

An Analysis of Environmental Dimensions Affected in Adoption of Hydrogen Fuel Cell Vehicles: A Study in Shah ALAM Industrial AREA, Selangor

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Abstract. The aim of the study is to identify the perceptions of respondents on environmental dimensions that affected in adoption of hydrogen fuel cell vehicles. The study was conducted at Shah Alam industrial areas of Selangor, Malaysia, with the number of respondents are 120 respondents with various job positions that related with engineering and automobiles industry. The findings of the research shows that the dimensions of HFCV Internal Environmental total score of the items statement is 3.40 with the percentage of agreement in implementation is 3.72 percent, HFCV Environmental Information Systems shows that the total score of the items statement is 3.63 with the percentage of agreement on use to great extent is 42.5 percent, HFCV Cooperation with Customers shows that the total score of the items statement is 3.81 with the percentage of agreement on implementation is 44.2 percent. The findings on HFCV Eco Design shows that the total score of items statement is 4.02 with the percentage of agreement on implementation is 42.3 percent, HFCV Environmental Organizational Culture shows that the total score of the items statement is 3.37 with the percentage of agreement is 34.2 percent, HFCV Environmental Leadership shows that the total score of the items statement is 3.34 with the percentage of agreement is 48.2 percent. HFCV Proactive Green Innovation shows that the total score of items statement is 4.10 ahead of automobile got the highest mean score of 4.32 with the percentage of agreement is 41 percent. HFCV Environmental performance shows that the total score of the items statement is 3.87 with the percentage of agreement is 39 percent and the last environmental dimensions was HFCV Environmental Risks shows that the total score of the item statement is 4.00 with the percentage of agreement is 40 percent

1 Introduction

A hydrogen fuel cell vehicle is a type of electric vehicle that uses a fuel cell instead of a battery to power the car. Hydrogen cars are basically electric cars. They have electric motors that drive the wheels just like an electric car but the difference lies in the battery. A hydrogen fuel cell creates a chemical reaction with the hydrogen that generates electricity, water and heat. Just like an electric car, there are no harmful exhaust emissions that can affect environment. But the continuous improvement on the management and behavioural dimensions of the HFCV manufacturers and users are needed to safe and secure the environment for the long term. The initiatives of HFCV management and behavioural dimensions that consists of HFCV internal environmental management, HFCV proactive in green management, HFCV environmental organizational culture, HFCV environmental leadership and HFCV environmental performance is in need to continuously care and cautions on the impact of environment in an adoption of HFCV.

2 Literature review

In the perspective of environmental impact, hydrogen fuel cells are a clean, reliable, quiet, and efficient sources of high-quality electric power. The hydrogen use as a fuel to drive an electrochemical process that produces electricity, with water and heat as the only by-products.

In the perspectives of environmental impact of hydrogen fuel cell vehicles, there is a few advantages of using hydrogen fuel cell as follows:

- 1) Converting hydrogen gas into electricity produces only water and heat as a product, meaning fuel cell vehicles did not create tailpipe pollution when they are driven
- 2) Hydrogen fuel cell vehicles combines the range and refuelling of conventional cars with the recreation and environmental benefits of driving on electricity.

3 Research methodology

3.1 The research objective

The research objective of the study is to identify the perceptions of the respondents on environment dimensions in adoption of hydrogen fuel cell vehicles in Malaysia.

3.2 The Respondents

The study was conducted at Shah Alam Industrial Area, Selangor. Shah Alam is the state capital of Selangor, Malaysia and situated within the Petaling District and a small portion of the neighbouring Klang District. It is located about 25 kilometres west of the country's capital, Kuala Lumpur. The respondents of the study was consists of employees at managerial and operation level in related industry as follows:

Industry Category	No of industry	Respondents
▪ Transportation equipment manufacturing	7	38
▪ Automobile Industries	2	43
▪ Car sales and service centre	15	22
▪ Metal product manufacturing	3	10
▪ Machinery manufacturing	4	7

3.3 The research instrument and measurement

The instrument and measurement of the questionnaire items was by use of “five-point scale from 1 to 5”. The rating constructs in this study were in following:

Measurement	Scales
1. <u>HFCV Internal Environmental Management</u> Adopted (Source: Zhu et al; Kenneth W. Green Jr and Pamela J. Zelbst, 2012, and revised the items to suit with the study requirement.	Five-point scale (1 –not considering it; 2 – planning to consider it; 3 – considering it currently; 4 – initiating implementation; 5 – implementing successfully)
2. <u>HFCV Proactive Green Innovation</u> Adopted (Source: O’Connor et al., 2006; Chen YS et al. (2012) and revised the items to suit the study requirement.	Five point Likert scale (1 – strongly disagree to 5 – Strongly agree)
3. <u>HFCV Environment Information Systems</u> Adopted (Source: Esty and Winston, 2006, Kenneth W. Green Jr and Pamela J. Zelbst 2012, and revised the items to suit with the study requirement.	Five-point scale (1 – not used at all; 5 – used to a great extent)
4. <u>HFCV Cooperation with customers</u> Adopted (Source: Zhu et al; Kenneth W. Green Jr and Pamela J. Zelbst, 2012, and revised the items to suit with the study requirement.	Five-point scale (1 –not considering it; 2 – planning to consider it; 3 – considering it currently; 4 – initiating implementation; 5 – implementing

	successfully)
5. <u>HFCV Eco Design</u> Adopted (Source: Zhu et al; Kenneth W. Green Jr and Pamela J. Zelbst, 2012, and revised the items to suit with the study requirement.	Five-point scale (1 –not considering it; 2 – planning to consider it; 3 – considering it currently; 4 – initiating implementation; 5 – implementing successfully)
6. <u>HFCV Environmental Organizational Culture</u> Adopted (Source: Chen, 2011, Chen et al. 2012)	Five point Likert scale (1 – strongly disagree to 5 – Strongly agree)
7. <u>HFCV Environmental Leadership</u> Adopted (Source: Chen, 2011, Chen et al. 2012)	Five point Likert scale (1 – strongly disagree to 5 – Strongly agree)
8. <u>HFCV Environmental Performance</u> Adopted (Source: Zhu et al; Kenneth W. Green Jr and Pamela J. Zelbst, 2012, and revised the items to suit with the study requirement.	Five point scale (1 – not at all; 2 – a little bit; 3 – to some degree; 4 – relatively significant; 5 – significant
9. <u>HFCV Environmental Risks</u> Adopted (Source: Sonya Graci and Jaqueline Kuehnel; downloading @ http://green.hotelscombined.com)	Five point Likert scale (1 – strongly disagree to 5 – Strongly agree)

3.4 Data analysis

Data analysis used in this study was descriptive statistics with mean score and the percentage of the agreement for the assessment of respondent perception on items measurement.

4 Research findings

The result of the findings were presented accordingly based on the following:

Section A: Respondent Demographic Profile

Job Title	Number
▪ Plant Manager	5
▪ Operation Manager	6
▪ Purchasing Manager	12
▪ Logistics Manager	8
▪ Sales Manager	15
▪ Engineering Manager	18
▪ Industrial Waste Manager	4
▪ Supply Chain Manager	6
▪ Information Systems Manager	7
▪ Executives and Administrative Officer	18
▪ Technician	21
TOTAL	120
Industry Category	Number
▪ Transportation equipment manufacturing	7
▪ Automobile Industries	2
▪ Car sales and service centre	15
▪ Metal product manufacturing	3
▪ Machinery manufacturing	4

The number of respondents involved in the study was 120 respondents. Demographic profile for respondents in Shah Alam Industrial Area, Selangor was summarized in majority of respondents as per shown in Table 1.

Table 1. Summary of demographic profile of respondents

No	Demographic Variable	Majority	Percentage (%)
1	Gender	Male	68
2	Citizen	Citizen	100.0
3	Age	31- 45 Years	65
4	Race	Malay	75
5	Religion	Muslim	80
6	Education Level	Diploma/Degree	58
7	Job Category	Administration	31.8
8	Monthly Income	RM 1,001 – RM 5,000	81.2

Section B: The Findings of Variables

1) HFCV Internal Environmental Management

The findings on HFCV Internal Environmental Management is shown in Table 2.

Table 2. The mean score of hfcv internal environmental management

HFCV Environmental Management	Internal Environment	Mean Score	% of Agreement on Implementation
▪ Commitment and support of HFCV environmental practices from top management towards		3.58	45%
▪ HFCV Environment Total Quality Management		3.45	38%
▪ HFCV Environmental compliance and auditing program		3.33	35%
▪ HFCV Environmental Program Systems		3.25	30%
▪ Total Score		3.40	37.2%

The findings on HFCV Internal Environmental Management shows that the total score of the items statement is 3.40 with the percentage of agreement in implementation is 37.2 percent.

2) HFCV Environment Information Systems

The finding on HFCV Internal Environmental Management is shown in Table 3.

Table 3. The mean score of HFCV environmental information systems

HFCV Environment Information Systems	Mean Score	% of Agreement on use to great extend
▪ HFCV can reduce transportation costs	4.01	52%
▪ Tracking HFCV environmental information (such as toxicity, energy used, water used and air pollution)	3.85	50%
▪ Monitoring emissions and waste production	3.77	48%
▪ Providing information to	3.69	45%

encourage choices of car vehicles by consumers		
▪ Improving decision making by executives by highlighting sustainability issues	3.55	40%
▪ Reducing energy consumption	3.45	38%
▪ Supporting the generation and distribution of renewable energy	3.40	35%
▪ Limiting carbon and other emissions	3.35	32%
▪ Total Score	3.63	42.5%

The findings on HFCV Environmental Information Systems shows that the total score of the items statement is 3.63 with the percentage of agreement on use to great extend is 42.5 percent.

3) HFCV Cooperation with Customers

The findings on HFCV Internal Environmental Management is shown in Table 4.

Table 4. The mean score of HFCV cooperation with customers

HFCV Cooperation with Customers	Mean Score	% of Agreement on Implementation
▪ Cooperation with customers for eco design of HFCV	4.11	54%
▪ Cooperation with customers for cleaner HFCV production	3.95	45%
▪ Cooperation with customers for HFCV green manufacturing	3.65	40%
▪ Cooperation with customers for using less energy during HFCV product transportation	3.55	38%
▪ Total Score	3.81	44.2%

The findings on HFCV Cooperation with Customers shows that the total score of the items statement is 3.81 with the percentage of agreement on implementation is 44.2 percent.

4) HFCV Eco Design

The findings on HFCV Eco Design is shown in Table 5.

Table 5. The MEAN Score of HFCV eco design

HFCV Eco Design	Mean Score	% of Agreement on Implementation
▪ Design of HFCV for reduced consumption of material/energy	4.21	48%
▪ Design of HFCV for reuse, recycle, recovery of material and/or component parts	4.01	41%
▪ Design of HFCV to avoid or reduce use of hazardous and /or their manufacturing process	3.85	38%
▪ Total Score	4.02	42.3%

The findings on HFCV Eco Design shows that the total score of items statement is 4.02 with the percentage of agreement on implementation is 42.3 percent.

5) HFCV Environmental Organizational Culture

The findings on HFCV Environmental Organizational Culture is shown in Table 6.

Table 6. The mean score of HFCV environmental organizational culture

HFCV Environmental Organizational Culture	Mean Score	% of Agreement
▪ The company concerns the knowledge of environmental management and protection of HFCV	3.55	45%
▪ The company concerns the collaboration of environmental management and protection of HFCV	3.40	34%
▪ The company concerns of environmental agreements of HFCV	3.30	30%
▪ The company concerns of the responsiveness of environmental management and protection of HFCV	3.25	28%
▪ Total Score	3.37	34.2%

The findings on HFCV Environmental Organizational Culture shows that the total score of the items statement is 3.37 with the percentage of agreement is 34.2 percent.

6) HFCV Environmental Leadership

The findings on HFCV Environmental Leadership is shown in Table 7.

Table 7. The mean score of HFCV environmental leadership

HFCV Environmental Leadership	Mean Score	% of Agreement
▪ The leaders within the company inspire a shared vision of the organization as environmentally sustainable, creating or maintaining green values throughout the company	3.55	58%
▪ The leaders within the company utilize well-developed approaches to environmental management which generally centre around a program customized to the company's specific business and market	3.40	50%
▪ The leaders within the company create partnerships with the company's stakeholders to solve environmental problems and to accomplish environmental goals	3.33	45%
▪ The leaders within the company can take on the responsibility of environmental education with the intent of engaging	3.10	40%

employees in environmental management initiatives

▪ **Total Score** **3.34** **48.2%**

The findings on HFCV Environmental Leadership shows that total score of the items statement is 3.34 with the percentage of agreement is 48.2 percent.

7) HFCV Proactive Green Innovation

The findings on HFCV Proactive Green Innovation is shown in Table 8.

Table 8. The mean score of HFCV proactive green innovation

HFCV Proactive Green Innovation	Mean Score	% of Agreement
▪ The company often undertakes active environment-related innovation in order to take initiatives new practices or products ahead of automobiles industry	4.32	45%
▪ The company actively commit to continuously invest resources in green innovations to successfully seize opportunities and to lead in the market	4.05	40%
▪ The company actively improve manufacturing processes to reuse, recycle, and reduce materials to decrease cost	3.95	38%
▪ Total Score	4.10	41%

The findings on HFCV Proactive Green Innovation shows that the total score of items statement is 4.10 ahead of automobile got the highest mean score of 4.32 with the percentage of agreement is 41 percent.

8) HFCV Environmental Performance

The findings on HFCV Environmental Performance is shown in Table 9.

Table 9. The mean score of HFCV environmental performance

HFCV Environmental Performance	Mean Score	% of Agreement on Significant
▪ Reduction of air emission	4.11	48%
▪ Reduction of effluent waste	4.05	45%
▪ Reduction of solid waste	3.85	38%
▪ Decrease in consumption for hazardous/harmful/toxic materials		
▪ Decrease in frequency for environmental accidents	3.70	35%
▪ Improvement in and environmental situation	3.65	28%
▪ Total Score	3.87	39%

The findings on HFCV Environmental Performance shows that the total score of the items statement is 3.87 with the percentage of agreement is 39 percent.

9) HFCV Environmental Risks

The findings on HFCV Environmental Risks is shown in Table 10.

Table 10. The mean score of HFCV environmental risks

HFCV Environmental Risks	Mean score	% of Agreement
▪ Water and land contamination	4.21	45%
▪ Air and noise pollution	4.00	42%
▪ Waste management	3.98	38%
▪ Supply chain environmental practices	3.84	35%
▪ Total Score	4.00	40%

The findings on HFCV Environmental Risks shows that the total score of the items statement is 4.00 with the percentage of agreement is 40 percent.

5 Recommendation and conclusions

5.1. Recommendation

Based on the study findings, the following recommendations to strengthen the environmental impact positively towards the adoption of HFCV are as follows:

- 1. HFCV Internal Environmental Management**
 - The top management should give full commitment on internal environmental management that can encourage proactive action and productive output on internal assessment and management of HFCV.
- 2. HFCV Environment Information Systems**
 - Provide information effectively and efficiently in HFCV
- 3. HFCV Cooperation with Customers**
 - The HFCV management should cooperate with customers in eco design, cleaner production, green product design and using less energy.
- 4. HFCV Eco Design**
 - The initiatives of designing the products that can reduced consumption of material and energy for reuse, recovery of material and recycle the component or material in HFCV
- 5. HFCV Environmental Organizational Culture**
 - The company that involve with HFCV must be concern on knowledge of environmental management, environmental agreements, responsiveness and the vision of environmental issues of HFCV.
- 6. HFCV Environmental Leadership**
 - The leaders in the organization that involves in HFCV adoption should be motivated to inspire a shared vision on environmental issues.
- 7. HFCV Proactive Green Innovation**
 - The management should be active in environment-related

innovation in order to take initiatives for HFCV to be ahead than other vehicles.

8. HFCV Environmental Performance

- The initiatives to reduce of air emissions, effluent waste, solid waste and the decrease in consumption for hazardous and harmful materials should be efficient.

9. HFCV Environmental Risks

- Risk minimization is now viewed as increasingly intertwined with good corporate social responsibility and governance.

6 Conclusion

Based on the findings, it indicates that the environmental dimensions in adoption of HFCV could generate many constraint and benefits of the HFCV success in future. This study verifies the issues of environment that need to be in precaution on action of HFCV implementation.

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