INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 10, (2024) E-ISSN: 2222-6990

Perception of Ai Integration in End-of-Life Vehicle (ELV) Practices among Technical Graduates In Malaysia

Ahmad Fadzil Bin Mohamad[1], Mohd Khairul Nizam Bin Suhaimin[2], Suriati Akmal[2],Wan Hasrulnizzzam[2], Hazly Rafis Abd Rahim[3]

[1]Institute of Technology Management and Entrepreneurship (IPTK), Universiti Teknikal Malaysia Melaka, [2]Faculty of Technology and Mechanical Engineering, Universiti Teknikal Malaysia Melaka, [3]Faculty of Electornic & Computer Technology and Engineering, Universiti Teknikal Malaysia Melaka

Corresponding Author Email: m.khairul@utem.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i10/23122 DOI:10.6007/IJARBSS/v14-i10/23122

Published Date: 05 October 2024

Abstract

The rapid advancement of artificial intelligence (AI) has spurred its adoption across various industries, including transportation and environmental sustainability sectors for example in End-of-Life Vehicle (ELV) management. AI holds the potential to revolutionize ELV practices by enhancing the efficiency of dismantling processes, optimizing recycling techniques, and ensuring resource recovery in a sustainable manner. However, despite the promising prospects, the success of AI implementation in ELV depends significantly on the perceptions and readiness of technical graduates entering the workforce. A survey was distributed anonymously to recent graduates from four institutions within the Malaysian Technical University Network (MTUN). A total of 152 responses were analysed. The results suggest that 67.1% of respondents were aware of the use of AI in ELV practices, and 75.7% agreed that AI could improve the efficacy of vehicle dismantling processes. Nevertheless, a substantial socio-economic challenge was underscored by the 36.2% of graduates who expressed apprehensions regarding the potential for AI to result in job displacement. Furthermore, 88.8% of respondents expressed the belief that additional education and training on AI in ELV practices are essential. These results emphasise the necessity of targeted educational reforms and industry partnerships to address the AI preparedness disparity among technical graduates. The study concludes with suggestions for policymakers, educators, and industry leaders to guarantee that the integration of AI not only improves the efficacy of ELVs but also fosters a skilled workforce that is prepared to adopt future technological advancements.

Keywords: Artificial Intelligence (AI), End-of-Life Vehicle (ELV), Technical Graduates,

Introduction

The integration of artificial intelligence (AI) into end-of-life vehicle (ELV) practices is becoming a critical innovation in the waste management and automotive sectors. AI has exhibited substantial potential to improve the sustainability and efficacy of ELV processes, including resource recovery, recycling, and dismantling. ELV management is undergoing a transformation in Malaysia, as it is in numerous other countries, as a result of the necessity for sustainable development and circular economy practices (Cardamone et al., 2022; Makarova et al., 2021). Nevertheless, the implementation and advancement of these AI-driven innovations are significantly contingent upon the perceptions and preparedness of technical graduates. The present investigation investigates the perspectives of technical graduates in Malaysia regarding the incorporation of AI into ELV practices, thereby elucidating the opportunities and obstacles that this integration presents.

Artificial intelligence has become a fundamental element of Industry 4.0, with implementations in a variety of sectors, such as automotive recycling. By optimising operations, reducing human error, and augmenting decision-making, AI-driven automation, machine learning, and robotics have revolutionised industries (Lee & Kwon, 2024; Liao et al., 2024). AI is particularly pertinent in the dismantling process, the sorting of recyclable materials, and the efficient utilisation of parts and materials in ELV practices (Nur et al., 2018). The capacity of AI to manage large datasets, identify patterns, and predict outcomes enables a more efficient approach to the management of ELV waste. Research indicates that the integration of AI into ELV practices can considerably enhance sustainability outcomes, mitigate environmental impact, and facilitate the global transition to a circular economy (Rao et al., 2024).

The successful adoption and implementation of AI technologies within the ELV sector are significantly influenced by technical graduates. These individuals are equipped with the necessary skills and knowledge to optimise ELV processes through the use of AI. Nevertheless, their perspectives on AI integration are influenced by a variety of factors, such as their awareness of the potential advantages and obstacles of AI in this context, their education, and their exposure to AI technologies (Magagula & Awodiji, 2024; Ismail & Yusof, 2023). The significance of technical education and training in equipping graduates to meet the requirements of AI-driven industries is underscored by a study conducted by Alam et al. (2024). It is imperative to comprehend the manner in which technical graduates perceive and interact with AI in order to ensure the success of these initiatives, as the automotive and waste management sectors increasingly depend on AI to achieve sustainability objectives.

The integration of AI into ELV practices provides a variety of advantages, such as cost savings, reduced environmental impact, and increased efficiency. For example, AI can be employed to optimise the dismantling of vehicles, guaranteeing the safe disposal of hazardous materials and the recovery of valuable components (Yuik et al., 2023). In addition, the sifting process can be expedited by AI-powered robotics and automation, which reduces the need for manual labour and minimises errors (Stöhr et al., 2024). In spite of these benefits, there are also obstacles to AI integration, particularly in the context of technical graduates' ability to implement and utilise these technologies in practical environments. The complexity of AI systems, the necessity for ongoing upskilling, and concerns regarding job displacement as a result of automation may present challenges for graduates (Summers et al., 2024).

The perceptions of AI integration in ELV practices among technical graduates are influenced by a variety of factors from a broader perspective. Previous research has suggested that the perception of AI's usefulness, its potential impact on professional positions, and the comprehension of the technology all influence the attitudes of individuals towards AI (Jeske et al., 2017; Krause & Ellram, 1997). Technical graduates may be particularly concerned about the ethical implications of AI, the necessity of regulatory frameworks, and the long-term sustainability of AI-driven systems in the context of ELV practices (Florin Cojanu, 2017). It is imperative to address these concerns by implementing targeted education, training, and policy initiatives in order to cultivate favourable perceptions of AI among technical graduates.

In summary, the incorporation of AI into ELV practices has the potential to significantly advance the objectives of sustainability and circular economy. Nevertheless, the success of this integration is contingent upon the aptitude and perceptions of technical graduates, who are critical stakeholders in the process. The objective of this investigation is to investigate the perspectives of technical graduates in Malaysia regarding the integration of AI into ELV practices. The objective is to determine the obstacles and opportunities they encounter when implementing AI technologies. Policymakers, educators, and industry leaders can develop strategies to assist technical graduates in utilising the maximum potential of AI in the ELV sector by comprehending these perceptions.

The paper is organised as follows: The following section offers a comprehensive literature review that analyses the current research on AI Integration in the ELV Industry and the perceptions of AI among technical graduates. The research design, which includes the survey employed to gather empirical data, is delineated in the methodology section. The survey results are presented in the results section, which emphasises the level of awareness and familiarity with AI tools, particularly in the context of ELV, and the perception of AI's function in ELV practices. Lastly, the discussion and conclusion sections contemplate the implications of these discoveries for the ELV industry and higher education, and they provide suggestions for preparing the next generation of technical graduates for a future in which AI is expected to play a more significant role in the End of life vehicle sectors.

Research Background

This literature review analyses the critical components of AI integration in End-of-Life Vehicle (ELV) practices and investigates the perspectives of technical graduates regarding the application of AI in these processes.. The review is subdivided into the subsequent subsections: (i) AI Integration in the ELV Industry, (ii) Perceptions of AI Among Technical Graduates, and (iii) The Role of Education in Shaping AI Perceptions.

AI Integration in the ELV Industry

The management of end-of-life vehicles is being revolutionised by the implementation of artificial intelligence (AI) in the ELV industry. AI is essential in the optimisation of the dismantling, recycling, and remanufacturing of vehicle components, thereby contributing to the circular economy (Cardamone et al., 2022). The accuracy and efficacy of ELV processes have been enhanced by the application of AI technologies, such as robotic automation, computer vision, and machine learning, to streamline the identification and sorting of materials (Rao et al., 2024). For instance, utilising artificial intelligence (AI) in material

classification systems can improve the separation of hazardous substances, metals, and plastics, which are essential for sustainable recycling (Yuik et al., 2023).

Research underscores that AI's capacity to manage extensive datasets and execute predictive analytics enables organisations to optimise their operations, minimise waste, and optimise resource recovery (Lee & Kwon, 2024). By identifying components that can be refurbished or repurposed, these AI systems can also improve the process of dismantling vehicles. Additionally, the ELV sector has demonstrated that automated systems powered by AI can substantially reduce labour costs and errors, thereby promoting greater sustainability (Nur et al., 2018). However, the integration of AI into ELV practices necessitates a significant investment in infrastructure and technology, which can present obstacles for small and medium-sized enterprises (SMEs) in the automotive recycling sector. The global trend towards a circular economy and the push for sustainable practices have incentivised the adoption of AI-driven solutions in the ELV industry, despite these barriers (Makarova et al., 2021).

Perceptions of AI Among Technical Graduates

The adoption and advancement of AI technologies in the ELV sector are significantly influenced by technical graduates. Several factors, such as their familiarity with the technology, the perceived simplicity of use, and the potential for job enhancement or displacement, influence their perception of AI integration (Sanusi et al., 2022). Yao and Wang (2024) assert that technical graduates who possess a comprehensive comprehension of AI applications are more inclined to perceive AI as a tool for enhancing productivity and accomplishing sustainability objectives.

According to a study conducted by Ismail and Yusof (2023), technical graduates in Malaysia, particularly those in engineering and technology-related disciplines, generally have a positive perception of AI when they have received sufficient education and training. Graduates who are proficient in AI technologies are more inclined to recognise its potential for improving ELV processes and contributing to the circular economy. Nevertheless, a lack of exposure to AI tools during their academic training can result in apprehension and uncertainty regarding its implementation in their future careers (Summers et al., 2024).

Additionally, graduates' perspectives regarding AI in the ELV sector are also influenced by their apprehensions regarding automation-induced job displacement (Jeske et al., 2017). Although AI has the potential to considerably improve operational efficiency, some technical graduates are concerned that the demand for human labour in specific aspects of ELV practices, such as vehicle dismantling and sorting, may decrease as a result of increased automation (Stöhr et al., 2024). It is imperative to address these concerns in order to ensure that AI integration is perceived as a complement to human labour, rather than a replacement.

The Role of Education in Shaping AI Perceptions

The perceptions of AI integration in ELV practices that technical graduates hold are significantly influenced by the education and training they receive. Educational institutions are required to equip students with the necessary skills and knowledge to operate in AI-driven environments (Magagula & Awodiji, 2024). The curriculum should incorporate practical

exposure to AI tools, hands-on training, and industry collaborations that enable students to experience AI applications in real-world ELV scenarios (Alam et al., 2024).

A comprehensive AI education provides technical graduates with the requisite competencies to fully leverage the potential of AI technologies, thereby allowing them to confront the challenges and opportunities associated with AI integration in ELV practices (Elkadry et al., 2024). Liao et al. (2024) contend that technical education should also emphasise the ethical and regulatory aspects of AI to guarantee that graduates are cognisant of the societal repercussions of AI-driven automation. In order to remain competitive in a job market that is constantly changing, technical graduates must pursue continuous upskilling and reskilling opportunities in addition to formal education. Graduates can remain adaptable to changes in the ELV sector and beyond by participating in ongoing professional development programs that emphasise AI-related skills (Ismail & Yusof, 2023). As AI technologies continue to develop and their applications in ELV practices become more sophisticated, these programs are of particular importance.

Methodology

This study utilized a survey to assess technical graduates' awareness, experience, and perceptions of AI in End-of-Life Vehicle (ELV) practices. The survey targeted recent graduates from MTUN universities, focusing on fields like mechanical engineering and automotive technology. It included questions on demographic information, familiarity with AI tools, and the role of AI in ELV practices, particularly addressing ethical concerns, benefits, and challenges. The survey was conducted online, ensuring anonymity, and the responses were analyzed to identify trends in AI awareness and usage, providing insights into how well-equipped these graduates are for AI integration in the ELV sector

Study Design

In order to evaluate the cognisance, experience, and perception of AI in ELV practices of technical graduates, this study implemented an anonymous 14-question survey.. The survey was disseminated to technical graduates from MTUN universities, which are institutions that specialise in vocational education, technology, and engineering.

Survey Instrument

The survey was divided into three sections: i) Demographic information, which encompassed age, university affiliation, and field of study. ii) Familiarity and awareness of AI tools, particularly in the context of ELV, and iii) Perception of AI's role in ELV practices, with queries addressing ethical concerns, benefits, and challenges. Additionally, respondents were requested to provide information regarding their utilisation of AI in academic or professional environments that were associated with ELV. In order to assess the broader scope of AI's impact on the field, enquiries regarding the ethical implications of AI adoption and prospective career impacts were incorporated.

Data Collection and Sample

The survey was designed to concentrate on recent graduates from MTUN universities who have completed degrees in fields such as environmental sciences, automotive technology, and mechanical engineering. Respondents were granted two months to complete the survey, which was disseminated online through email and university platforms. In order to guarantee

candid responses, participation was voluntary and anonymous, and no identifying information was collected.

Data Analysis

Descriptive statistics were implemented to emphasise critical tendencies in the responses. In order to facilitate comparisons among various groups, the data was categorised by age, institution, and subject of study. The levels of AI awareness, the extent of AI usage, and perceptions of AI's function in ELV practices were summarised using percentages. The demographic details of the participants are summarized in Table 1. The table provides an overview of the gender, age range, their field studies and universities, years of graduation and working experiences in ELV sectors. This information is crucial for contextualizing the findings and ensuring that the results are representative of the population under study

Table 1
The demography details of the participants

Items	**N (%)**
Gender	
- Male	97 (63.8%)
- Female	55 (36.2%)
Age Range (years)	
- 18–24	37 (24.5%)
- 25–30	83 (54.6%)
- 31–35	21 (13.8%)
- 36+	11 (7.2%)
Field Study	
- Mechanical Engineering	140 (42.8%)
- Electrical Engineering	95 (29.1%)
- Industrial Technology	60 (18.4%)
- Other Engineering Fields	32 (9.8%)
MTUN University	
- Universiti Malaysia Pahang (UMP)	44 (29.1%)
- Universiti Teknikal Malaysia Melaka (UTeM)	41 (27.5%)
- Universiti Tun Hussein Onn Malaysia (UTHM)	38 (25.1%)
- Universiti Malaysia Perlis (UniMAP)	27 (18.3%)
Years of Graduation	
- 2019 50 (15.3%)	23 (15.3%)
- 2020 90 (27.5%)	42 (27.5%)
- 2021 110 (33.6%)	52 (33.6%)
- 2022 77 (23.6%)	36 (23.6%)
Work Experience in AI-related ELV Projects	
- Yes	39 (26.0%)
- No	113 (74.0%)

Finding

A request for participation was sent to 498 technical graduates from four institutions of the Malaysian Technical University Network (MTUN) to complete the survey, resulting in a response rate of 37% (184/498). Of those, 32 did not respond to any survey questions beyond demographic characteristics, and their data was omitted. This resulted in the inclusion of 152 responses in the final analysis. Table 2 illustrates the findings regarding the perceptions of technical graduates regarding the incorporation of artificial intelligence into End-Of-Life Vehicle (ELV) practices.

Table 2
Technical Graduates' Perceptions of Artificial Intelligence Integration in End-of-Life Vehicle (ELV) Practices

Perception Item	Agree	Neutral	Disagree
AI awareness in ELV practices			
I am aware of the use of AI in ELV practices	102 (67.1%)	30 (19.7%)	20 (13.2%)
AI can improve the efficiency of vehicle dismantling processes	115 (75.7%)	25 (16.4%)	12 (7.9%)
AI usage in academic or professional settings			
I have used AI tools in my academic projects related to ELV	60 (39.5%)	40 (26.3%)	52 (34.2%)
I have experience using AI tools in ELV-related tasks at work	40 (26.3%)	45 (29.6%)	67 (44.1%)
Ethical considerations of AI in ELV			
AI in ELV will lead to job displacement	55 (36.2%)	42 (27.6%)	55 (36.2%)
It is important to have human oversight when using AI in ELV processes	130 (85.5%)	15 (9.9%)	7 (4.6%)
AI's future in ELV practices			
AI will play a critical role in the future of ELV industry	120 (78.9%)	22 (14.5%)	10 (6.6%)
Technical graduates need more education and training in AI for ELV practices	135 (88.8%)	10 (6.6%)	7 (4.6%)

The perception of AI's function in ELV practices is generally positive, as evidenced by Table 2. 75.7% of respondents concur that AI can enhance the efficiency of vehicle dismantling. This is consistent with the current body of literature, which posits that AI has the potential to enhance processes such as parts identification and recycling, thereby reducing both labour and time costs. Nevertheless, the table also underscores concerns, particularly those related to job displacement. A substantial proportion of respondents are concerned about the potential for automation to replace human workers, as 36.2% of graduates believe that AI will result in job losses. This discovery implies that, despite the widespread perception that AI is advantageous for operational efficiency, there is concern regarding its social implications, particularly the potential reduction in employment opportunities in the ELV sector.

The high degree of consensus (85.5%) regarding the necessity of human supervision in AI-driven processes indicates that graduates acknowledge the constraints of AI, particularly in

intricate decision-making scenarios within ELV processes. This is indicative of the recognition that, despite the potential of AI to enhance repetitive or data-driven tasks, human input is still essential for making nuanced, context-sensitive decisions. Finally, 88.8% of graduates indicated that they required additional education and training in AI for ELV practices. As for the sphere of study and AI awareness in ELV practices, the results are presented in Table 3.

Table 3
Cross-Tabulation of AI Awareness and Field of Study in ELV Practices

Field of Study	Aware of AI in ELV (Yes)	Aware of AI in ELV (No)	Total
Mechanical Engineering	70 (80%)	18 (20%)	88
Electrical Engineering	50 (65%)	27 (35%)	77
Industrial Technology	35 (55%)	28 (45%)	63
Other Engineering Fields	30 (70%)	13 (30%)	43
Total	185 (67%)	86 (33%)	271

The cross-tabulation in Table 3 suggests a strong relationship between the discipline of study and the level of awareness of AI in ELV practices. The most knowledgeable about AI applications in ELV were graduates of Mechanical Engineering (80%) and Other Engineering Fields (70%), which is likely due to the fact that their fields are actively involved in the technical aspects of dismantling and recycling, where AI has been implemented more visibly. In contrast, only 55% of Industrial Technology graduates reported knowing about AI in ELV, which may indicate that this field has had less exposure to AI tools and applications. This disparity may be attributable to the curriculum's emphasis on manufacturing systems, as Industrial Technology programs may prioritise these systems over the specific AI-driven innovations in ELV.

Table 4
Logistic Regression Analysis Predicting AI Awareness in ELV Practices

Variable	B (Coefficient)	Standard Error	Odds Ratio (Exp(B))	p-value
Field of Study (ref: Other)				
- Mechanical Engineering	0.85	0.20	2.34	0.001**
- Electrical Engineering	0.45	0.18	1.56	0.05*
- Industrial Technology	-0.20	0.22	0.81	0.35
Work Experience in AI-related ELV (Yes)	1.20	0.25	3.32	0.001**
Age (years)	0.15	0.12	1.16	0.15

Table 4 illustrates the logistic regression analysis, which identifies numerous critical variables that substantially predict AI awareness in ELV practices. In comparison to graduates from other disciplines, Mechanical Engineering graduates were more than twice as likely (Odds Ratio = 2.34) to be aware of AI in ELV. This is consistent with the technical requirements of ELV dismantling, in which mechanical engineers are actively involved in the optimisation of mechanical processes that AI can improve.

The Odds Ratio of 3.32 indicates that graduates with practical experience in AI were more than three times as likely to be aware of AI in ELV practices. Similarly, work experience in AI-related ELV projects was a significant predictor. This underscores the significance of industry

collaboration, apprenticeships, and work placements in the development of hands-on AI learning. Conversely, the non-significant p-value suggests that the field of Industrial Technology did not significantly predict AI awareness. This implies that further efforts are required to increase awareness and practical experience in this discipline, which may be under-represented in AI exposure as a result of its curriculum focus or industry partnerships.

Table 5
Correlation Matrix Between Perception Items

Perception Item	AI Improves ELV Efficiency	Job Displacement Concern	AI's Role in ELV Future	Need for AI Training
AI Improves ELV Efficiency	1.00	-0.34	0.75	0.60
Job Displacement Concern	-0.34	1.00	-0.45	-0.30
AI's Role in ELV Future	0.75	-0.45	1.00	0.65
Need for AI Training	0.60	-0.30	0.65	1.00

The correlation matrix in Table 5 illustrates significant relationships among various perception items. The robust positive correlation (r = 0.75) between the role of AI in enhancing ELV efficiency and its role in the future of the ELV industry implies that graduates who believe AI improves current processes are also confident in AI's long-term significance in the industry. This suggests that respondents maintain a forward-thinking perspective, considering AI to be a critical, ongoing component of ELV advancements. Nevertheless, the divergence in perspectives is underscored by the negative correlation (r = -0.34) between AI's influence in efficiency and concerns about job displacement. Graduates who perceive AI as advantageous for operational efficacy are less inclined to express apprehension regarding job losses. This implies that certain graduates are of the opinion that AI will enhance human workers rather than supplant them, while others are apprehensive about its socio-economic implications. The graduates' recognition that AI is essential to future ELV practices is further substantiated by the positive correlation (r = 0.65) between the need for AI training and AI's role in the future of ELV.

Discussion

The general positive outlook of technical graduates regarding the incorporation of Artificial Intelligence (AI) in End-of-Life Vehicle (ELV) practices is accompanied by significant concerns regarding job security and the quality of current education. Although the respondents primarily acknowledge the advantages of AI in improving operational efficiency in ELV processes, they also express apprehensions regarding its social impact, particularly in relation to potential job displacement. This multifaceted perspective is indicative of both optimism regarding AI's potential in the industry and concerns regarding its potential impact on employment.

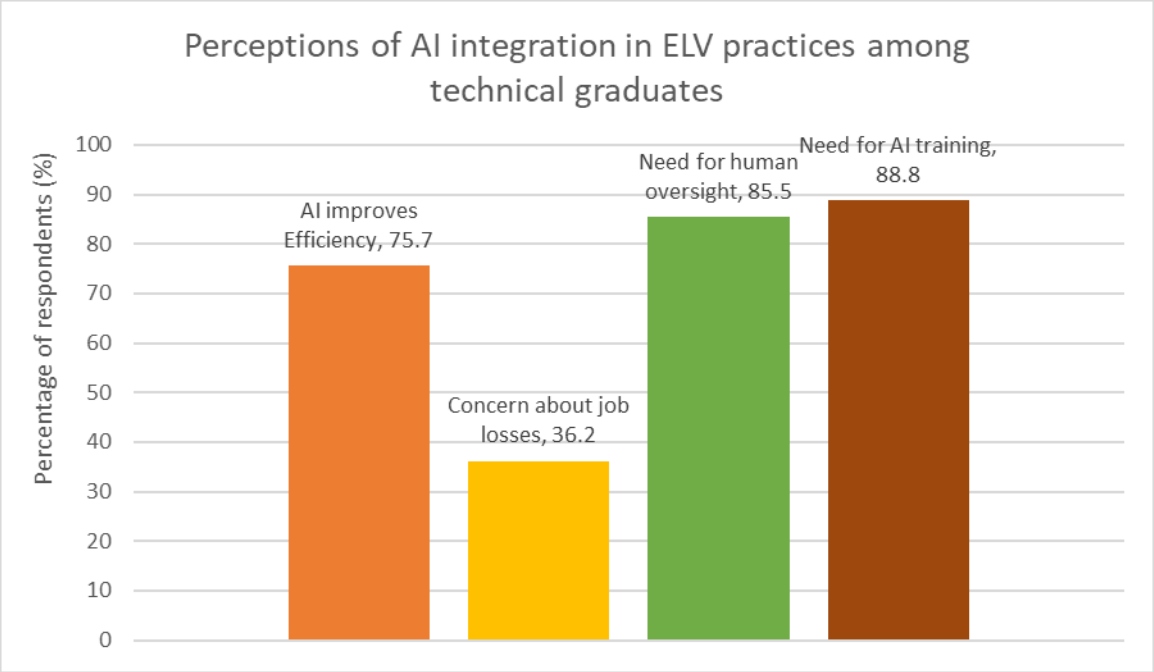

Figure 1 : Perceptions of AI Integration in ELV practices among technical graduates

The main findings from the discussion regarding technical graduates' perceptions of AI integration in ELV practices are illustrated in the bar chart above. It emphasises the substantial demand for AI-related education and training (88.8%) and the strong positive perception of AI's function in enhancing efficiency (75.7%). Nevertheless, the recognition that human oversight is still essential (85.5%) in AI-driven processes continues to be a notable issue, despite the concerns about job displacement (36.2%). A substantial number of respondents (75.7%) concurred that AI could enhance the efficiency of vehicle dismantling, which is consistent with extant research that emphasises AI's capacity to optimise tasks such as material recycling and parts identification. This operational improvement is especially pertinent in the ELV industry, where processes are labour-intensive and time-consuming. AI systems are capable of completing repetitive duties at a faster pace and with greater precision than human employees, resulting in increased productivity and reduced operational costs. The positive response of graduates to AI's function in this field indicates that they recognise its transformative potential in enhancing current ELV practices.

36.2% of respondents expressed apprehensions regarding the potential for AI to result in employment displacement, despite the efficiency advantages. This apprehension is indicative of a prevalent theme in discussions regarding automation and AI in various industries, where technologies that are intended to enhance efficiency frequently supplant human labour. Graduates are concerned that the implementation of AI may diminish the necessity for human labour in the ELV sector, where numerous positions necessitate laborious dismantling and sorting of vehicle components. The divergence in perspectives, as evidenced by the negative correlation between perceived efficiency benefits and concerns about job losses, indicates that, despite the fact that a significant number of individuals acknowledge the operational enhancements that AI provides, a significant number remain sceptic about its broader socio-economic implications.

The results also suggest a strong preference for the preservation of human supervision in ELV processes that are driven by AI. Even in AI-optimized duties, the vast majority of respondents (85.5%) concurred that human involvement remains indispensable. This discovery emphasises a fair assessment of AI's constraints, as graduates are aware that, although AI can improve efficiency in routine duties, it may not be capable of managing more intricate decision-making processes. This viewpoint is indicative of broader industry trends, in which AI is increasingly employed to enhance human abilities rather than to completely supplant them, particularly in sectors that necessitate nuanced problem-solving and context-sensitive decisions. The data also reveals a critical theme: the disparity in AI-related education and training. The majority of graduates, approximately 89%, indicated that they required additional AI education that was specifically designed for ELV practices. This indicates a substantial deficiency in the current curricula, as AI tools and techniques are not adequately emphasised, despite their increasing significance in industries such as ELV. In fields such as Mechanical Engineering, which are more closely related to ELV processes, there is a higher level of AI awareness, with 80% of Mechanical Engineering graduates reporting awareness of AI applications. Conversely, only 55% of Industrial Technology graduates were cognisant of AI's involvement in ELV, indicating a discrepancy in the proportion of students who were exposed to AI-related content in various academic disciplines.

This education gap is also associated with the strong positive correlation between the desire for AI training and the perceived significance of AI in the future of the ELV industry. The graduates acknowledge that AI is essential for the future development of the industry and is not only significant for current ELV processes. Nevertheless, they may encounter difficulties in completely integrating AI technologies into their professional responsibilities in the absence of sufficient training. Consequently, it will be imperative to broaden the scope of AI-related education to encompass technical disciplines, as well as to provide students with practical experience through internships and collaborative projects, in order to equip them with the skills necessary to navigate a future that is influenced by AI-driven innovations in the ELV sector. The significance of work experience in AI-related tasks is further underscored by the logistic regression analysis. Graduates who had practical experience with AI in ELV were significantly more likely to be aware of AI applications. This discovery emphasises the importance of real-world initiatives, internships, and industry collaborations in the development of AI competencies among students. Institutions that incorporate AI exposure into their curricula will better prepare their graduates to meet the demands of an increasingly AI-driven workforce. Therefore, although technical graduates generally regard AI as a valuable tool for enhancing ELV practices, there are still apprehensions regarding job displacement and an evident need for more focused AI education. Targeted educational interventions, particularly in sectors that have been behind in AI awareness, and a balanced approach to AI integration that takes into account the human workforce and operational efficiency will be necessary to address these issues. It will be imperative to enhance AI training by providing graduates with practical exposure and updating curricula to ensure that they are adequately equipped to succeed in a changing ELV industry.

Conclusion and Future Work

The integration of AI into ELV techniques offers substantial prospects for improving the efficiency, sustainability, and overall efficacy of the automobile recycling sector. Technical graduates, anticipated to spearhead this innovation, typically see AI positively, particularly

about its capacity to enhance dismantling and recycling operations. Nonetheless, apprehensions remain about job displacement and the sufficiency of education and training to adequately equip individuals for AI-driven settings. The results highlight the necessity of tackling these difficulties via focused educational initiatives, industrial partnerships, and policy structures. By augmenting AI-focused courses and offering practical experience, technical graduates will be better prepared to engage with the burgeoning ELV sector and advance Malaysia's overarching sustainability objectives. Future initiatives must concentrate on closing the educational divide and fostering a harmonious integration of AI technologies that enhances human proficiency, guaranteeing a workforce that is both technologically skilled and socially accountable in the era of automation.

Acknowledgements

The authors extend their gratitude to Universiti Teknikal Malaysia Melaka (UTeM) for their financial support. This transdisciplinary research is part of a dissertation submitted as a partial fulfilment to meet the requirements for the Doctor of Philosophy degree at UTeM.

References

Alam, M. J., Ogawa, K., & Ahsan, A. H. M. (2024). Japanese investment for skills development program in attaining sustainable employability: The case of Bangladesh. World Development Sustainability, 4. https://doi.org/10.1016/j.wds.2024.100150

Ayanwale, M. A., Molefi, R. R., & Matsie, N. (2023). Modelling secondary school students' attitudes toward TVET subjects using social cognitive and planned behavior theories. Social Sciences and Humanities Open, 8(1). https://doi.org/10.1016/j.ssaho.2023.100478

Cardamone, G. F., Ardolino, F., & Arena, U. (2022). Can plastics from end-of-life vehicles be managed in a sustainable way? Sustainable Production and Consumption, 29, 115–127. https://doi.org/10.1016/j.spc.2021.09.025

Elkadry, H., Shamsuzzaman, M., Piya, S., Haridy, S., Bashir, H., & Khadem, M. (2024). A fuzzy Delphi-AHP framework for identifying and prioritizing factors affecting students' satisfaction in public high schools: Insights from the United Arab Emirates. Journal of Engineering Research (Kuwait). https://doi.org/10.1016/j.jer.2023.12.008

Florin Cojanu, P. V. (2017). New Perspectives To Develop Psychomotor Capacity For Romanian Childrens From Primary. Social & Behavioural Sciences Edu World 2016 7th International Conference.

Ismail, N., & Yusof, U. K. (2023). A systematic literature review: Recent techniques of predicting STEM stream students. Computers and Education: Artificial Intelligence, 5. https://doi.org/10.1016/j.caeai.2023.100141

Jeske, D., Sheehan, C., Linehan, M., & Sheehan, & Linehan. (2017). Employee engagement in discussion: Goals, perspectives and recommendations. Journal of Human Resource Management, 21–29.

Krause, D. R., & Ellram, L. M. (1997). Critical Elements of Supplier Development the Buying-Firm Perspective. European Journal of Purchasing & Supply Management, 3(1), 21–31. https://doi.org/10.1016/S0969-7012(96)00003-2

Liao, F. N., Zhang, C., Zhang, J. J., Yan, X., & Chen, T. X. (2024). Hyperbole or reality? The effect of auditors' AI education on audit report timeliness. International Review of Financial Analysis, 91. https://doi.org/10.1016/j.irfa.2023.103050

Lee, S. J., & Kwon, K. (2024). A systematic review of AI education in K-12 classrooms from 2018 to 2023: Topics, strategies, and learning outcomes. Computers and Education: Artificial Intelligence, 6. https://doi.org/10.1016/j.caeai.2024.100211

Liao, F. nan, Zhang, C., Zhang, J. jin, Yan, X., & Chen, T. xiang. (2024). Hyperbole or reality? The effect of auditors' AI education on audit report timeliness. International Review of Financial Analysis, 91. https://doi.org/10.1016/j.irfa.2023.103050

Magagula, M. M., & Awodiji, O. A. (2024). The implications of the fourth industrial revolution on technical and vocational education and training in South Africa. Social Sciences and Humanities Open, 10. https://doi.org/10.1016/j.ssaho.2024.100896

Makarova, I., Shubenkova, K., Package, C. E., Buyvol, P., Shepelev, V., & Gritsenko, A. (2021). The role of reverse logistics in the transition to a circular economy: Case study of automotive spare parts logistics. Waste Management, 173–185.

Nur, T., Raja, A., Zameri, M., Saman, M., Sharif, S., Simic, V., & Wahab, D. A. (2018). Development of a performance evaluation tool for end-of-life vehicle management system implementation using the analytic hierarchy process. https://doi.org/10.1177/0734242X18790361

Rao, J., Hagare, D., & Tao, Z. (2024). Upcycling of End-of-Life-Vehicle (ELV) plastics as a replacement for natural fine aggregate in concrete. Resources, Conservation & Recycling Advances, 21(March).

Saidin, Z. H. (2020). The Influence of After-Sales Service Quality, Relationship Quality and Alternative Attractiveness On Customer Loyalty of Malaysian National Carmakers.

Sanusi, I. T., Olaleye, S. A., Oyelere, S. S., & Dixon, R. A. (2022). Investigating learners' competencies for artificial intelligence education in an African K-12 setting. Computers and Education Open, 3, 100083. https://doi.org/10.1016/j.caeo.2022.100083

Stöhr, C., Ou, A. W., & Malmström, H. (2024). Perceptions and usage of AI chatbots among students in higher education across genders, academic levels and fields of study. Computers and Education: Artificial Intelligence, 7. https://doi.org/10.1016/j.caeai.2024.100259

Summers, A., Haddad, M. El, Prichard, R., Clarke, K. A., Lee, J., & Oprescu, F. (2024). Navigating challenges and opportunities: Nursing student's views on generative AI in higher education. Nurse Education in Practice, 79. https://doi.org/10.1016/j.nepr.2024.104062

Yao, N., & Wang, Q. (2024). Factors influencing pre-service special education teachers' intention toward AI in education: Digital literacy, teacher self-efficacy, perceived ease of use, and perceived usefulness. Heliyon, 10(14). https://doi.org/10.1016/j.heliyon.2024.e34894

Yuik, C. J., Zameri, M., Saman, M., Hasrul, N., Ngadiman, A., & Hamzah, H. S. (2023). Supply chain optimisation for recycling and remanufacturing sustainable management in end-of-life vehicles : A mini-review and classification. Waste Management & Research, 41(13), 554–565. https://doi.org/10.1177/0734242X221123486