INVESTIGATING THE FACTORS IMPACTING THE GROWTH OF THE METAL RECYCLING INDUSTRY IN MALAYSIA

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Abstract. The metal recycling industry plays a pivotal role in the circular economy (CE), fostering jobs creation and bolstering a country's GDP. Despite numerous studies scrutinising challenges within this sector, scant attention has been paid to its specific impacts in Malaysia. Thus, this study aims to delve into the ramifications of factors such as limited awareness, government policies, market price fluctuations, and workforce shortages on the growth trajectory of Malaysia's metal recycling industry. Employing a quantitative approach, this research gauges insights from business proprietors, marketing and procurement managers, and executives within the metal recycling domain. Utilizing Likert questionnaires as the primary measurement tool, this study disseminated 170 surveys to targeted respondents. Findings from the study unveil significant, adverse correlations between independent variables-namely, lack of awareness, governmental policies, market price volatility, and lack of manpower-and industry growth. Furthermore, this study sheds light on the implications derived from these findings and outlines potential avenues for future research in this domain.
Keywords: *lack of awareness, government policy, metal market price trends, lack of manpower, industry growth*

Introduction

The recycling process stands as a pivotal component in fostering a circular economy, generating substantial job opportunities and bolstering a country's GDP. Notably, the metal recycling industry in developed nations such as Germany, Austria, South Korea, the United Kingdom, and Japan has achieved a higher level of maturity compared to developing countries, including those in Southeast Asia. According to a report, Malaysia's national recycling rate surged to 33.17 percent in 2022, with the total volume of recycled goods reaching 4,626 million tonnes (The Star Web Portal, 2022). However, despite this progress, Malaysia's recycling rate still lags behind that of developed nations, leaving significant room for improvement. Hence, fostering growth in the metal industry holds the potential to create numerous job opportunities in Malaysia and substantially contribute to its GDP, particularly in the post-pandemic era and following China's implementation of the National Sword policy in 2017, which rigorously monitors recyclable waste imports. This research endeavour aims to provide valuable insights for practitioners, academics, and the general public, enhancing understanding of the metal recycling industry. By raising awareness about the importance of recycling and shedding light on the challenges faced by Malaysia's metal recycling sector, this study seeks to contribute to the industry's advancement and sustainable development.

Literature review

The aim of this research is to scrutinise the hurdles encountered by Malaysia's metal recycling industry. Over the past five years, studies have been reviewed concerning

challenges such as lack of awareness, government policies regarding scrap metal, trends in metal prices, manpower shortages, and the industry's growth trajectory. Researchers have pinpointed various studies examining the relationship between these challenges and the growth of the recycling industry: for instance, the correlation between lack of awareness and industry growth (Nithya et al., 2021); the impact of government policies on industry growth (Yoshida, 2022); the connection between metal price trends and the recycling industry (Renner and Wellmer, 2020); and the significance of skilled manpower on industry growth (Shamee and Shamsuddin, 2019). However, these studies have failed to adequately address the impact of these challenges on the growth of the recycling industry. This study will delve deeper into key concepts central to the current research, such as lack of awareness, government policy, metal price trends, manpower shortages, and the growth of the metal recycling sector. Lack of awareness refers to a lack of knowledge or understanding regarding a particular issue or situation. For instance, due to insufficient environmental awareness and knowledge about e-waste disposal and collection options among households, they often resort to selling e-waste to informal collectors or dumping it as solid waste (Ahirwar and Tripathi, 2021; Wang et al., 2017).

Past research has highlighted the impact of inconsistent government policies on the metal recycling industry. Studies indicate that metal recycling trade hinges on key market prices, such as those set by the London Metal Exchange (LME) and Shanghai LingTong. For instance, the price of recycled copper is typically determined by applying a discount to the price of copper cathode, traded daily on the LME (Corral-Marfil et al., 2021). In this industry, recyclers and traders often refer to LME or LingTong prices as benchmarks for trading. Moreover, shortages of skilled manpower have posed challenges for manufacturers, leading to higher human capital costs and reduced productivity (Rite, 2019). The lack of skilled workers has also been identified as a barrier in end-of-life vehicle (ELV) management (Mohamad-Ali et al., 2018). Meanwhile, industry growth is a measure of economic progress within a specific sector. It can be determined through factors such as profit gains, contributions to GDP, market demand, sales figures, and investments in the industry (Bhatt and Vaidya, 2024).

Research model and theory

The theory under scrutiny and to be assessed in this context is Stakeholder Theory. As articulated by Freeman (2024), Stakeholder Theory offers a perspective on capitalism that underscores the intricate interrelationships between a business and its various stakeholders, including customers, suppliers, employees, investors, communities, and others vested in the organisation. This theory advocates for firms to generate value not only for shareholders but for all stakeholders involved. The adoption of the Circular Economy (CE) plays a pivotal role in fostering business practices geared towards regeneration, sustainability, and restoration. Circular Economy (CE) represents a regenerative production-consumption system aimed at maintaining resource extraction rates and waste generation rates within sustainable boundaries. By closing the loop, reducing system size, and prolonging the value of resources within the system, CE endeavours to uphold planetary sustainability (Suárez-Eiroa et al, 2019). The model highlighted in this study is the Circular Economy model, which encompasses two distinct value chain models: the linear value chain and the closed-loop value chain. In comparison to the linear value chain model, the closed-loop value chain model is particularly pertinent to this research. In the linear value chain model, disposal methods

such as landfilling and incineration are often considered the most economically viable options (Fulconis et al., 2018).

Research framework and hypotheses

The research framework (*Figure 1*) and hypotheses are includes:

H1: Lack of awareness has a negative significant impact on industry growth of the metal recycling industry in Malaysia.
H2: Government policy that is strict regarding rules and regulations related to metal scrap has a negative significant impact on industry growth of the metal recycling industry in Malaysia.
H3: Market price trend has a negative significant impact on industry growth of the metal recycling industry in Malaysia.
H4: Lack of manpower has a negative significant impact on industry growth of the metal recycling industry in Malaysia.

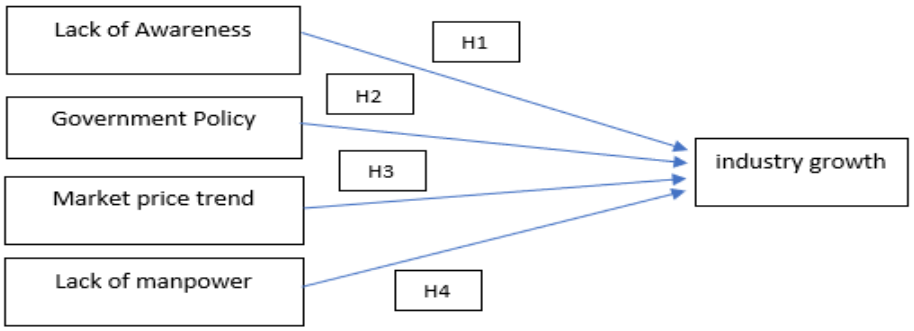

Figure 1. *Conceptual framework.*

Materials and Methods

This research employs a quantitative research methodology, making SPSS software a suitable tool for analysing the relationship between independent and dependent variables. Additionally, demographic profiling and normality testing, utilizing measures such as skewness and kurtosis, will be conducted to assess whether the dataset conforms to a normal distribution. Furthermore, the reliability of the questionnaire survey data will be assessed using Cronbach's alpha coefficient. Descriptive statistics will be utilized to summarize the data, facilitating comprehension. This includes calculating percentages, means, and standard deviations. Subsequently, regression analysis will be performed to test the hypotheses of the research, employing multiple regression models. In this model, industry growth will serve as the dependent variable, while lack of awareness, government policy, market price trends, and lack of manpower will be treated as independent variables. The research aims to survey a minimum of 150 respondents, adhering to Hair et al. (2010) rule. This approach is deemed suitable due to the challenges in identifying the quantity of waste generators in Malaysia, as well as their sporadic disposal and sale of scrap metal. Convenience sampling method is adopted owing to its rapidity, convenience, cost-effectiveness, and accessibility. Given that the recycling industry in Malaysia is relatively small compared to other sectors such

as healthcare and electronics manufacturing, convenience sampling proves more practical compared to alternative methods.

Results and Discussion

Descriptive statistic

The study investigated the impact of various factors on the growth of the metal recycling industry, including lack of awareness, government policy, market price trends, and lack of manpower. Descriptive statistics were utilised to gauge respondent agreement levels regarding the influence of each factor (*Table 1*). Lack of awareness emerged as a significant concern, with respondents expressing a strong agreement (mean of 4.236) regarding its impact on industry growth. This finding indicates a consensus among participants that insufficient awareness negatively affects the metal recycling industry's development. Similarly, government policy was perceived to have a notable impact on industry growth, with respondents exhibiting a high level of agreement (mean of 4.020) regarding this influence. The close proximity of the data to the maximum agreement level suggests a widespread acknowledgment of the significance of government policies in shaping the industry's trajectory. Market price trends were also identified as influential factors, with respondents strongly agreeing (mean of 4.053) on their impact on industry growth. This finding underscores the recognition among participants of the profound effect that market price fluctuations have on the metal recycling sector. Additionally, lack of manpower emerged as a significant challenge, with respondents indicating a strong agreement (mean of 4.087) regarding its impact on industry growth. This highlights the consensus among participants regarding the detrimental effects of manpower shortages on the industry's ability to thrive.

Table 1. *Descriptive statistic.*

Category	N	Minimum	Maximum	Mean	Std. Deviation
Lack of awareness	150	2.20	5.00	4.236	0.575
Government policy	150	3.00	5.00	4.02	0.495
Market price trend	150	1.60	5.00	4.053	0.563
Lack of manpower	150	2.20	5.00	4.087	0.561
Industry growth	150	1.00	4.20	2.009	0.600

Furthermore, the study explored respondent perceptions of current and future industry growth unaffected by the aforementioned factors. The descriptive statistics revealed a significantly lower mean (2.009), indicating a stronger disagreement among participants regarding the industry's growth prospects when factors such as lack of awareness, government policy, market trends, and manpower shortages are not considered. This suggests a widespread recognition among respondents that these factors play pivotal roles in shaping the metal recycling industry's growth trajectory. Overall, the findings underscore the multifaceted nature of challenges facing the metal recycling industry in Malaysia. Lack of awareness, government policy, market price trends, and manpower shortages were identified as significant obstacles to industry growth. Addressing these challenges is crucial for fostering a conducive environment for the sustainable development of the metal recycling sector in the country.

Reliability test

In this study, Cronbach's Alpha was utilised to assess the reliability of the questionnaire across various variables. Typically, Cronbach's alpha values fall within the range of 0 to 1. However, if the alpha value is below 0.6, it may indicate insufficient reliability. *Table 2* presents the computed Cronbach's alpha coefficients for each variable, all of which range between 0.6 and 1. According to Hajjar (2018), alpha values falling between 0.6 and 0.8 are considered acceptable. Consequently, the results of this study are deemed reliable and acceptable.

***Table 2**. Reliability test-Cronbach Alpha.*

Variables	Cronbach Alpha	Status
Lack of Awareness	0.789	Acceptable
Government Policy	0.63	Acceptable
Market price trend	0.75	Acceptable
Lack of manpower	0.80	Acceptable
Industry growth	0.79	Acceptable

Correlation

To confirm the absence of multicollinearity, a Pearson Correlation test was conducted. As outlined by Shrestha (2020), multicollinearity is unlikely to be present when the Pearson Correlation coefficient is below 0.8, with a significance level of 0.05 (2-tailed). Thus, multicollinearity is deemed absent when the coefficient value is less than 0.8, at the 0.05 significance level (2-tailed). Upon examination of *Table 3*, it is evident that there is no significant correlation among the independent variables, as indicated by the Pearson Correlation coefficients of 0.525, 0.406, 0.489, 0.414, 0.457, and 0.588, all at the 0.05 significance level (2-tailed).

***Table 3**. Correlations between independent variables.*

Variable		LoA	GP	MPT	LoM
LoA	Pearson Correlation	1	0.525*	0.406*	0.489*
	Sig. (2-tailed)	-	<0.001	<0.001	<0.001
	N	150	150	150	150
GP	Pearson Correlation	0.525*	1	0.414*	0.457*
	Sig. (2-tailed)	<0.001	-	<0.001	<0.001
	N	150	150	150	150
MPT	Pearson Correlation	0.406*	0.414*	1	0.588*
	Sig. (2-tailed)	<0.001	<0.001	-	<0.001
	N	150	150	150	150
LoM	Pearson Correlation	0.489*	0.457*	0.588*	1
	Sig. (2-tailed)	<0.001	<0.001	<0.001	-
	N	150	150	150	150

*Note: * means correlation is significant at the 0.05 level (2-tailed).*

Regression

This study examined the influence of lack of awareness, government policy, metal market price trends, and lack of manpower on the growth of Malaysia's metal recycling industry (*Table 4*). The findings revealed significant negative relationships between these variables and industry growth. Firstly, the study found a negative and significant relationship between lack of awareness and industry growth, supported by a coefficient

value of -0.213 and a p-value of 0.001 (H1). Similarly, government policy was found to have a negative and significant impact on industry growth, with a coefficient value of -0.135 and a p-value of 0.038 (H2). Furthermore, the study confirmed a negative and significant relationship between metal market price trends and industry growth, supported by a coefficient value of -0.349 and a p-value of less than 0.001 (H3). Lastly, lack of manpower was found to negatively affect industry growth, with a coefficient of -0.281 and a p-value of less than 0.001 (H4)

Table 4. *Multiple linear regression.*

Variable	Coefficient	Sig.	F-value	Sig.	Results
Intercept term	6.347	< 0.001	54.843	< 0.001	-
Lack of awareness H1	-0.213	0.001	-	-	Supported
Government policy H2	-0.135	0.038	-	-	Supported
Market price trend H3	-0.349	< 0.001	-	-	Supported
Lack of manpower H4	-0.281	< 0.001	-	-	Supported

Addressing the research questions, the study found that lack of awareness directly impacts industry growth, with an increase in lack of awareness resulting in a decrease in industry growth by 0.213 units (RQ1). This finding is consistent with past studies by Kihila et al. (2021), Gunarathne et al. (2020), Ichikowitz and Hattingh (2020), Ismail and Hanafiah (2019) and Yong et al. (2019). Regarding government policies, the study revealed a negative impact on industry growth, with an increase in government policies leading to a decrease in industry growth by 0.135 unit (RQ2). Concerning metal market price trends, the study found that an increase in these trends correlates with a decrease in industry growth by 0.349 unit (RQ3). Lastly, lack of manpower was found to directly impact industry growth, with an increase in lack of manpower resulting in a decrease in industry growth by 0.281 units (RQ4).

Conclusion

Previous research has contributed significantly to enhancing the understanding of how the structure of value chain activities can impact outcomes in the realm of circular economy. Suárez-Eiroa et al. (2019) conducted a comprehensive literature review on circular economy and proposed operational principles that bridge theoretical aspirations with practical implementation strategies within the sustainable development framework. The study revealed that formulating these operational principles entails aligning objectives derived from theoretical goals with practical strategies for implementation. This alignment process facilitates the identification and resolution of challenges impeding the growth of the metal recycling industry, thereby advancing broader objectives of fortifying a resilient circular economy framework. One key outcome of implementing this study is gaining precise insights into the challenges confronting the metal recycling industry in the current landscape. Effective management and strategic planning are imperative for recycling companies to surmount these challenges and realize direct business profits. The findings underscored that the metal market trend poses the most formidable challenge to industry growth, directly impacting profitability due to raw materials constituting a significant portion of operational costs.

Moreover, the study highlighted how inconsistent government policies and unwarranted barriers hinder industry growth. It advocates for robust communication

between government entities and metal recycling industry associations to understand the sector's requirements and collaboratively address environmental concerns. Additionally, the government is urged to enact relevant regulations and policies aimed at increasing public awareness to minimize wastage of recyclable materials. This study encountered several limitations that warrant consideration. Primarily, the empirical findings are most pertinent within the context of Malaysian metal recycling companies. Attempting to generalise these findings to other scenarios, such as metal recycling companies in different developing and developed countries, should be approached cautiously. Additionally, limitations stem from potential biases arising from how respondents assessed the conditions encountered during the research. Responses may vary based on respondents' positions, leading to discrepancies in evaluations due to differing levels of understanding on the issues. Moreover, the study relies on respondents' honesty in their survey responses, which may present a limitation as it cannot be guaranteed that all respondents will provide entirely candid answers. Furthermore, the time constraints inherent in a master's research project may have limited the scope of the study. Although the framework developed is grounded in empirical facts and identifies four variables affecting metal recycling industry growth in Malaysia, it is acknowledged that there may be other variables impacting this industry in the real world.

The primary objective of this research is to explore the influence of lack of awareness, government policy, metal market price trends, and lack of manpower on the growth of Malaysia's metal recycling industry. The study findings indicate that the most significant factor impacting industry growth is the trend in metal market prices, followed by manpower shortages, lack of awareness, and government policy. Moving forward, future research endeavours could delve deeper into various factors contributing to the lack of awareness regarding metal recycling practices across different demographics. Moreover, conducting surveys or qualitative studies could provide insights into the perceptions, motivations, and barriers related to recycling awareness among diverse stakeholder groups. Additionally, comparative analyses of government policies concerning the metal recycling industry in developed and developing countries could be undertaken to evaluate the effectiveness of specific policies. Longitudinal studies may also be conducted to assess how fluctuations in metal market prices influence recycling rates and industry growth over time. Furthermore, exploring strategies to address the shortage of skilled labour in the metal recycling industry or examining the feasibility of implementing Industry 4.0 solutions to mitigate manpower issues could be avenues for future research efforts.

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Conflict of interest

The authors confirm that there is no conflict of interest involved with any parties in this research.

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