

ROLE OF ENVIRONMENTAL SUSTAINABILITY IN SHAPING CONSUMER PERCEPTION OF POULTRY INDUSTRY

ABDUL RAHMAN, M. H.^{1*} – AHMAD, A. A.² – MD SAPRY, H. R.¹

¹ *Industrial Logistics Section, Universiti Kuala Lumpur MITEC, Johor, Malaysia.*

² *Johor Business School, Universiti Tun Hussein Onn, Johor, Malaysia.*

**Corresponding author
e-mail: mhilmiar[at]junikl.edu.my*

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Abstract. This research study examines the role of environmental sustainability in shaping consumer perception of the poultry industry in Pahang, Malaysia. As the industry expands, exploring how environmental sustainability determinants, including environmental impact, resource efficiency as well as climate change adaptation affect public attitudes becomes essential to support industry growth. Using a quantitative approach, the data were gathered from 411 respondents and analysed using SmartPLS to analyse the relationships between determinants and consumer perception. The research findings show that environmental impact as well as climate change adaptation is the primary determinants of consumer perception, whereas resource efficiency has a negligible direct effect. The structural model shows 85.5% of the variance in perception, meaning that consumers emphasise environmental responsibility and proactive adaptation measures. The research findings suggest that clear communication on adaptation strategies and environmental-related actions is essential to consumer acceptance of poultry producers while improving efficiency alone may not change consumer attitude.

Keywords: *environmental sustainability, consumer perception, poultry industry, environmental impact, climate change adaptation*

Introduction

The poultry industry in Malaysia is a vital industry that ensure the national food security and also contributing to the economic development. Over the years, the industry expanded steadily in terms of production, encouraged by policies emphasised on food security and the use of modernize systems. Official livestock figures have increased since 2021 for all states. Pahang as a state ranked number 9 in terms of number of livestock. In 2021 and 2022, the number is approximately 14 million livestock. However, there is a sudden increase of 2 million in 2023, and it is expected that there will be a total of 17 million livestock in 2024. The figures reflect a steady increase in the sector, showing a sign of the state's contribution in national poultry production. The growth is raising concerns regarding the environmental footprint of poultry industry in the country. The drive toward strengthening the sector input to increase the productivity has created trade-offs between efficiency and environmental impact. Recent studies using Life Cycle Assessment (LCA) revealed that the industry itself contributes significantly to greenhouse gas emissions specifically on the carbon, methane and nitrous emission by feed and manure (Tetteh et al., 2022; Costantini et al., 2021; Suffian et al., 2018). The findings establish the need to increase the urgency of implementing sustainable practices starting in states that have smaller numbers of livestock compared to other states.

To enhance the sustainability of poultry industry, it is important to divert industry stakeholders' intention toward the aspect of resource efficiency. Positioning this shift

clearly can be taken as actions toward sustainability that can help aligning poultry producers with sustainability practices and growing consumer expectation. Malaysian government has published policies through National Agrofood Policy 2021 – 2030 to support the movement toward the implementation of circular economy in agriculture (MAFI, 2021). These moves strive for the use of water, feed and energy efficiently while reducing waste production and sustaining livestock waste management systems. The policies are relevant and needed in Pahang state, where the poultry industry is still currently smaller compared to other states in Malaysia and expected to grow larger in the future where responsible usage of resources is required to sustain and expand the industry. Environmental sustainability can be explained as the idea to reduce environmental impact, improve resource efficiency and adapt to climate change, which are the central to explore and guide researchers.

Growing awareness in climate change has led many stakeholders in the poultry industry to change the way they operate their business. It offers additional risk to the production especially in tropical country like in Pahang, Malaysia. The environment conditions including rising surrounding temperatures, changing raining season and high humidity contribute to the productivity of broiler chicken (Oke et al., 2024; Suharni et al., 2021). To sustain the industry, implementing ways to increase resiliency in poultry farming can be done by adopting strategies such as improved ventilation, thermally efficient housing and adaptive feeding routines. The collaboration between governments, academic institutions and commercial sectors can establish the access of information to counter climate change effect. These three factors are studied together because they are positioning the mitigation of the operational efficiency and resilience. Environmental impact analyses how the industry contributes to the environmental impact and enabling the identification of largest source of contributor (Costantini et al., 2021). Resource efficiency emphasises on the input output ratios that influence both environmental impact and farmers economy, and therefore, understanding the level of practicality of implementation (Bist et al., 2024). Climate change adaptation focuses on the future of industry and its stability that can shape mitigation procedures so that the industry can remain prevalent under the pressure of climate change (Attia et al., 2024).

Problem statement

The poultry industry has been contributing enormously to the popularity of affordable protein source in Malaysia. Achieving long term viability requires the focal point of advancing the environmental sustainability goals together with the production. However, the industry faces challenges related to environmental sustainability, resource efficiency and climate change adaptation. These factors are actively influencing the perception of consumers in buying poultry-based products. Evidence from the neighbouring country have also strengthen this sentiment where poultry production contributes significantly to greenhouse gas emissions through farming activities, suggesting similar concerns are present in Malaysia (Azmi et al., 2023). In addition, resource efficiency has remained a critical issue of the industry. Although management practices and technologies in sustainability are available, the implementation isn't reliable (Suharni et al., 2021). At the same time, climate change poses direct effects toward the poultry production via reduced feed intake, slower growth and lower productivity (Oke et al., 2024). The impacts emphasize effective adaptation to increase resiliency of poultry farming systems.

The perception of public is increasingly due to the awareness of these sustainability challenges. The purchasing decisions by the consumers has been shaped by various factors including health consciousness, animal welfare and environmental concerns (Weng et al., 2022). In particular, waste management is crucial in terms of how it degrade the environment quality, and this can negatively impact the trust of the consumers (Himu and Raihan, 2023). Thus, it is essential to understand the public attitudes in order to sustain the industry in long periods of time. Studies in Malaysia have proven that the adaptation behaviours are strongly influenced by public risk perception (Chin et al., 2022). The poultry sector is encouraged to align its practices with consumer perception. This paper investigates how environmental impact, resource efficiency and climate change adaptation affect the public perception of the poultry industry in Pahang, Malaysia. As a state of the poultry producers, it examines how the residents perceive environmental aspect of the production and how strategies for improving resiliency and efficiency can influence the perception. By exploring these relationships, this paper provides insights on how the industry can improve its sustainability aspect while aligning itself with the public expectations. The findings contribute to knowledge that can benefit industry stakeholders and policymakers who seek to balance the economic viability with environmental element.

Literature review

Environmental impacts of any industry have attracted significant attention to its effects on public perception. Exploring the impacts further can support the establishment of approaches to sustain the practices specifically on the poultry industry. One major environmental concern associated is the emission of greenhouse gases (GHGs). A study focused on the life cycle assessment (LCA) to evaluate impacts on environment measured in CO₂ equivalent (Andretta et al., 2021). The primary contributor of the GHGs is the feed production and management. The approach to this study is useful as a basis to the development of innovation in feeding strategies which could be implemented in farms throughout Pahang state. One critical issue that can be linked to the poultry industry is water pollution. Poultry waste includes various organic material and contaminants such as antibiotics, hormones, heavy metals, and pesticide residues are released to the environment when the farmers use the method of cleaning the litter by spraying the water (Himu and Raihan, 2023). The water used for this activity is usually released to nearby rivers, streams and groundwater, which lead to the degradation of environment and contamination of water sources (Krupka et al., 2023). Another impact is encouraging the growth of common duckweed that is perceived negatively and positively at the same time. Currently, it is mostly perceived as a sign of water pollution since the usage of the weed as the poultry feed isn't widely implemented. Poultry farming produces large amount of waste especially litters. Although the new approach of handling litters is to use it as fertilizers on nearby farms, it is not widely adopted among small scale farmers. A recent study on farms with more than 10 years of poultry use, conclude that the top layer of soil is heavily covered by phosphorus (Chakraborty et al., 2021). This will encourage the growth of weed, but it will start leaking to the surroundings once the soil and weeds are unable to absorb it. Heavy metals such as arsenic, copper, zinc and lead contained in the litters pose negative impacts on animals and human (Tuchkova et al., 2021). Studies such as these encourage farmers to monitor the level of pollution and find solution to avoid the long-term impacts to the surrounding area.

Air quality is a major concern in poultry farming especially for the workers who spend long hours working in the farm. A recent study analysed how air quality in the farming area affects the health of poultry workers (Ogunleye et al., 2022). The study measured variety of air pollutants such as ammonia, fine dust, carbon dioxide and methane which were found to be higher than the safety limit set by the World Health Organization. It also concludes that a small portion of workers faced severe breathing difficulties, and it is proven that poor air quality can harm workers' respiratory health. The study by Hidayat et al. (2021) also supports the above-mentioned study and it emphasize the biggest contributor to the air pollution is manure. Nutrients that aren't fully absorbed by the livestock will end up in manure and break down into harmful gases. The authors suggest several ways to reduce air pollution, including better manure management, feeding management and encourage the use of feed and waste additives. In poultry farming, resource efficiency is highlighted to be the key to both economic performance and environmental protection. Elements including feed efficiency, water use, energy use and land use are contributing to the reduction of operational costs and also increase consumer trust. With the knowledge, farmers in Pahang will be able to produce less pollution which is essential in the surrounding areas. Feed for livestock is contributing to the highest element of the total production for poultry farmers. Improving the efficiency of feed consumption is the essential step toward sustainable farming. The key nutrient of the feed is nitrogen, and it will be released to the environment through the droppings. Too much nitrogen can harm the environment by damaging the water and soil quality and producing harmful gas. A study suggests that by reducing protein levels in feed by small percentage of 2% and with the support of additional amino acids, it can cut up to 29% of nitrogen waste. It also led to less water consumption and drier bedding in poultry housing (Alfonso-Avila et al., 2022). Zampiga et al. (2021) come out with the similar conclusion since it can reduce the protein levels without stunting the livestock growth. However, they also suggest more research to be conducted on the use of amino acids to determine the ideal balance of the acids.

Feed formulation of the poultry industry has seen significant growth from manual calculation to sophisticated computer-based system. Advanced software tools enable the aspect of least cost when coming up with feed formula which small scale farmers can gain a lot of advantages. However, nutritionist and feed producers still face challenges due to the fluctuation of global supply of ingredient materials. The use of advanced technologies has made it easier to adapt with these issues by enabling faster adjustments and establishment of new feed formulation (Alhotan, 2021). In addition to technology, alternative feed ingredients such as food byproducts, seed meals and plant ways have been explored by rural and small-scale farmers. This benefits them in terms of reducing the over reliance on the conventional feed sources. These ingredients provide nutrients needed that ensure the health of livestock and enhance its quality of meat and eggs (Vlaicu et al., 2024). Agriculture sector relies heavily on water for various activities. In poultry farming, having sufficient water is essential to ensure the sustainability of the operations and ensure the health of the livestock. Hence, the use of water efficiently has become crucial in the face of growing water need due to climate change, competitions from other sectors and the increase of food demand. Public and private investment in research and development (R&D) to improve water use efficiency in poultry industry is needed (Da Rosa et al., 2023). Data from multiple poultry producing countries highlights the gain in production performance and water efficiency due to the

investment in R&D. This approach is needed to counter water scarcity that negatively affect feed efficiency, growth rates, egg production and overall poultry welfare (El Sabry et al., 2023). Thus, exploring ways to manage water efficiently has becoming more important. On the other hand, the integration of technology in monitoring the water usage and the implementation of automation systems have potential benefits in terms of ensuring the livestock experience the optimal condition of growth (George and George, 2023). These systems can enhance the sustainability of poultry industry by minimizing waste, reducing energy and water consumption and lowering the production costs.

The aspect of resource efficiency within the poultry industry has encouraged more research as part of environmental sustainability theme. Li et al. (2022) studies the poultry housing system and concludes that it contributes to almost half of energy used in production, including heating, cooling and ventilation systems. Hence, they emphasized on the need for efficient design in the housing. Poultry are known to be highly affected by heat stress especially in the hot and humid state such as Pahang, Malaysia. Maintaining suitable temperature for the livestock is a crucial element for bird health and productivity. Research from another tropical region has provide an alternative cooling mechanism (Shahzad et al., 2021). Unlike air conditioning system that consume electricity heavily, an energy-efficient evaporative cooling system can reduce the temperature up to several degrees Celsius. Adopting mechanism that can reduce the energy consumption aligns with the target of adapting to the climate change, being responsible toward the environment and meeting the customer needs. Furthermore, land usage is another significant aspect of resource efficiency in the poultry industry because the amount of land use is proportional to the number of livestock produced and the impact to the environment. Previous studies have shown that farming that provide higher-welfare system that is for slower growing breed or on pasture require more land use (Chan et al., 2022). At the global level, similar research conclude that it isn't necessarily an efficient way to use land as the same area could produce more foods if used for crops. However, efficiency does improve when poultry farmers are using land that is less suitable for crops (Van Zanten et al., 2016). As for Pahang, finding the right balance is essential where land is shared between agriculture, urban development and conservation. With an efficient way to use land that enable small footprint over higher footprints, it can reduce the impact to the environment, increase the productivity and enable more opportunities for farmers to sustain the poultry industry.

The climate change awareness affecting the poultry industry has been given much attention to how it affects production efficiency, and livestock health. Adapting strategies toward climate change is essential in developing policies and interventions that requires understanding of the consumers. One of the most pressing challenges is heat stress. The survival of the poultry is affected by rising surrounding temperatures and humidity which can lead to the fall of productivity. Based on the study done by Kennedy et al. (2022), adapting to climate change mitigate the effect of reduced feed efficiency and egg production, weight loss, and meat quality. Thus, strategies including shading, water sprinkling and dietary adjustments are explored, and the benefits are reducing heat and increase the adaptivity of poultry to heat. Moreover, one of the genetic approaches researched is naked neck gene that offer the ability to increase heat dissipation and strengthen performance in hot and humid environments (Fernandes et al., 2023). Such genetic strategies and improved management practices may provide pathways to maintain high productivity while meeting consumer expectations for

sustainable poultry production. Broiler production is easily affected by heat stress, and it adds to the financial risks by fluctuating the input costs. The challenges came from the climate change increase pressures to the poultry industry and put the sustainability of the production into risks (Apalowo et al., 2024). Genetic solutions aren't the only way explored in the industry. Experts also explore dietary strategies including antioxidant use, balance amino acids, probiotics and vitamin supplements since it has been proven to increase poultry tolerance toward hot conditions. In addition, climate change is expected to strengthen the negative impacts by increasing water demand, reduce feed availability and increase risks toward diseases (Attia et al., 2024). Adaptation strategies and region-specific mitigation policies are vital as various parts within the industry affected by the climate change. Broader climate-resilient practices and supportive policies are critical to support the industry in Pahang, Malaysia.

Another aspect of climate change faced by the poultry farmers is water scarcity. Water doesn't only serve as nutrient but also a critical element of feed digestion, regulating body temperature and overall health. In the study by Hargitai et al. (2024), the potential of water reuse pathways was analysed in poultry processing. These strategies have shown that the on-site water treatment, selective reuse for non-potable functions can significantly lower the freshwater usage. However, it presents trade-off in energy use and social acceptance even though it is a form of adaptation against water scarcity. Ingrao et al. (2023) studies the causes and impacts of water scarcity and offer various mitigation strategies. These include water-use practices, recycling of wastewater, desalination by solar power systems, and the strengthening of irrigation efficiency. Although these strategies are implemented in crop producing industry, it holds values of resource efficiency and technological innovation beneficial to livestock industries. As Pahang, Malaysia faces periodic water stress, these insights may offer possible adaptation methods and therefore, improving the resilience of poultry industry. The way environmental sustainability practices implemented and communicated is greatly affect the consumer perception on the poultry industry. Globally, studies have shown that consumers have become increasingly correlate between environmental responsibility and animal welfare to product trust, quality and safety. A study by Alfonso-Avila et al. (2022) shows that consumers now are well aware of the higher animal standards with environmentally friendly product and the tendency to pay for premium products are closely related to clear labelling and traceable monitoring system on the supply chain. However, consumers that superficial sustainability claims can increase consumer scepticism since greenwashing undermine trust in the poultry industry. This issue is crucial to the scope of study where consumer awareness on sustainable food systems is increasing together with the demand for affordable protein source. Consumers perceive less positively on poultry compared to beef or dairy products since large scale farming raise concerns on environmental pollution and animal welfare.

Many consumers aren't satisfied with the sensory qualities, especially texture and after taste which limiting the wide acceptance of chicken bred by environmentally friendly plant-based feed. However, perception on the naturalness, value quality and health benefits positively influence decision to purchase organic chicken meat. This is also going along with the consumers with higher awareness on the environmental issue. These findings suggest that health and welfare assurances can positively shape consumer preferences. Consumers are willing to pay for slow growth chicken due to how information is disseminated and they are aware on the welfare of the animals. Pro

sustainability narratives can increase demand while critical narratives will reduce it. Collectively, the studies show that there is a positive awareness on the sustainability among the consumers but in regions similar to Pahang, Malaysia, their perceptions are influenced by the trade-off between environmental benefits, product quality and affordability. Addressing the issue of affordability is a critical factor that will affect the perception toward the sustainability of the poultry industry.

Materials and Methods

This paper implements a quantitative research design to examine the role of environmental impact, resource efficiency and climate change adaptation in shaping consumer perception of the poultry industry in Pahang, Malaysia. The approach is suitable because it enables the gathering of numerical data, which then, can be analysed statistically to determine the patterns, correlations and trends in consumer perception. The design of cross-sectional survey is used to enable data to be collected at a single point in time. It is appropriate for identifying the relationships between key variables. Plus, cross-sectional studies are time-efficient and cost-effective compared to other method such as longitudinal designs, which require the researcher to make observations over time. This research paper gathered data through a structured survey questionnaire. Surveys are commonly used in quantitative research since it efficiently enables the data gathering of standardized responses from a large number of participants. The questionnaire consists of three sections where the first section focuses on the demographic of the respondents, the second section is divided into four sub-sections, one for each variable used, and lastly is for the recommendation. The questionnaire includes closed-ended questions to support the objective analysis and strengthen reliability. A Likert scale from 1 (strongly disagree) to 5 (strongly disagree) is employed to find the relationship between consumer perception in the poultry industry with environmental impact, resource efficiency and climate change adaptation.

The question was fully distributed online to reach more population within Pahang Malaysia. Google Forms and various social media platforms, such as Facebook, Instagram, and X were used to gather information. The study employed a non-probability purposive sampling technique across three social media platforms such as Facebook, Instagram and X (Twitter). The technique used is considered as the most effective approach as it enables the researcher to target participants who are relevant to the objectives, specifically those who are within the geographical location. On Facebook, participants were accessed through groups that include the name of Pahang and locations within the state, which provide number of participants that can access the questionnaire. On Instagram and X (Twitter), relevant participants were identified through the use of hashtags and geotags. This is to indicate their interest in the location under study. Although this method doesn't give all members equal opportunity of being selected, it can be justified by the practicality, suitability and efficiency for the research, where depth of data and its relevance are more emphasized than statistical representation. The sample size is determined by using sample size determination table where a minimum sample of 384 respondents is required to achieve 95% confidence level and a 5% margin error. The total population in Pahang, Malaysia as for the year of 2024 is 1.7 million people. Respondents are informed of the study's purpose and their participation in the survey is voluntary and anonymous.

The collected data of the questionnaire is analysed by using descriptive statistical methods. Partial Least Squares Structural Equation Modeling (PLS-SEM) is used via SmartPLS to process and analyse the data. This analysis is appropriate to summarize large datasets and identifying patterns and trends. Four descriptive analysis techniques applied including mean, standard deviation, skewness and kurtosis. The measurement model is examined for indicator reliability, internal consistency and convergent validity. The structural model is evaluated using standardised path coefficients and their significance is obtained from a non-parametric bootstrap procedure. Model explanatory power is analysed with r-square and r-square adjusted, and the substantive importance of path is evaluated by the effect size. This study employs a quantitative research approach with a survey-based methodology to investigate consumer perception of the poultry industry in Pahang, Malaysia. A structured questionnaire is used to collect data from a sample of 411 residents, ensuring broad consumer representation. Descriptive analysis techniques provide valuable insights into consumer perceptions regarding environmental impact, resource efficiency, and climate change adaptation. The findings will help policymakers and poultry producers make informed decisions toward sustainable industry practices.

Results and Discussion

Table 1 shows the descriptive statistics for the research. The mean scores for all variables, Environmental Impact (EI), Resource Efficiency (RE), Climate Change Adaptation (CCA) and Consumer Perception (CP) ranges from 4.073 to 4.135, indicating favourable respondent evaluations of sustainability and its practices in the poultry industry. Standard deviation for EI (0.894), RE (0.877), CCA (0.868) and CP (0.850) indicates that responses are closely related to the respective means and the variability between respondents is limited. The skewness results were slightly negative for EI (-0.591), RE (-0.534), CCA (-0.502) and CP (-0.501) suggesting a slight tendency for higher and more favourable ratings. The excess kurtosis figure was negative where EI (-0.593), RE (-0.602), CCA (-0.520) and CP (-0.671), suggesting distributions are flatter than normal curve and extreme scores aren't common. This shows that the views of the poultry industry's environmental responsibility, efficient resource use and climate change adaptation are positive and not limited to a small group of highly supportive consumers. These perceptions seem to be commonly accepted among the consumer base in Pahang. This also suggests that sustainability-related efforts in the industry are perceived as normal and expected business practice. *Figure 1* presents the relationship between EI, RE, CCA and CP. In *Table 2*, item loadings for EI ranged from 0.917 to 0.925, RE items between 0.967 and 0.919, CCA items between 0.884 and 0.911 and CP items between 0.838 and 0.898. All loadings surpass the commonly accepted 0.70 threshold. Therefore, this model indicates strong indicator reliability and meaningful contribution to its latent construct. Practically, the results suggest there's valid reflections of EI, RE, CCA and CP in the Pahang poultry industry.

Table 1. Descriptive analysis.

Category	Mean	SD	Skewness	Kurtosis
Environmental Impact (EI)	4.135	0.894	-0.591	-0.593
Resource Efficiency (RE)	4.102	0.877	-0.534	-0.602
Climate Change Adaptation (CCA)	4.073	0.868	-0.502	-0.520

Consumer Perception (CP)	4.127	0.850	-0.501	-0.671
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Table 2. Model measurements.

Indicator	Loading	Cronbach Alpha	Composite reliability	Average Variance Extracted (AVE)
EI1	0.917	0.954	0.965	0.845
EI2	0.925			
EI3	0.923			
EI4	0.914			
EI5	0.917			
RE1	0.878	0.938	0.953	0.801
RE2	0.919			
RE3	0.902			
RE4	0.908			
RE5	0.867			
CCA1	0.884	0.941	0.955	0.810
CCA2	0.906			
CCA3	0.907			
CCA4	0.911			
CCA5	0.893			
CS1	0.881	0.925	0.944	0.770
CS2	0.875			
CS3	0.897			
CS4	0.898			
CS5	0.838			

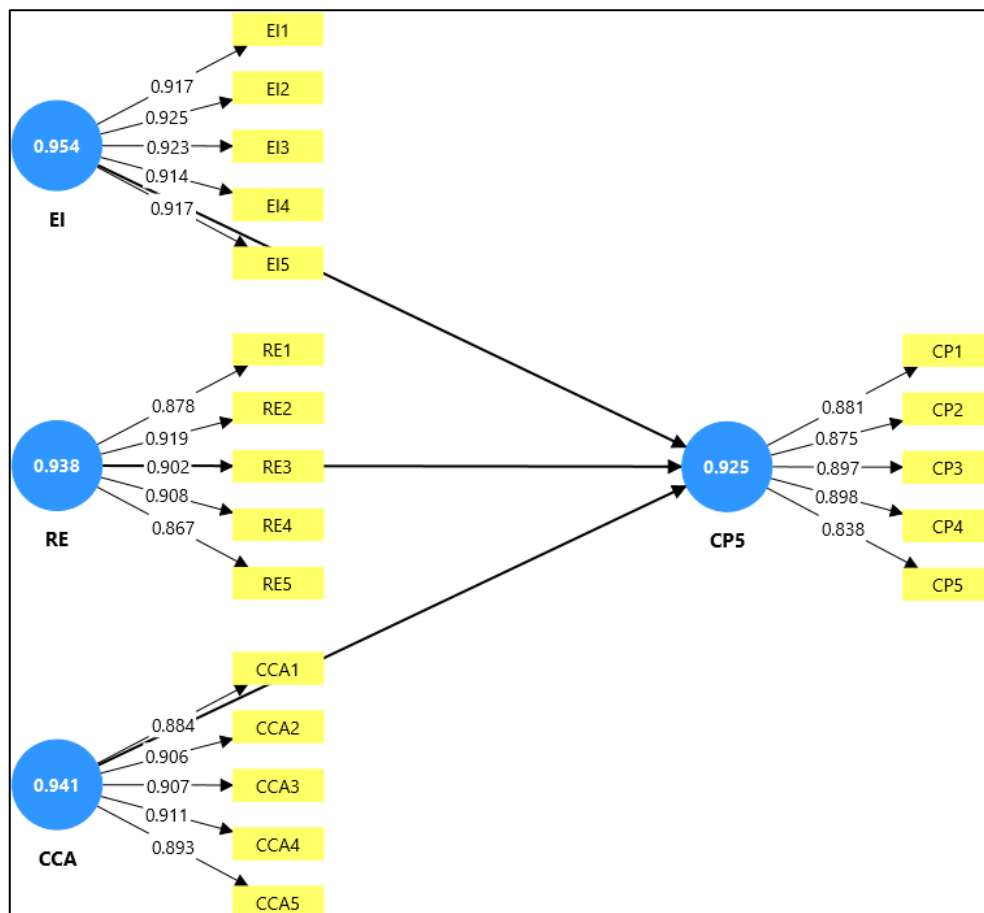


Figure 1. Model measurement illustration.

Cronbach alpha values were 0.954 for EI, 0.938 for RE, 0.941 for CCA and 0.925 for CP. From statistical standpoint, the values above 0.90 shows excellent internal consistency. Moreover, this suggests that the respondents answered in a coherent way,

supporting the use of constructs to determine the consumer attitudes toward sustainability practices. Composite reliability values were 0.965 for EI, 0.953 for RE, 0.955 for CCA, and 0.944 for CP. Statistically, the values are above 0.90 implies that the shared variance among the items is explained by the underlying construct rather than by a random error. In applied terms, the high reliability values implies that the latent construct are measured with precision, strengthening confidence in the relationship between environmental sustainability constructs and consumer perception. Average variance extracted (AVE) values were 0.845 for EI, 0.801 for RE, 0.810 for CCA, and 0.770 for CP. The values exceed the 0.50 benchmark, showing strong convergent validity where each construct explains a large proportion of variance in its indicators. High AVE scores imply that the measurement model reliably captures the dimensions of sustainability and consumer perception. This reduce measurement error and support inferences on how EI, RE, CCA are related to consumer attitudes. *Figure 2* illustrates the structural model of relationships between EI, RE, CCA and CP constructs. *Table 3* shows the path analysis result for the structural model. The path from EI to CP has a standardised coefficient of 0.430, a standard error of 0.077, a t-value of 5.590, a p value of 0.000 and f-square value of 0.247. The positive coefficient suggests a substantial and positive relationship. The t value exceeds conventional critical values showing a statistically significant effect. The f squared value implies to a medium to large effect size by common benchmarks. These figures confirms that improvement in practices related to EI will likely produce meaningful gains in consumer perception on the poultry industry.

Table 3. Path analysis.

Category	Standard coefficient	SD	T	p-values	f-value
EI > CP	0.430	0.077	5.590	0.000	0.247
RE > CP	0.123	0.088	1.393	0.164	0.013
CCA > CP	0.409	0.072	5.677	0.000	0.186
	CP				
R-square	0.855				
R-square adjusted	0.854				

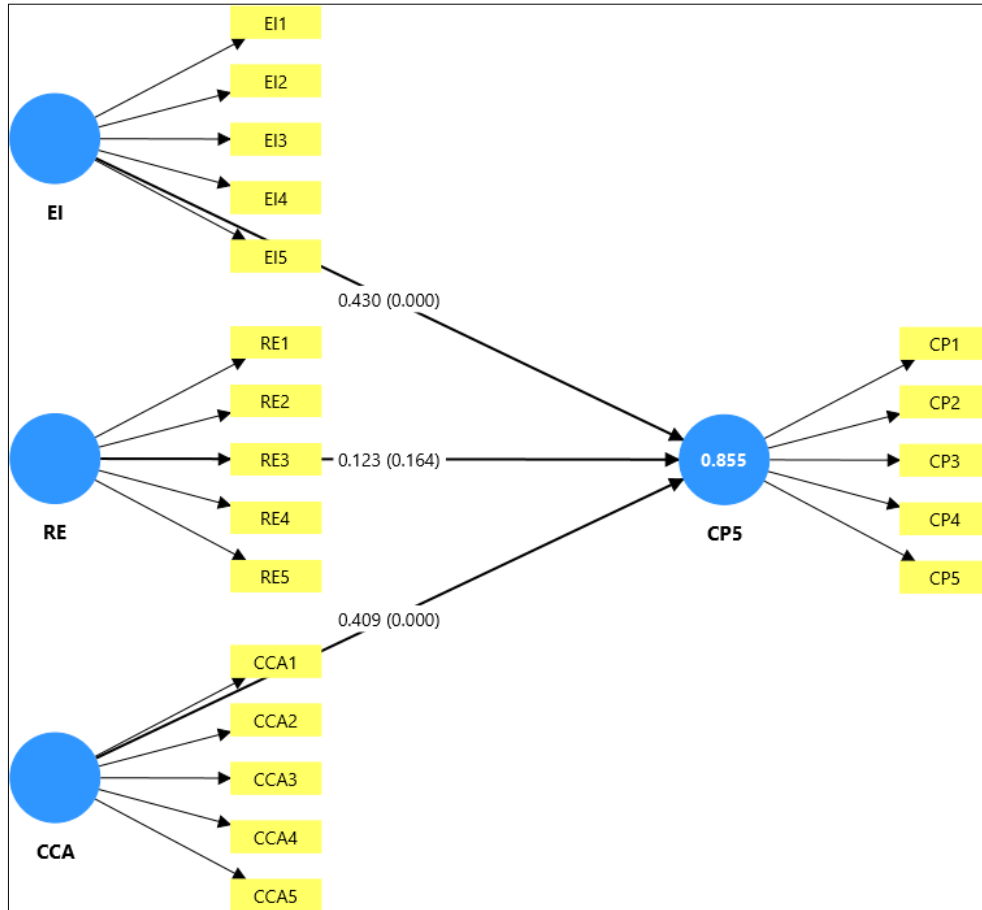


Figure 2. Structural model illustration.

The path from RE to CP shows a standardized coefficient of 0.123, a standard error of 0.088, a t value of 1.393, a p value of 0.164 and an f squared of 0.013. The coefficient is small, and the p value is insignificant, the t value doesn't reach the conventional threshold for significance at the 0.05 level, while the f-squared value indicates a negligible effect and only make small contribution to consumer perception. This confirms that improving based on the element of resource efficiency alone is unlikely affecting the consumer perception. It also suggests that efforts based on RE should be combined with other elements including EI or CCA initiatives to produce significant consumer impact. The path from Climate Change Adaptation to Consumer Perception has a standardized coefficient of 0.409, a standard error of 0.072, a t value of 5.677, a p value of 0.000 and an f squared of 0.186. Following the standard conventional values for respective coefficient and t value parameters, it shows a strong and significant positive effect. The f-squared value corresponds to medium effect size, implying significant positive influence on consumer perception. Moreover, consumers recognize the CCA measures can meaningfully strengthen the overall perception. The structural model states 85.5% variance in the CP, with R-squared of 0.855 and an R-squared adjusted of 0.854. The small difference between both values suggests that the model offers a reliable measure of power without inflation from predictor number. Furthermore, the high value of variance implies that EI and CCA together account for most of the factors affecting consumer perception of the poultry industry in Pahang, highlighting its role in influencing consumer attitudes toward sustainability practices.

The findings reveal that the strongest predictors of consumer perception in Pahang are environmental impact and climate change adaptation and it aligns with the recent empirical works about environmental practices within poultry industry (Arefin et al., 2024; Elsayed et al., 2024). The sentiment is also supported by the recent national initiatives for the poultry sector where policies and reforms are shifting toward sustainability and efficiency (Bernama, 2024). This also means that the poultry producers who invest and communicate the environmental and adaptation to consumers are likely to see tangible benefits among consumers in 2026. The study's results suggest that industry and policy steps now under discussion at the national level, which include improved climate governance, and this will further increase the awareness for firms to adapt with consumer expectations. The Thirteenth Malaysia Plan and related national agencies clearly prioritised climate resilience and environmental management, which will strengthen regulations for sustainable development in coming years. Therefore, the poultry businesses in Pahang and other states in Malaysia should emphasize on communicating adaptation measures, traceability display and aligning investments with government incentives.

Conclusion

This research explains that EI and CCA are significant determinants of consumer perception in Pahang's poultry industry. However, the RE determinant has only a minor and non-significant direct affect to the perception. The measurement model displays strong indicator loading, high internal consistency and convergent validity, and the structural model explain the significant proportion of variance in consumer perception. Collectively, these findings implies that consumers in Pahang respond based on visible and realistic actions on environmental and climate change interventions. Policymakers and poultry stakeholders should seek to improve public attitudes by emphasising direct environmental practices and clear dissemination of adaptation information. The study has several important limitations that inhibit the generalisation of the conclusion. Data were gathered from consumer survey in a single state, which constrain inference about causal direction beyond Pahang. The research did not obtain tangible result from farms, and therefore, there are no direct figures from producers for environmental-based operation routines such as energy and land use, waste management, water consumption or adaptation measures to examine whether the actual practices match with the consumer perception. The sole reliant on self-reported consumer feedback increase the risk of common method bias, and thus, the lack of behavioural outcomes explains that the study is unable to translate the positive perceptions into purchase intention. Future research should consider the combination of consumer survey data with farm level indicators and behavioural measures. Field experiments or longitudinal measures would allow stronger causal inference and comparative studies across other states in Malaysia would verify the external validity. The boundary conditions can be clarified by examining the demographics, trust in related institutions and exposure to information about sustainability practices. Lastly, mixed method studies would allow a more complete understanding of how sustainability practices affect industry outcomes and consumer behaviour.

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Conflict of interest

The authors declare no conflict of interest for this study.

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