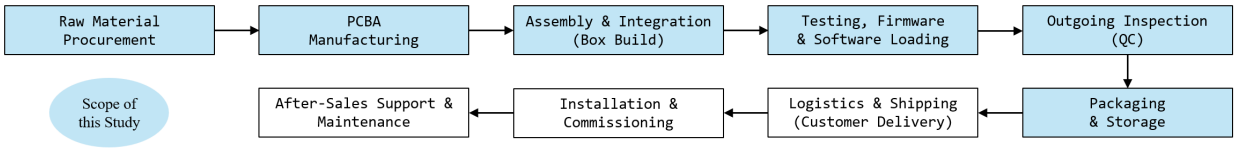


Figure 1. Value Chain of Company X's Hardware V

2. Literature Review

The articles reviewed explored different factors that influence where companies decide to manufacture, including need to maintain flexibility and adaptability, drivers for outsourcing and offshoring, motivations for reshoring and value chain implications. Together, these studies helped build a clearer picture of the complexities companies face in decision-making.

Theyel and Hofmann (2021) found that companies that keep manufacturing close to home or bring it back tend to be more flexible, respond faster, and develop new ideas more easily. On the other hand, moving production to another country (offshoring) can reduce these benefits, especially if the factory is far from important teams like research and marketing. Beyond cost and quality, the paper examined how changing manufacturing locations affected flexibility, customer feedback, and overall business strategy.

Lo et al. (2010) found that Taiwanese electronics companies preferred to set up factories in eastern China because of tax benefits, strong supply chains, and easy access to important markets like Japan. They used the Analytic Hierarchy Process (AHP) method to study this. Even though there were political risks, these regions had clear and stable government policies, which helped reduce problems. The article highlighted that tax benefits, a smooth supply chain, and political stability were key factors when choosing where to manufacture.

Gylling et al. (2015) found that moving production overseas (offshoring) initially helped cut costs. However, over time, problems like fluctuating exchange rates, slow response to customer needs, and quality issues made it more expensive and less efficient. They used methods like Time-Driven Activity-Based Costing (TDABC) and Total Landed Cost (TLC) to study this. Helkama Velox found that making products locally in Finland was cheaper and better for customers, because they improved their processes and cut costs.

Engelen (2020) explained that China was not the top manufacturing country just because of cheap labor. Its strong and well-connected supplier network helped make products faster and cheaper than elsewhere. The study also examined why China was still the leader in electronics manufacturing, even though countries like Mexico, Taiwan, Vietnam, and Malaysia are trying to catch up. China stayed ahead because of its efficient factories and suppliers, while other countries were still building their systems. The article also mentioned that automation and AI were changing electronics manufacturing, making companies less dependent on workers.

Moore (2023) examined why some electronics companies were moving production away from China. The main reasons were higher costs, trade issues, and political tensions, especially with the U.S. Other countries like Mexico and Vietnam are being considered for manufacturing. However, many still struggle with weak supply chains and poor infrastructure. Malaysia stands out because it has a strong semiconductor industry and is close to China, which helps keep shipping costs low. However, China still has better infrastructure and a more advanced supply chain, making it hard for companies to move production elsewhere, even with new options.

Yang (2016) found that many companies were moving factories from coastal China to Southeast Asia, especially Vietnam, Indonesia, and Cambodia. The main reasons were to cut costs, reduce risks, and reach new customers. Companies require favorable government policies, strong infrastructure, and skilled workers to succeed. Higher wages, lack of land, and changing rules in parts of China (like the Pearl and Yangtze River areas) were pushing companies to leave. This shift was making Southeast Asia more connected to the global economy.

Hartman et al. (2017) cautioned that using only the TCO model to decide on manufacturing locations can be misleading. This is because it does not fully show the real challenges of outsourcing, like hidden costs, quality problems, and continuous improvement. The study noted that companies need to gather complete and accurate data on costs and assess the complexities of manufacturing processes to decide on production location. This is of heightened importance now that costs are rising in places like China.

3. Methodology

This study used both case studies and surveys to find the ideal location to manufacture Hardware V for Company X. The case study method looked into how production location affects costs, quality, dealing with CM, and the long-term impact on brand reputation and market share. It used 2017-2023 data from Company X's ERP system, employee interviews, and past records. Structured surveys helped collect customer numbers and opinions about product quality and value as well as gathered feedback from supply chain and production staff. The study used Total Cost of Ownership (TCO), Return Material Authorization (RMA), SWOT, and PESTLE to analyze the data to assess risks and opportunities. It also applied the Analytic Hierarchy Process (AHP) and Hofstede's Cultural Dimensions to compare factors like cost, quality, and risk management. Net Present Value (NPV) was used to see how the financial impact changes over time. This combined approach gives a complete picture of the decision using both accurate company data and external research, as shown in Figure 2.

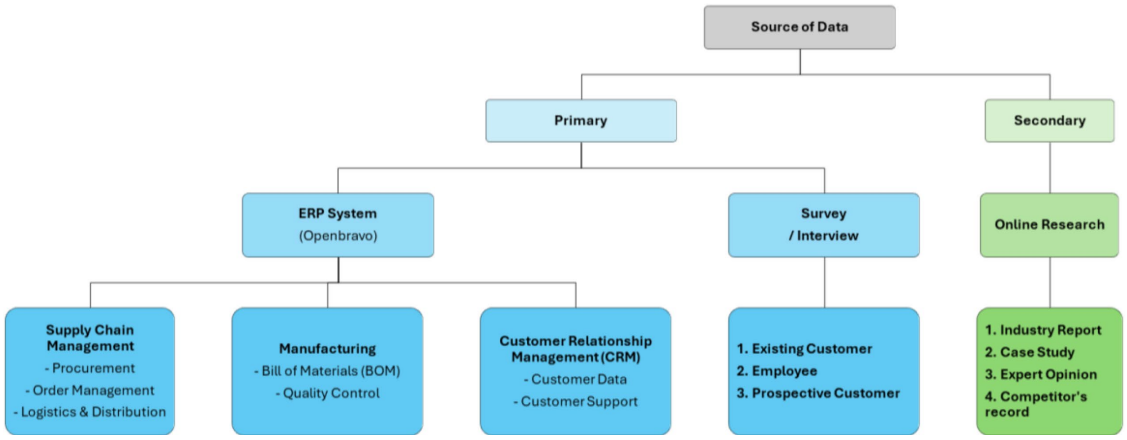


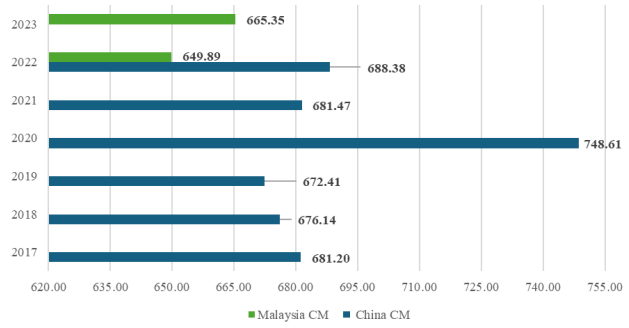
Figure 2. Structure of data collection of primary and secondary data

4. Results and Discussion

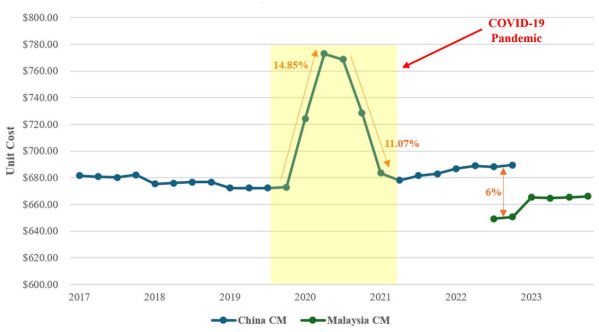
4.1 Total Cost of Ownership Analysis

Figures 3(a) and (b) shows the unit costs for Hardware V between production in China and Malaysia from 2017 to 2023 based on Company X's ERP system. The China CM had an average unit cost of $691.37, with fluctuations influenced by factors like the COVID-19 pandemic, supply chain disruptions, and currency exchange rates. In contrast, Malaysia CM's costs for 2022-2023 were more stable, averaging $660.20, benefiting from trade policies such as Licensed Manufacturing Warehouse (LMW) tax exemptions.

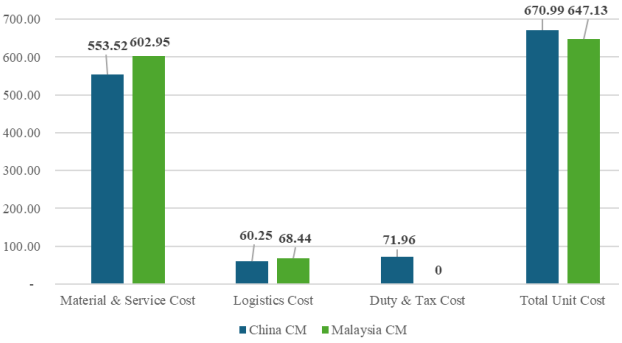
When current costs are compared in Figure 3(c), Malaysia's unit cost ($647.13) remains 3.69% lower than China's ($670.99), but removing tax and duty reveals China's cost advantage ($599.03 per unit). Additionally, if Malaysia were subject to an 8% Sales and Service Tax (SST), its costs would rise to $695.37, making China more cost-effective, as evidenced in Figure 3(d). These findings underscore the critical role of tax exemptions and policies in influencing manufacturing cost competitiveness.



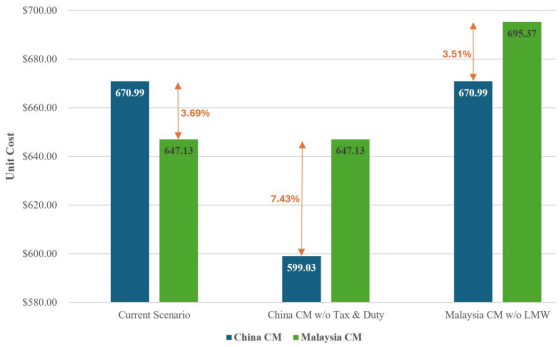
(a) Average unit cost per year, 2017-2023



(b) Average unit cost per quarter, 2017-2023



(c) Cost breakdown: China and Malaysia CM, 2024



(d) Three cost scenarios: China and Malaysia CM

Figure 3. Total cost of ownership analysis for Hardware V

4.2 Quality and Pareto Analysis

The analysis of Return Merchandise Authorization (RMA) (Law 2020) records from the ERP system for 2017-2023 highlighted significant differences in product quality between the China and Malaysia CMs. Figure 4 shows that the China CM had an average return rate of 2.86%, with a range of 7.00% and a standard deviation of 2.10%, indicating inconsistent quality. In contrast, the Malaysia CM demonstrated better quality control, with a lower average return rate of 1.92%, a range of 2.84%, and a standard deviation of 1.76%. These findings suggest that the Malaysia CM consistently produces higher-quality Hardware V with fewer and more stable returns, making it the preferable option for ensuring reliable product quality.

China CM	Units Supplied	Units Returned	% of Return
Mean	210	5	2.86%
Median	195	4	2.95%
Range	313	14	7.00%
Standard Deviation	118	4	2.10%

Malaysia CM	Units Supplied	Units Returned	% of Return
Mean	502	9	1.92%
Median	609	6	2.06%
Range	394	26	2.84%
Standard Deviation	188	11	1.76%

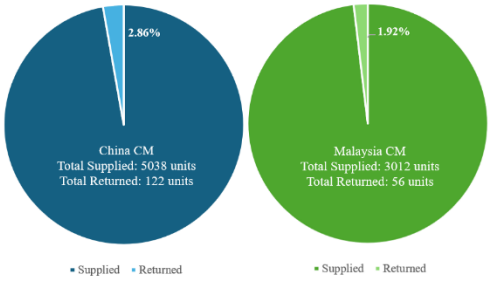


Figure 4: Statistics on return rates for China and Malaysia CM

Figure 5 shows the Pareto analysis and reveals that the top two issues, C1 (32.02%) and C2 (23.03%), accounted for over half (55.06%) of all returns. The inclusion of two more issues, C3 and C4, raises the total to 82.02%, highlighting the significant impact of these key problems. By addressing these top four causes, Company X can effectively reduce most returns and improve product reliability. Lesser issues, such as errors in remote software updates and QR/2D

barcode scanner malfunctions, can be addressed later as they have a minor overall impact, allowing for efficient resource allocation.

Cause Indicator	Cause	Frequency	Percentage	Cumulative %
C1	5" Touch LCD Panel Malfunction	57	32.02%	32.02%
C2	Contactless Card Reader Tamper Mode	41	23.03%	55.06%
C3	Network/Connectivity Issue	25	14.04%	69.10%
C4	8ohm Speaker (Buzzer) Problem	23	12.92%	82.02%
C5	Error in Remote Software Update	19	10.67%	92.70%
C6	QR/2D Barcode Scanner Malfunction	13	7.30%	100.00%
		178		

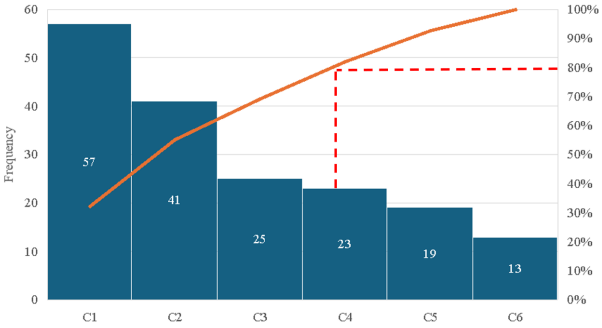


Figure 5. Pareto analysis of RMA data

4.3 SWOT and PESTLE Analysis of Contract Manufacturing

The SWOT analysis of Table 1 compares the strengths, weaknesses, opportunities, and threats of making Hardware V in China and Malaysia. This helps Company X make better decisions about where to manufacture. China has lower material and labor costs, a strong manufacturing industry, advanced technology, and long-term supplier connections. This makes it cheaper to produce large quantities. However, China also has political tensions, trade issues, and quality control issues, which could cause delays or hurt Company X's reputation (ARC Group 2022). Malaysia is closer to key Southeast Asian markets, and Company X's headquarters is in Singapore. It also offers better control over operations, a stable business environment, and tax benefits. However, Malaysia also has higher labor and material costs, smaller factories, and less experience in manufacturing on a large scale. This makes it harder to increase production quickly and adjust to demand changes (ARC Group 2023).

China has a strong supply chain and advanced technology, making it suitable for mass production at low costs. Malaysia has benefits like lower shipping costs, faster market access in Southeast Asia, and more sustainable operations. The main risks are that China's trade issues could cause disruptions, while Malaysia's higher costs and smaller factories might make production less competitive. As Hardware V's demand changes over time, and Malaysia offers better market access and sustainability benefits, it is the better option for Company X despite some challenges.

Table 1. SWOT analysis

	China	Malaysia
Strengths	Lower Costs (*Pre duty & Tax*)	Closer to SG Headquarters
	Well-Developed Factory	Better Production Control
	Long Experience Together	Good Business Environment
Weaknesses	Political Issues	Higher Costs (*w/o LMW Scheme*)
	Less Production Control	Smaller Factory
	Quality Problems	Lesser Experience with Aurotransit
Opportunities	Bigger Production Scale	Growing SEA Market
	Access to Advanced Technology	Sustainability
	Strong Supply Chain	Less Dependence on China
Threats	Geopolitical Risks	Competition from China
	Over-Reliance on China	Local Risks
	Intellectual Property (IP) Risks	Less Advanced Technology

Table 2. PESTLE analysis

	China	*Malaysia*
Political	• Strong government support for manufacturing. • Risks from political tensions, especially with Western countries.	• Stable political environment with government initiatives. • Attractive alternative to China with lower geopolitical risks.
Economic	• Large and well-developed manufacturing setup. • Strong economic growth in 2024.	• Reliable logistics and telecommunications infrastructure. • Expected economic growth in 2024.
Social	• Growing demand for sustainable and eco-friendly products. • Importance of "Guanxi" (relationship-building) and reputation in business.	• Due to government programs, an increasingly skilled electronics and semiconductor workforce. • Growing focus on sustainable and ethical business practices.
Technological	• Leading in advanced technology, with growth in AI. • Strong digital transformation with real-time monitoring.	• Progressing in high-tech manufacturing, focusing on semiconductors, integrated circuits, and parts for electric vehicles (EVs). • Increasing adoption of automation and digitalisation to boost productivity.
Legal	• Companies must navigate strict intellectual property (IP) protections. • Manufacturers should use detailed contracts and seek legal support to protect IP rights.	• Business-friendly legal environment supporting foreign manufacturing investments. • Strengthening IP protections, making it attractive.
Environmental	• Strict environmental regulations. • Manufacturers must balance cost management with environmental responsibility.	• Focus on environmental sustainability with initiatives like the Kulim Green Industrial Park. • Adhering to environmental standards increases business costs.

The PESTLE analysis of Table 2 examines the significant factors affecting manufacturing in China and Malaysia, helping Company X make better decisions and manage risks. China benefits from strong government support, advanced technology, and a well-developed supply chain, making it a top manufacturing hub. However, it also faces political tensions, trade restrictions, and risks related to intellectual property theft, which could create business uncertainties. On the other hand, Malaysia offers a stable political environment, lower costs, and proximity to Southeast Asian markets, making it an attractive option for companies that want to reduce their dependence on China while maintaining production efficiency.

Economically, China is a global leader in high-tech manufacturing, with advanced technologies like AI and IoT helping it stay ahead (E-BI 2024). However, rising labor costs and inflation make production more costly (IBS Electronics 2024). In contrast, Malaysia has lower labor costs and government-driven technological growth, particularly in semiconductors and electric vehicle parts (Sharon 2024). Socially, both countries are focusing on sustainability, with China improving its green manufacturing practices and Malaysia aligning with global environmental standards (Rane 2024). These trends show that Malaysia is becoming a strong competitor in technology-driven manufacturing, offering a good balance between cost, innovation, and sustainability (MIDA 2023).

Legally, China has complex regulations, especially regarding intellectual property and environmental laws, which can increase operational costs for companies. On the other hand, Malaysia has a more business-friendly legal system with better protections for intellectual property (Kennemer, 2023). Environmentally, both countries promote sustainability, with China enforcing stricter emission controls and Malaysia developing green projects like the Kulim Green Industrial Park. While these measures help meet global sustainability standards, they also add business costs. Malaysia's stable government, lower risks, and growing technology sector make it a strong long-term manufacturing option. Despite some challenges, Malaysia offers promising opportunities for companies looking for a sustainable and cost-effective alternative to China.

4.4 Analytic Hierarchy Process (AHP) Analysis with PESTLE Elements

The Analytic Hierarchy Process (AHP) analysis in Figure 6 compares China and Malaysia as manufacturing locations for Hardware V, using seven main criteria and 21 sub-criteria, reflecting cost, quality, operational efficiency, and risk management. This structured approach aligned with macro-environmental factors from the PESTLE analysis and ensured consistency with a verified Consistency Ratio (CR).

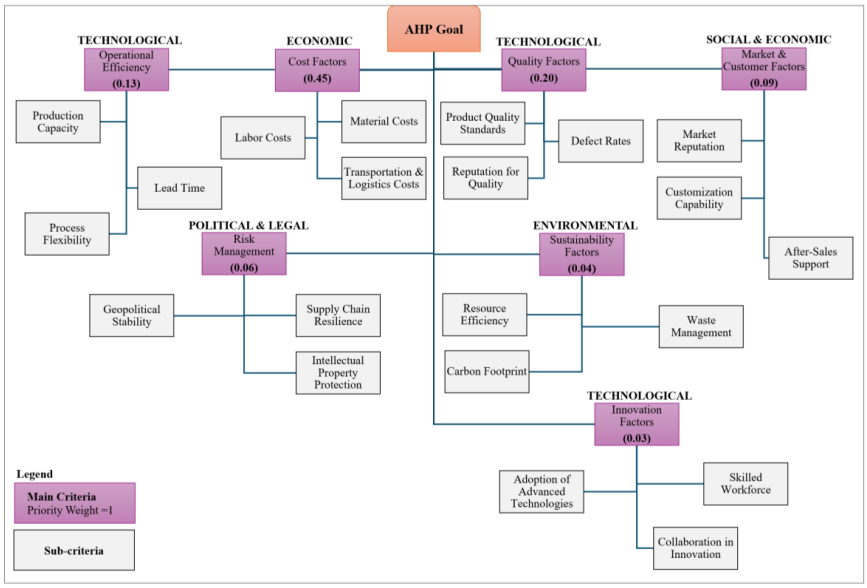


Figure 6. Decision-making chart with AHP

The results showed China had a higher overall score of 1.84, driven by its lower labor and material costs, making it the more cost-efficient choice. However, Malaysia scored higher on quality and risk management, indicating strengths

in producing higher-quality products and mitigating risks like political instability and trade restrictions. While China is the preferred option for short-term cost efficiency, Malaysia's quality and risk management advantages suggest it may support a more sustainable and reliable long-term production strategy. This analysis, summarised in Figure 7, provides Company X with a balanced decision-making framework, emphasising the importance of revisiting the evaluation as market and production conditions evolve.

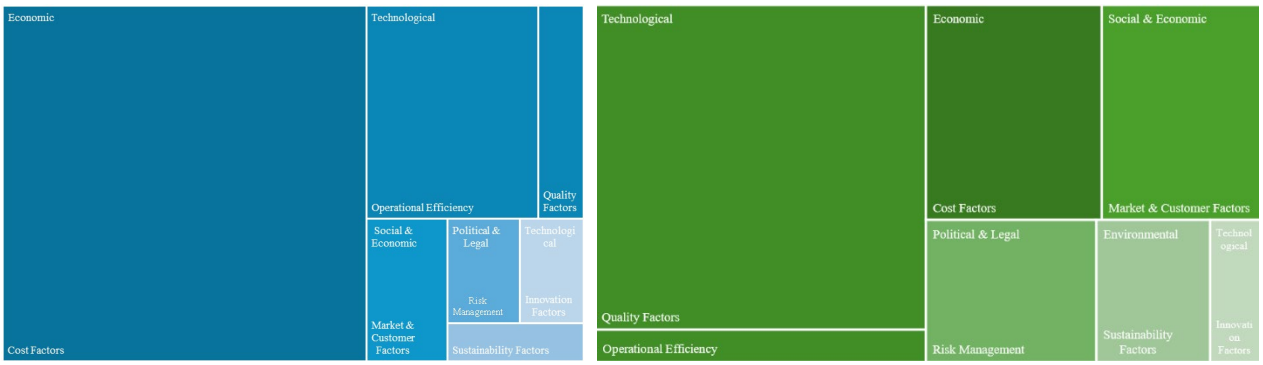


Figure 7. Treemap scores for AHP main criteria: China (left) and Malaysia (right)

4.5 Application of Hofstede's Six Cultural Dimensions and NPV Analysis

Hofstede's Cultural Dimensions framework (Vinney 2024) evaluates the suitability of both China and Malaysia for Company X's manufacturing needs (Figure 8). Their high-Power Distance Index supports hierarchical decision-making, while their collectivist culture emphasizes loyalty and teamwork. China's slightly higher individualism and strong focus on achievement (66 vs. Malaysia's 50) suggest a more competitive, goal-oriented environment. At the same time, Malaysia offers a more balanced approach, prioritizing relationships and work-life balance. Both countries' low uncertainty avoidance index indicates openness to change, although Malaysia's preference for clearer guidelines may support structured operations. China's high long-term orientation aligns well with long-term planning and continuous improvement, while Malaysia's middle-ground approach allows flexibility. In indulgence versus restraint, Malaysia offers a more relaxed and employee-focused environment, contrasting with China's disciplined, restrained atmosphere. Considering Company X's emphasis on long-term strategy, operational discipline, and high performance for Hardware V, China emerges as the more aligned choice. However, Malaysia provides unique advantages in terms of flexibility and employee satisfaction.

The Net Present Value (NPV) analysis of Table 3 compares the financial benefits of manufacturing Hardware V in China versus Malaysia, considering costs, payment terms, and lead times. Using a 7% discount rate, the NPV for China is $427,861.33, while Malaysia's is higher at $457,331.54, offering a financial advantage of $29,470.20. Malaysia's favorable payment terms allow payment 30 days after dispatch, enhance cash flow flexibility, and enable Company X to retain funds longer for other investments or operational needs. Malaysia's lead time is two weeks longer than China's, but this is negligible within the overall 52–78 week project timeline. As AFC demand is derived, customers are likely to accept this increase when procuring from Company X, an OEM.

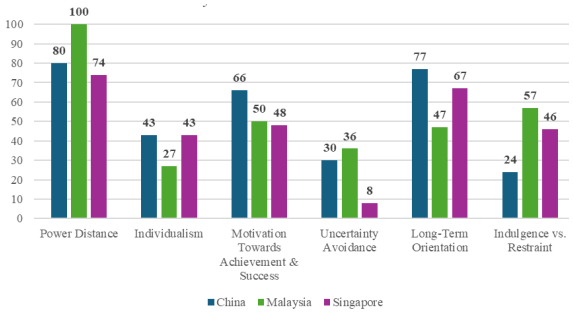


Figure 8. Hofstede's cultural dimensions: selected country values

Table 3. NPV calculations on 1000 units Hardware V order for China and Malaysia CM

Order Quantity (Unit)	1000	Payment Term - Customer	50% upon order, balance before pickup
Unit Selling Price	$ 1,100.00	Lead Time - China CM, Week(s)	4
Discount Rate	7%	Payment Term - China CM	50% advance, balance before dispatch
Unit Cost (China CM)	$ 670.99	Lead Time - Malaysia CM, Week(s)	6
Unit Cost (Malaysia CM)	$ 647.13	Payment Term - Malaysia CM	30 days, from dispatch date

Event	Time (Days)	China	Malaysia	China NPV	Malaysia NPV
50% Advance Payment from Customer	0	$550,000.00	$550,000.00	$550,000.00	$ 550,000.00
Initial 50% Payment to China CM	0	-$335,495.00	$ -	-$335,495.00	$ -
50% Balance Payment from Customer	28	$550,000.00	$ -	$547,054.77	$ -
Balance Payment to China	28	-$335,495.00	$ -	-$333,698.44	$ -
50% Balance Payment from Customer	42	$ -	$550,000.00	$ -	$ 545,588.08
Payment to Malaysia	72	$ -	-$647,130.00	$ -	-$ 638,256.54
			Total NPV (SUM):	**427,861.33**	**457,331.54**

4.6 Analysis of Structured Interviews with Company X's Team

Structured interviews with nine Company X employees revealed slightly higher satisfaction with the Malaysia CM than the China CM, with Malaysia scoring an average of 3.54 versus China's 3.28 across all categories. Most employees rated Malaysia positively, while China's score reflected more neutral experiences. Employees highlighted Malaysia's quality control and satisfaction strengths, while China was noted for better problem-solving but lower efficiency (Figure 9). Communication and logistics were rated similarly for both locations, though cultural differences posed challenges, particularly in China. Ratings for Malaysia were more consistent, indicating stable positive experiences, while China's ratings varied widely. Overall, internal feedback favored Malaysia as the preferred location for producing Hardware V, reflecting better employee experiences and perceived operational strengths.

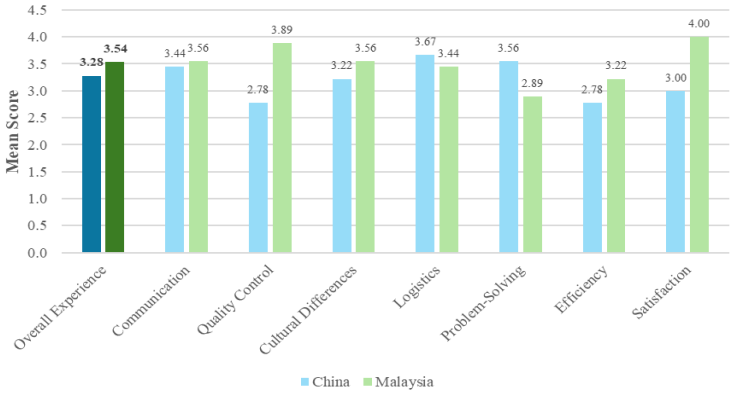


Figure 9. Average score of interview questions in each category

4.7 Customer and Market Analysis

Customer surveys provided insights into their perceptions of Hardware V, particularly its manufacturing location. Figure 10 shows that customers rated the product positively with an average score of 3.82, indicating satisfaction with its quality regardless of origin. However, products made in Malaysia received a higher recommendation rate than those manufactured in China, with a 22.58% difference in favor of Malaysia (Figure 11). While the product's origin influenced trust and buying decisions for some customers, it was not the primary factor for most. Positive feedback indicates that customers perceive Malaysia-made products as higher in quality and subject to lower import duties, as compared to China-made products.

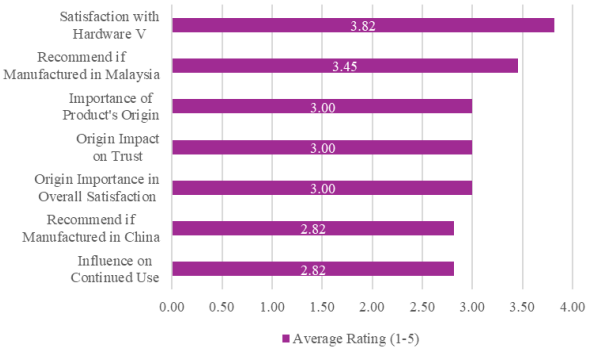


Figure 10. Average ratings of customer surveys

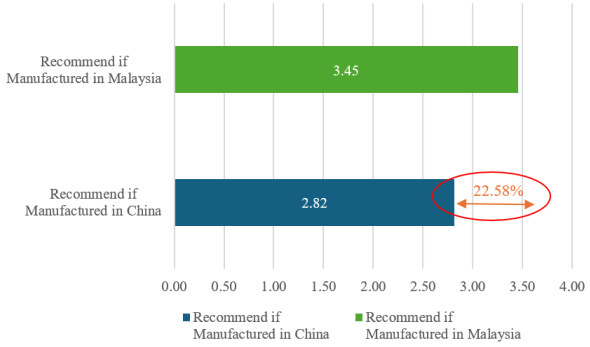


Figure 11. Recommendation rating based on product origin

Table 4 reveals the economic implications of the product's origin due to varying import duties across countries. For example, U.S. customers would face a 27.6% duty on Hardware V made in China compared to only 2.6% if made in Malaysia, creating significant cost savings. Similarly, Indian customers benefit from a duty exemption for Malaysian products versus a 7.5% duty for those from China. This cost advantage makes Malaysia a more appealing manufacturing location for many markets. However, Figure 12 indicates that 55% of customers might switch vendors if their preferences for manufacturing location are not met, emphasizing the strategic importance of aligning production decisions with customer expectations. Table 5 summarizes customers' preferred manufacturing locations and their reasons.

Table 4. Location's duties for China and Malaysia

Project - Customer	Hardware V HS Code	Duties Origin China	Duties Origin Malaysia
California, USA	8543.70.98.60	27.6%	2.6%
Merida, Mexico	8543.70.99.99	0%	0%
Costa Rica	8543.70.99.00.90	0%	0%
Quito Ecuador	8543.70.90	0%	0%
Lima Peru	8543.70.90	0%	0%
Nigeria	8543.70	10%	10%
Egypt	8543.70.90	20%	20%
UAE	8543.70.90	0%	0%
India	8543.70.99	7.5%	0%
Maldives	8543.70.10.99	20%	20%
Canberra Australia	8543.70.00.92	0%	0%

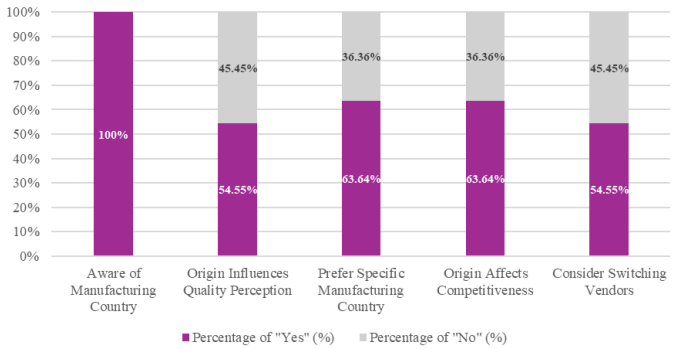


Figure 12. Customer's "Yes or No" scores

Table 5. Customer's preferred manufacturing locations and reasons

No. (C)	Project - Customer	Preferred Country	Reasons for Importance (1)	Reasons for Importance (2)	Reasons for Importance (3)	Reasons for Importance (4)
1	California, USA	Other - USA or Mexico	Quality assurance	Ethical considerations	Support for domestic market	Environmental considerations
2	Merida, Mexico	Malaysia	Price competitiveness	Support services	Functionality	
3	Costa Rica	N.A.	Environmental considerations	Sustainability	Price competitiveness	
4	Quito Ecuador	N.A.	Price competitiveness	Reliability	Support services	
5	Lima Peru	N.A.	Functionality	Price competitiveness	Support services	
6	Nigeria	Other - Possibly Europe or the USA	Quality assurance	Previous experiences with products from certain countries		
7	Egypt	Other - Europe	Quality assurance	Brand reputation	Reliability	
8	UAE	Other - European countries, US, or Japan	Quality assurance	Brand reputation	Ethical considerations	Environmental considerations
9	India	Other - India	Support for domestic market	Quality assurance	Brand reputation	
10	Maldives	N.A.	Price competitiveness	Support services		
11	Canberra Australia	Malaysia	Quality assurance	Ethical considerations	Support for domestic market	

5. Conclusions and Recommendations

This section brings together the main findings of this study to aid Company X decide whether manufacturing Hardware V is better suited in Malaysia or China. This section summarizes the pros and cons of each location, covering costs, quality, operational ease, and market needs based on the project's goals. Finally, it provides a clear recommendation,

considering key factors and stakeholder feedback, to guide Company X toward the best manufacturing choice for future growth and success in the Automated Fare Collection (AFC) industry.

5.1 Conclusions

This study establishes Malaysia as the ideal production location for Hardware V, supported by critical factors such as total cost, quality, future value, and employee feedback (Table 6). While findings from PESTLE, AHP, and Hofstede's analysis favor China, customer surveys and operational insights strongly favor Malaysia. This decision aligns with Company X's cost savings goals, improved product quality, and stronger relationships with customers and employees, ensuring long-term growth and competitiveness in the AFC industry.

Recent market developments further validate this choice. Rising geopolitical tensions, such as U.S.-China trade issues, have prompted major companies like IBM (Liu 2024) and HP (Investing.com 2024) to reduce their reliance on China. Malaysia is emerging as a preferred alternative due to its political stability, tech-friendly policies, and economic growth (Banerjee 2024). Significant investments, such as Infineon's SGD10 billion chip factory, highlight Malaysia's growing appeal (ST Business 2024). Conversely, China faces economic challenges, including declining foreign investments, signaling increased risks (The Feed 2024). These trends strengthen the case for Malaysia as the strategic location for Hardware V production.

Table 6. Summary of results

Analysis Type	Results	
	China	Malaysia
Total Cost of Ownership		✓
Quality (RMA)		✓
SWOT		✓
PESTLE	✓	
Analytic Hierarchy Process (AHP)	✓	
Hofstede's Six Cultural Dimensions	✓	
Net Present Value (NPV)		✓
Internal Interview		✓
Customer Survey		✓

5.2 Recommendations

This study focused on factory gate costs for Hardware V. However, future research should incorporate end-to-end costs, including transportation, installation, and after-sales services, for a more comprehensive expense analysis. Additionally, conducting separate quality Pareto analyses for each manufacturing location would help identify and address location-specific issues more effectively. While customer surveys indicated a preference for Malaysia-made products, more profound studies on customer satisfaction and product performance post-deployment could provide actionable insights.

With a growing emphasis on sustainability, future studies should evaluate the environmental impact of manufacturing in Malaysia and China, focusing on energy use, waste, and emissions. Expanding risk assessment through a detailed matrix considering supply chain and political risks could enhance disaster preparedness. Lastly, exploring emerging manufacturing hubs like Vietnam, India, and Thailand could uncover new alternatives to China and Malaysia, aligning with broader market trends and strategic opportunities.

Acknowledgements

We extend our sincere gratitude to the management of Company X, notably the CEO and Vice President of Operations, for their invaluable support and guidance throughout this project. We appreciate the contributions of the Supply Chain, Finance, and Engineering teams, whose expertise and insights were pivotal to the project's success. Special thanks go to Company X's customers for their cooperation and feedback, which greatly enriched the quality of this study.

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