**WHAT DRIVES A FIRM’S SUSTAINABILITY MANAGEMENT?: DEVELOPING A HOLISTIC MODEL**

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# Introduction

Sustainable management is created based on the current environmental issues which are considered to affect the industry. Companies pursue sustainability management for various reasons, including morality and intergenerational equity, survival and organisation benefits, and risks management. A number of companies have demonstrated the transformations on technologies, products and business model. This transformations happened because companies are aware of their responsibilities towards the triple bottom lines of business.

The concept of sustainability has been acknowledged for many years, but not every individual has a full understanding of it (Whitten, 2013). The sustainability knowledge is crucial to support industries in implementing and managing both forward and reverse flows of materials. Without basic sustainability understanding, company strategies would not work effectively. Developing a fundamental and comprehensive understanding of sustainable management would help managers consider and improve business operations in sustainable ways especially if they are working with a competitive sector like automobile industry. The automobile industry involves a series of complicated supply chains due to its involvement in thousands of components and parts when producing vehicles. Advance technology and innovation enables components and parts to be reused, recycle or remanufacture. These activities are known as reverse logistics (RL).

RL is one of the initiatives to attain sustainability in supply chain management. RL makes a significant contribution to the sustainable initiatives of organisations (Sarkis et al., 2011) because it leads to greener products and products available for recycling or remanufacturing. RL is quite complex in terms of amount of input, quality, types of return and others. Even though RL is complex, it can be a cost centre as well as a sustainability driver to the company if it is appropriately managed.

This study investigates the relationships of the influential sustainability drivers. It focuses on the understanding of practitioners and academics on the fundamentals of implementing sustainability actions. In particular, it highlights how the influential sustainability drivers are interrelated to assist the development of sustainable reverse logistics in the UK automobile sector. The research questions to be addressed in this study are “what are the drivers in sustainability management?’ and ‘how are these drivers interacting with each other?’. The answer to these questions will cover the grey area between existing and future solutions for reverse supply chains (Bouzon et al., 2015).

The remaining of this paper is organised as follows. Section 2 reviews the literature on the influential sustainability drivers and Section 3 describes the methodology used in this study. The analysis result is presented in Section 4, followed by discussions and conclusion in Section 5.

# Overview of sustainability drivers

The modern industrialisation applies sustainable development as strategic plans to address environmental issues. The strategic plans in tackling the environmental issues are essential because they drive the beneficial agenda towards social and economic aspects. As an action to support sustainable development in their supply chains, companies often apply reverse logistics (RL) practices.

Influential drivers are the variables or conditions which comprehensively contribute to the success of the implementation of a strategy or management approaches. This study discusses the critical influential drivers of the sustainability implementation. The categorisation of the drivers is based on the triple bottom line; economic, environmental and social aspects. The selection of the drivers is also based on the notion of reverse logistics, but they might be slightly related with forward logistics.

It is because forward logistics notions and techniques play a big role in RL concepts. More specifically, this research reviewed the literature from automobile industry’s perspectives. After a thorough literature review, 11 sustainability drivers were emerged as below.

**Saving Energy Cost:** Energy saving is an efficient way of dealing with the rise of energy prices. Automobile companies must design an efficient cost management strategy to minimise their utility expenses. Volvo implemented a reverse logistics process of salvaging and dismantling cars and generated revenues by selling the used metal, plastics and car parts (Stock et al., 2002). Companies reduce consumption of energy through reverse logistics activities (Marchi and Zanoni, 2017). The function of reverse logistics information system also helps to improve processing efficiency of products return, thus saving the energy and costs on inventory and transportation.

**Energy Efficiency Target**: An energy efficiency target plan and monitoring the energy performance would help to ensure the constant improvement of energy efficiency (Ngai et al., 2013). This plan brings benefits because it guides company to manage the right collection routes and modes in reverse logistics. Different transportation modes have variations in the total energy consumption.

**Material Recyclability Target**: Automobile companies committed to increasing the recycle rate for their products (Blanco, 2014). In the UK, 85% of car materials are recyclable. The strategies to reach the maximum recovered rate could be seen in many business plans. For instance, Renault used more than 30% recycled materials in their new vehicles meanwhile Jaguar designed their products to be 95% recoverable and 85% recyclable.

**Product Innovation and Development:** R&D is essential for companies to strive for upcoming products at the same time meeting the business pressures. Experiments regarding suitable new service technologies have been found such as replacing the small modules with 3D Print. Also, some mechatronic components that are ideal for remanufacturing have been found, such as window lifter, turbo charger and air flow meter.

**Enhancement of Sustainability Technology:** Companies can enhance sustainability technology as a strategic method to support their contribution to achieving the sustainability agenda (Bhanot et al., 2015). General Motors (GM) simplified its process for returning automotive parts by allowing parts to be returned to a single facility using GM’s pre-printed shipping labels (Stock et al., 2002).

Meanwhile, Bosch builds sensors into its power tools that indicate if the motor is worth reconditioning. The sensors reduce inspection and disposition costs hence allowing the company to realise profits on the remanufactured power tools (Guide Jr and Wassenhove, 2002).

**Alternative Energy:** Due to the rising price of fossil fuels, companies start turning onto alternative energy sources. In Stockham, electric trucks have already been used for a year to collect recycled goods. Substituting diesel with biofuel makes it possible to reduce energy usage and climate change. (Hassan and Kalam, 2013). In the same context, General Motors (GM) and subsidiary GM Ventures installed the solar panel charging canopies at GM facilities and Chevrolet auto dealerships as an action for reduction of electrical energy consumption.

**Worker’s Health and Safety:** Companies are responsible to ensure their workers to be safe and not to be exposed to hazardous materials or chemicals while sorting the returned products. ELV Directive stated that recovery of batteries requires pre-treatment since it contains hazardous materials which will pollute the environment and cause health and safety problems. Hazardous materials like lead in lead-acid batteries and cadmium in electric vehicle batteries should require special handling and extensive care.

**Stakeholder Pressure:** The automobile industry is now working on a strategic management, which is based on the sustainable contexts to attract public attentions and to encourage people to put trust on their products. In addition, there are relations between public concerns, companies’ R&D and sustainability. The rising stakeholder concerns on sustainability have encouraged companies to enhance their interactions and needs that affect business orientations (Pfeffer, 2005).

**Waste Management:** Manufacturer produces the highest proportion of waste. Zero Waste concept is applied within the automobile industry. There have been many success stories related to the implementation of Zero Waste. For instance, Toyota Motors North America Inc. declared that it reached near zero waste to landfill.

**Emission Target:** The entry point of development of green industries and sustainable development is CO2 and another pollutant emission (Wang and Zou, 2015). Air pollution is harmful to people and the environment. EPA put forth an international standard such as ISO14001 to guide companies reduce the greenhouse gas. If companies apply a low-carbon principle, it will help them reduce the emission in a better way. Delivery activities within RL require a proper truck routing to minimise the emission. It is because the increase of transportation kilometres will rise the carbon emission propotionately by up to 65%.

**Compliances with Directives and Policies:** There are various laws to protect the growing volume estimated car to be scrapped. For instance in China, between 3 to 6 million cars are expected to be scrapped but only 380 thousand units were dismantled for recycling (Yan and Yan, 2009). In the EU, between 7 to 8 million tons of waste generated from End-of-life vehicles (ELV). ELV Directive has been created as an action to tackle this situation. Also many regulations underline sustainability, such as EU Directive (2008/98/EC) and Industrial Emission Directive (2010/75/EU). These types of notable regulations are applied by governments to motivate the public and people in the industry to increase their attentions to the environment.

# Methodology

Interpretive Structural Modelling (ISM) is a method which enables individuals or groups to develop graphical demonstration related to a particular problem. Many researchers have applied ISM to sustainability topics. For instance, Thirupathi and Vinodh (2016) used ISM in analysing the sustainable manufacturing factors in Indian automotive component sector. The general process of ISM is described in Figure 1. Details of each step will be discussed in the following section with the results. To fully reflect automobile industry’s contexts, practitioners were invited to Step 1 and Step 2 for deciding sustainability drivers and their contextual relationships.



Step 3: Develop a structural self- interaction matrix (SSIM)

Step 6: Draw ISM graph

Step 5: Level Partitioning

Step 4: Develop a reachability matrix

Step 2: Establish Contextual Relationship between elements

Step 1: Identify and list the elements

Figure 1: ISM Steps

# Results

The results present ISM steps to develop a graphical structural map of the sustainability drivers and highlighting the causal connection between the drivers. It also gives a holistic view of how sustainability drivers influence the implementation of sustainability agenda in the automobile industry.

***Step 1: Identifying and listing the elements***: A set of sustainability drivers was defined from literature and has been validated by 55 UK automobile practitioners through a questionnaire survey. The validation results are shown in Table 1. It can be seen that Stakeholder Pressure has been rejected. Therefore, it was removed from the list. Meanwhile, there is new driver has been found. Internal Culture was suggested by practitioners as a driver that caused the sustainable management. To avoid rearrangement of the entire list, Internal Culture is replacing Stakeholder Pressure and marked as driver number eight.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | ***Drivers Title*** | ***Acceptance*** | ***Rejection*** | ***Amended*** | ***Validity*** |
| *1* | Saving Energy Rate | 42 | 13 | 2 | ✔ |
| *2* | Energy Efficiency Target | 40 | 15 | 1 | ✔ |
| *3* | Material Recyclability Target | 40 | 15 | 0 | ✔ |
| *4* | Product Innovation and Development | 35 | 20 | 0 | ✔ |
| *5* | Enhancement of Sustainability Technology | 38 | 17 | 0 | ✔ |
| *6* | Alternative Energy | 33 | 22 | 0 | ✔ |
| *7* | Worker’s Health and Safety | 37 | 18 | 1 | ✔ |
| *8* | Stakeholder Pressure | 26 | 29 | 0 | ✘ |
| *9* | Waste Management | 38 | 17 | 0 | ✔ |
| *10* | Emission Target | 40 | 15 | 0 | ✔ |
| *11* | Compliance with Directives and Policies | 44 | 11 | 0 | ✔ |
| \* | Additional driver: Internal Culture |  |  |  | ✔ |

Table 1: Sustainability Driver List

***Step 2: Establishing Contextual Relationships between Elements***: In this step, the contextual type of “leads to” was selected to constraint the relationship to direct effects. The 11 drivers generated 55 questions on pair-wise interrelationships between two elements. In this study, 5 academics were asked to make decisions on the contextual relationships between the sustainability drivers.

***Step 3: Developing a Structural Self-Interaction Matrix (SSIM)*:** The contextual relationships were summarised into a SSIM by assigning one of the four symbols to (*i,j*) entry. The academics were requested to classify the relationships between two sustainability drivers as V (elements i leads to elements j), A (elements j leads to elements i), , X (elements i and j cause each other) or O (elements i and j are not related at all). Table 2 shows the final result of SSIM.

***Step 4: Developing a Reachability Matrix (RM):*** RM is developed from SSIM by filling each (i,j) entry with 1, 0 or 1\*. The initial reachability matrix (Table 3) was created by following rules; If the (i,j) entry in the SSIM is V, then the (i,j) in the RM becomes 1 and the (j,i) entry becomes 0. If the (i,j) entry in the SSIM is A, then the (i,j) in the RM becomes 0 and the (j,i) entry becomes 1. If the (i,j) entry in the SSIM is X, then the (i,j) in the RM becomes 1 and the (j,i) entry becomes 1. If the (i,j) entry in the SSIM is O, then the (i,j) in the RM becomes 0 and the (j,i) entry becomes 0. In the final reachability matrix, transitivity (1\*) can be checked by considering any indirect relationships among elements (Table 4).

***Step 5: Level Partitioning****:* Based on the given final reachability matrix, reachability set, antecedent set and intersection set can be generated as can be seen in Table 5. Reachability set consists of the element itself and other elements which will be driven by the element. The antecedent set consists of the element itself and other elements which affected the element. Intersection set is derived by comparing previous two sets. There are 8 level were found in this study.

***Step 6: Drawing an ISM-based Model****.* A graph was generated by arranging 11 elements according to the partitioned levels and reconnecting those elements to final reachability matrix. There are no transitivity (1\*) were taken into account. The ISM analysis demonstrated the most sustainability drivers were interacted with each other except for awareness of emission rate. The compliances with directives and policies occupied at the bottom of the model since it influenced most of the drivers.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *j* | | | | | | | | | | | | |
| *i* | No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1 |  | A | V | V | V | V | O | O | V | V | O |
| 2 |  |  | V | V | V | V | O | O | O | V | A |
| 3 |  |  |  | A | A | O | O | A | A | V | A |
| 4 |  |  |  |  | V | V | O | A | V | V | A |
| 5 |  |  |  |  |  | X | O | X | X | V | A |
| 6 |  |  |  |  |  |  | O | O | O | V | A |
| 7 |  |  |  |  |  |  |  | X | O | O | A |
| 8 |  |  |  |  |  |  |  |  | X | O | A |
| 9 |  |  |  |  |  |  |  |  |  | V | A |
| 10 |  |  |  |  |  |  |  |  |  |  | A |
| 11 |  |  |  |  |  |  |  |  |  |  |  |

Table 2: Structural Self-Interaction Matrix (SSIM)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | 11 |
| 1 |  |  | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | 1 | | 1 | 0 |
| 2 | 1 | |  |  | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | 0 | | 1 | 0 |
| 3 | 0 | | 0 | |  |  | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 1 | 0 |
| 4 | 0 | | 0 | | 1 | |  |  | 1 | | 1 | | 0 | | 0 | | 1 | | 1 | 0 |
| 5 | 0 | | 0 | | 1 | | 0 | |  |  | 1 | | 0 | | 1 | | 1 | | 1 | 0 |
| 6 | 0 | | 0 | | 0 | | 0 | | 1 | |  |  | 0 | | 0 | | 0 | | 1 | 0 |
| 7 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |  |  | 1 | | 0 | | 0 | 0 |
| 8 | 0 | | 0 | | 1 | | 1 | | 1 | | 0 | | 1 | |  |  | 1 | | 0 | 0 |
| 9 | 0 | | 0 | | 1 | | 0 | | 1 | | 0 | | 0 | | 1 | |  |  | 1 | 0 |
| 10 | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | |  | 0 |
| 11 | 0 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Driving  Power |
| 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1\* | 1 | 1 | 0 | 8 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1\* | 1\* | 1 | 0 | 9 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| 4 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1\* | 1 | 1 | 0 | 7 |
| 5 | 0 | 0 | 1 | 1\* | 1 | 1 | 1\* | 1 | 1 | 1 | 0 | 8 |
| 6 | 0 | 0 | 1\* | 0 | 1 | 1 | 0 | 1\* | 1\* | 1 | 0 | 6 |
| 7 | 0 | 0 | 1\* | 1\* | 1\* | 0 | 1 | 1 | 1\* | 0 | 0 | 6 |
| 8 | 0 | 0 | 1 | 1 | 1 | 1\* | 1 | 1 | 1 | 1\* | 0 | 8 |
| 9 | 0 | 0 | 1 | 1\* | 1 | 1\* | 1\* | 1 | 1 | 1 | 0 | 8 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 11 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| Degree of  dependence | 2 | 1 | 10 | 8 | 9 | 8 | 5 | 9 | 9 | 10 | 1 |  |

Table 3: Initial Reachability Matrix Table 4: Final Reachability Matrix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Reachability Set | Antecedent Set | Intersection Set | Level |
| 1 | 1,3,4,5,6,8,9,10 | 1,23 | 1 | 7 |
| 2 | 1,2,3,4,5,6,8,9,10 | 1,11 | 1 | 7 |
| 3 | 3,10 | 1,2,3,4,5,6,7,8,9,11 | 3 | 2 |
| 4 | 3,4,5,6,8,9,10 | 1,2,4,5,7,8,9,11 | 4,5,8,9 | 5 |
| 5 | 3,4,5,6,7,8,9,10 | 1,2,4,5,6,7,8,9,11 | 4,5,6,7,8,9 | 3 |
| 6 | 3,5,6,8,9,10 | 1,2,4,5,6,8,9,11 | 5,6,8,9 | 4 |
| 7 | 3,4,5,7,8,9 | 5,7,8,9,11 | 5,7,8,9 | 6 |
| 8 | 3,4,5,6,7,8,9,10 | 1,2,4,5,6,7,8,9,11 | 4,5,6,7,8 | 6 |
| 9 | 3,4,5,6,7,8,9,10 | 1,2,4,5,6,7,8,9,11 | 4,5,6,7,8,9 | 3 |
| 10 | 10 | 1,2,3,4,5,6,8,9,10,11 | 10 | 1 |
| 11 | 2,3,4,5,6,7,8,9,10,11 | 11 | 11 | 8 |

Table 5: Level Partitioning Results



Level

3

Worker’s Health

and Safety

Internal

Culture

Alternative

Energy

Product Innovation

and Development

Level

2

Enhancement of

Sustainability Technology

Level

1

Compliance with Directives and Policies

Energy Efficiency Target

Saving Energy Cost

Waste Management

Recyclability Material Target

Emission Target

Figure 2: The ISM-based Model of 11 Driver Elements

# Discussions and Conclusion

The objective of the ISM in this study is to develop a hierarchy of sustainability drivers that would help in assisting the development of sustainable reverse logistics in the automobile sector. The developed model provides opportunity to understand the sustainable management driver networks. It is clear that identification of drivers is important as it would lead to the highest effectiveness in managing the sustainable management. There were 11 sustainability drivers proposed by literature. It has been validated by practitioners, and then further discussed by academics. This study applied data triangulation to improve the validity and reliability of the research.

The ISM model shows there are three level of sustainability drivers: Level 1-Results Drivers, Level 2- Action Drivers and Level 3-Planning Drivers. The categorisation of these levels are adapted from the fundamental functions of management; planning, organising, leading and controlling. The researchers used these fundamentals to interpret the drivers’ levels because the effectiveness of sustainable management implementation can be measured through the level of actions. Company need a proper plan and integrate it with the best actions to achieve the best results (Maheshwari, 2004).

Level 3 consists of the drivers of planning that are related to the internal and external necessities to attain the sustainability. There are five drivers under this level, which are compliance with directives and policies, energy efficiency target, saving energy cost, worker’s health and safety and internal culture. Álvarez-Gil et al. (2007) argued that the success of sustainability result is from a combination of external pressures and an organisational factor. Companies are having internal commitments such as requirements for saving the costs and improving the worker’ welfare. They are also required to be aware hence taking steps to comply with policies and regulations to show their contributions to sustainability.

Level 2 includes all the activity drivers to support the planning stage. Integrated actions are required to move the sustainability concept along the supply chain to meet the planned expectations (Jedlinski, 2014). There are four drivers are categorised under Level 2; alternative energy, waste management, enhancement of sustainability technology and product innovation and development. Companies use their capabilities to get resource-efficient solutions, effective waste management system and enhance products and technologies to capture the values in business and contribute to sustainability (Kurdve et al., 2015).

Level 1 consists of the two main drivers; emission target and material recyclability target. This level generates insights on how the actions (Level 2) affects the outcome (Level 1) on ISM model. In other words, Level 1 is the consequence of Level 2 and Level 3. For instance, internal culture driver leads (Level 1) the product innovation (Level 2). Then it leads the material recyclability rate (Level 1).

Organisational culture is one of the key areas for effective implementation of innovation (Loewe and Dominiquini, 2006). The continuous process of innovation drives companies’ stepping in increasing the product recyclability level (Biddle, 1993).

Emission target is positioned as the top driver on the model. All the causal relationships are pointing to this driver at the end of the network. This is because this driver consists of the highest degree of dependence and emission peaks are the entry points to the sustainability actions (Wang and Zou, 2014). The attribution of this driver is supported by Nishitani et al. (2016) that stated companies are having a better performance if they adopt low-carbon supply chain principle.

Several managerial implications can be drawn from this study. This paper demonstrates a sustainability driver model and applies it to the reverse logistics of the automobile sector. It will encourage practitioners to understand the importance of each driver and to evaluate how core drivers influence their organisations’ sustainability practices. Organisations can then develop specific response strategies in relation to these drivers. For future work, this study can be tested in different industries.

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