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Study on Information Transition to Facilitate Sustainable Consumption: Multi-Stakeholders' Viewpoints

Jing Shao

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In cooperation with

Supervisors:

Prof. Marco Taisch

Prof. Miguel Ortega Mier

Tutor:

Prof. Paolo Trucco

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Abstract

From both practical and theoretical studies, it is necessary to strengthen information transition and provide a facilitator to bridge the gap between consumers' attitude and behavior. It could help translate consumers' beliefs and values about sustainability into their demands and promote green purchasing behavior. This study focused on the in-depth understanding of how to provide a facilitator within Attitude-Facilitator-Infrastructure (AFI) framework in order to provide incentives for promoting sustainable consumption.

This research starts from the empirical study on barrier analysis between environmentally friendly products and their consumers. The study was conducted in the context of European automobile industry by employing grey-Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. The results suggested that the main focus should move to how to provide advanced measures as a facilitator to promote sustainable consumption. After a systematic review on sustainability assessment approaches, this study developed a set of necessary attributes based on cognitive consumer behavior model. The proposed set of attributes could adequately meet the consumer–focused criteria, and play the role of facilitator in AFI framework.

Furthermore, in order to gain comprehensive insights from different stakeholders, such as academic experts, industry experts, and consumers, several studies were conducted based on viewpoints from multiple stakeholders. Firstly, an expert evaluation exercise (EEE) was used to evaluate the importance and applicability of the attributes. Unnecessary attributes and the ones that could not be measured properly at plant level are eliminated. And then, the importance of attributes were evaluated and ranked based on a survey of 683 respondents' by employing structural equation modeling (SEM) approach. As the result, numeric weights of the importance of attributes are gained from the configuration model for the automobile industry, by employing Analytic Hierarchy Process (AHP) method.

This study provides empirical insights on importance and weights of numbers of necessary attributes from multi-perspective and highlights the different viewpoints that

might exist among various stakeholders. This study contributes to the research fields of developing an information transition approach from cleaner production to sustainable consumption, as well as marketing instrument development. The proposed configuration model could serve as a fundamental study for developing related governmental/regional public policies, including existing sustainability monitoring initiatives. It could also be integrated into management and administration procedures with the goal of developing more sustainable cities. Furthermore, it is also very beneficial and constructive for practitioners to provide consumers with product-level sustainability information. Such environmentally and socially–conscious information will provide an effective way for consumers to facilitate product comparisons and choose products, resulting in increased market share and profit for practitioners. Consequently, it will provide a long–term competitive advantage due to increased differentiation.

Abstract

Sia dalla pratica che dagli studi teorici, è emersso che è neccessario rafforzzare transizione delle informazioni e provedere un facilitatore per coprire il gap tra mentalità e comportamento degli consumatori. Può essere utile trasformare convinzioni e valutazioni circa sostenibilità in loro esigenze e promuovere green purchasing. Questo studio è foccalizzato sulla conoscienza appofondita di come fornire facilitatore dentro AFI framework in modo da fornire stimoli per promuvere consumo sostenibile.

Questa ricerca parte dallo studio empirico sulla analisidi della bariera tra prodotti ambientalmente amichevoli e loro consumatori. Lo studio è stato condotto nel contesto della European automobile industry by employing grey-Decision-Making Trial e Evalutaion Laboratory (MEMATEL) method. I risultati hanno suggerito che lo sforzo maggiore dovrebbe spostarsi su come provedere misure avanzate che funzioni come un facilitatore per promuovere consumo sostenibile. Dopo una revisione sistematica sugli approcci del assestamento sostenibile, questo studio ha sviluppato una serie di attributi basati sul modello del comportamento cognitivo del consumatore. La serie di attributi proposti possono adeguatamente soddisfare il consumer-focused criterio, e fungere come il facilitatore in AFI framework.

Innoltre, per ottenere maggiore opinioi dai diversi stakeholders quali esperti accademici, esperti industriali e consumatori, numerosi studi sono condotti basando sui punti di vista dei multipli stakeholders. Inanzittutto un esercizio di valutazione di esperto(EEE) è stato usato per valutare l'importanza e applicabilità degli attributi. Gli attributi non neccessari e quelli che potrebbere non essere misurati correttamente negli stabilimenti sono stati scartati. Poi l'importanza degli attributi sono valutati e ordinati basandosi su uno studio di 683 risposte utilizzando l'approccio di modellizazione di equazione strutturare (SEM). Come risultato, pesi numerici della importanza degli attributi sono ottenuti dal modello di configurazione per industria automobilistica utilizzando il metodo di Processo analitico gerarchico (AHP).

Questo studio fornisce suggerimenti empirici sulla importanza e pesi dei numeri di attributi neccessari dal multi prospettiva e evidenziare diversi punti di vista che possono

esistere tra vari stakeholders. Questo studio contribuisce ai campi di ricerca dell'approccio per sviluppare transazoine di informazioni da produzione pulita a consumo sostenibile oltre allo sviluppo di uno strumento di marketing. Il modello di configurazione proposto può servre come studio fondamentale per sviluppare politiche pubblichce statali/regionali come iniziative di monitoraggio di sostenibilità esistenti. Può anche essere integrato nelle procedure manageriali e amministrativi con lo scopo di sviluppare città più sostebili. Oltrettutto, è anche molto vantaggioso e costruttivo per i professionisti fornire ai consumatori le informazioni sulla sostenibilità sui prodotti: informazioni quali amientale e consapevolezza sociale provederano un modo effettivo di facilitare i consumatori a comparare i prodotti e scegliere, con come risultato una maggiore quota di mercato e profitti per i professionisti. Di conseguenza, questo studio fornisce un vantaggio compettitivo a longo termine dovuto alla differenziazione aumentata.

Research outcomes Disclaimer

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- Gonzalez S.J., Bettiga D., **Shao J.,** (2014) Crowdfunding: A new meaning for fundraising & user innovation. Proceedings of the **19th DMI**: Academic Design Management Conference, pp.2683-2709, **London, 2–4 Sep., 2014**. ISBN 978-0-615-99152-8.
- **Shao J.,** Taisch M., Ortega-Mier M. (2014) A Proposal of Consumer Driven Framework for Enabling Sustainable Production and Consumption. Proceedings of the Advances in Production Management Systems International Conference, **APMS 2014, Ajaccio, France, September 20-24, 2014,** Part II, DOI: 10.1007/978-3-662-44736-9_50, Online ISBN:978-3-662-44736-9
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- **Shao J.,** Taisch M., Ortega-Mier M. (2014) Sustainability Assessment Instruments for Consumers, Proceedings of 20th Engineering, Technology and Innovation, **ICE 2014, Bergamo, Italy, 23-25, June, 2014** Publisher: IEEE, DOI:10.1109/ICE.2014.6871624
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- Taisch, M., **Shao, J.** (2013) Critical mapping of sustainable index methodologies. Proceedings of the IEEE International Conference on Industrial Engineering and Engineering Management **IEEM2013,** pp.1228-1232, **Bangkok, Thailand, 10-13 Dec. 2013**. DOI: 10.1109/IEEM.2013.6962607. Available at

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CHAPTER 1: INTRODUCTION

1.1 RESEARCH TRENDS AND MOTIVATION

The rapid development of recent industrialization and urbanization has put increasing demand on the natural resources and the environment. This growing demand has led to serious environmental degradation posting a mounting threat to the sustainable development of the world's economy and society. Many efforts have been put to achieve and maintain sustainable development within these contexts. To achieve this goal, effective environmental policies have been implemented worldwide since the Brundtland report was announced in the 1980s (WCED, 1987). However, progress towards sustainability is nearly impossible to achieve without considering the collective actions of over 7 billion human beings, since unsustainable consumption patterns and levels are regarded as a major cause of unsustainable development (Shen and Saijo, 2009; UNDP, 1998; Worldwatch, 2004).

Instead of only concentrating on sustainable production innovations, approaches that could guide sustainable consumption patterns have gained traction as viable sustainable development strategies (Fuentes, 2014; Miniero et al., 2014). As the EU announced, "changing unsustainable consumption and production patterns" is the target of 10 Year Framework of Programs (10YFP) and it encourages national and regional initiatives to accelerate the shift toward sustainable consumption and production (Barber, 2011).

Based on empirical studies of consumer behavior, it is clear that consumers already have greater demand on product-level sustainability information to help them make purchase decisions (Grunert et al., 2014; Marucheck et al., 2011). It can be seen in consumer attitude that they have moved from satisfying elementary survival needs to represent their lifestyle and other possible values through their purchasing (Meise et al., 2014). 87% of consumers are concerned about the social and environmental impacts of the products they buy (Bonini and Oppenheim, 2008). Furthermore, consumers demand more information regarding a product's supply chain and production history (Marucheck et al., 2011). By using this information, they tend to mix their green knowledge and attitudes with green brand awareness when choosing a green product (Matthes et al., 2014; Zhao et al., 2014).

Additionally, recent studies also suggest that, considering full transparency of information for products, consumers are ready to pay a premium for a product (Owusu and Anifori, 2013; Xu et al., 2012). Notably, some studies show that consumers would pay for certain socially–conscious attributes, such as non–animal experimentation or non–child–labor (Auger et al., 2008), or pay about 10% more as a so–called “ethical price premium” (Pelsmacker et al., 2005).

However, even though the consumers are willing to pay a price premium of sustainability or changing their consuming habits, the fact is that they still lack the sufficient and reliable information needed to make informed choices (Jacobsen and Dulsrud, 2007). One of the most important reasons is the limited sustainability–related information transition from sustainable production to sustainable consumption (Caniato et al., 2012; Lebel and Lorek, 2008; Meise et al., 2014). Currently, consumers mainly can get certain sustainability information by looking forward trustworthiness, reference groups (of other green consumers), and personal efficacy of doing something for collective benefits for the communities where they live (Gupta and Ogden, 2009).

Few attempts have been made to explore sufficient sustainability information that should be provided for consumers. However, numbers of related theories have been utilized to investigate various issues related to consumers who conduct green purchasing. The studies that are based on stakeholder theory examine roles of consumers within green supply chain practice. Such as influencing factors of environmental purchasing (Björklund, 2011), environmentally oriented reverse logistics (Sarkis et al., 2010). Several researchers present fundamental theories in understanding the attitude formation in consumers’ adoption of green products and behavior. For example, Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980), Planned Behavior (TPB) (Ajzen, 1991), Perceived Behavior Control (PBC) and Norm Activation Theory (NAT) (Schwartz, 1977). The models that are focusing on pro-environmental consumer behavior subsequently emerged, e.g., the Value-Belief-Norm model (Stern et al., 1999) and the

Attitude-Behavior-Context model (Stern, 2000). In such models, the importance of value, consequential belief and sense of responsibility are suggested as three elements that influence customer behavior.

Furthermore, the Attitude-Facilitator-Infrastructure (AFI) framework was developed, as shown in Fig. 1 (Akenji, 2014). This framework shows that facilitator is the key element in the whole system and could properly reflect consumers and other stakeholders' attitudes. The facilitator's functionality is assured with the help of infrastructures. Laws, policies and administrative procedures that were created by governmental policy and business decision makers are included in the definition of facilitator, and they could provide incentives for promoting sustainable consumption. As Akenji argued, facilitators "provide incentives to encourage a particular pattern of behavior or course", or "place constraints to discourage unwanted outcomes" (Akenji, 2014). More critically, "facilitators provide agency to stakeholders of sustainable consumption" (Akenji, 2014).

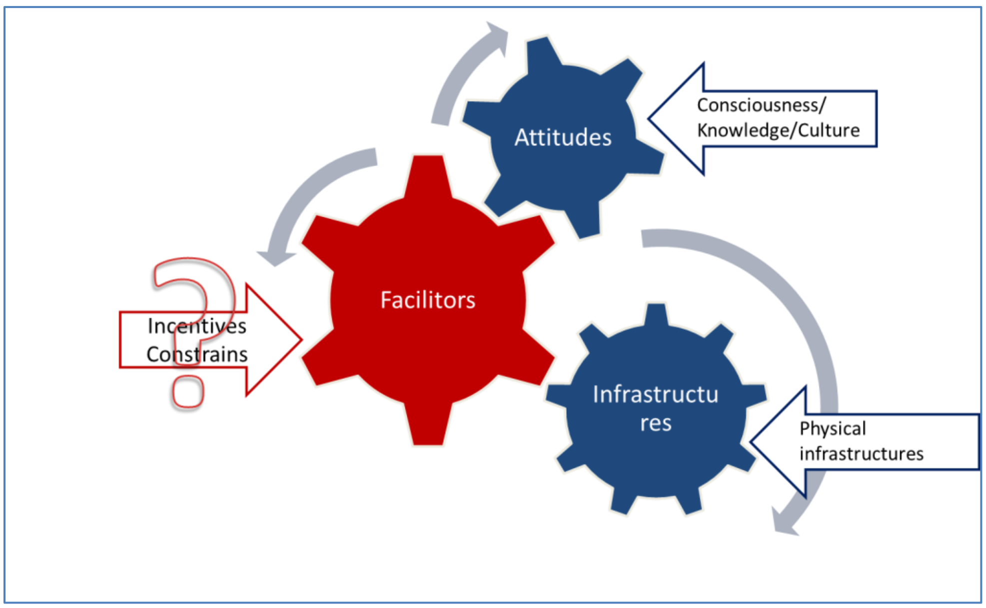

Fig. 1: KEY ELEMENTS FOR MAINSTREAMING SUSTAINABLE CONSUMPTION

Source: (Akenji, 2014)

The automobile industry is often described as "the engine of Europe" in the 21st century and their management practices, organizational forms, and particularly its response to environmental concerns are not only important in their own right, but also for influencing many other business sectors (Orsato and Wells, 2007). The technologies of electric vehicles (EVs) improve the reduction of energy consumption and pollutant emissions (Bradley and Frank, 2009; Faria et al., 2013). Although EVs are the fastest growing vehicle segment, with a global growth rate of 76 percent in 2014 (ZSW, 2015), their sales are still marginal, mainly attributes to a number of barriers exist between such environmentally friendly products and their consumers, which makes the promotion of these products challenging. Previous studies were conducted from consumer or policy implication perspectives. Additionally, most of the studies focused on one or several related barriers that exist in the transition process of environmentally friendly products and their consumers. However, it is hard for practitioners to address all the proposed barriers simultaneously. In order to promote environmentally friendly products effectively, it is better to focus on some critical gaps.

More specifically, there are two main gaps that are going to be addressed in this study:

1) Lack of identification and analysis on the barriers that exist between environmentally friendly products and their consumers. The main critical influential factors that influence green purchasing should be explored.

2) Lack of theoretical and empirical research on information transition to bridge the gap between consumers' attitude and behavior. The transition of sustainability information of production could consider as a facilitator to promote green purchasing behavior.

1.2 RESEARCH OBJECTIVES AND RESEARCH QUESTIONS

According to the research gaps, four research objectives integrated with nine main research questions will be organized as following in this research:

Objective 1: To identify the barriers that exist between environmentally friendly products and their consumers in the context of European automobile industry, and identify the critical influential factors that influence green purchasing through visualizing their prioritization and influence severity based on empirical data.

RQ1) In the literature, what are the barriers that are proposed in the context of European automobile industry?

RQ2) What are the inter-relationships among these barriers?

RQ3) Which factors are the main critical influential factors that influence green purchasing?

Objective 2: Review on possible approaches that assess sustainability performance of the product in industrial engineering and marketing science fields, and analyze their feasibility for providing sustainability information for consumers.

RQ4) What are the existing approaches that assess sustainability performance of the product?

RQ5) What are the criteria that could evaluate current approaches in terms of their feasibility of providing necessary information for consumers?

RQ6) Which approach could be investigated in order to provide necessary information for consumers, and how those approaches could be possibly adjusted and then meet the needs of consumers.

Objective 3: From multiple stakeholders' perspectives, develop a list of necessary attributes that could provide by companies towards successful presenting sustainability information of the product to their consumers.

RQ7) What dimensions and attributes are needed to be included to assess the social and environmental impact of a product, based on selected indicators?

RQ8) What attributes are necessary based on viewpoints from multiple stakeholders?

RQ8.1) What attributes are necessary and applicable based on viewpoints from academic and industry experts?

RQ8.2) What attributes are necessary based on viewpoints from consumers?

Objective 4: Develop configuration model of European automobile companies.

> **RQ9)** What is the configuration model in the context of Italian automobile companies?

1.3 STRUCTURE AND OUTLINE OF THE THESIS

There are 10 chapters in this thesis. The state of art of related research and the research objectives of this study was presented in Chapter 1. Then, the background regarding sustainable consumption, related theoretical framework and automobile industry in EU as well as the exist barriers between products and their consumers will be shown in chapter 2. Next, several different methodologies that are applied in various states of this study will be introduced in Chapter 3. According to the research objectives and methods provided above, Chapter 4 will show the result of barrier analysis that relates to research objective 1. Chapter 5 put emphasis on systematic review of sustainability assessment approaches that refers to research objective 2. Based on the analysis results, Chapter 6 will show the development process of necessary attributes, which provides preliminary research result that relates to research objective 3. Chapter 7 and 8 will present the viewpoints of multiple stakeholders, including academic and industry experts, and consumers. The results show insights from multi-stakeholders and attempts to achieve research objective 3. Next, Chapter 9 describes the configuration model of automobile industry based on Italian case, which relates to research objective 4. At the last, the conclusion, as well as the contribution of this study will be summarized in Chapter 10.

To visualize the research objectives and research questions, the structure, and outline of this thesis is shown in Fig. 2. The content was clustered based on literature review, methodology and research results. For each research objective, related literature review, methodology and result is presenting accordingly.

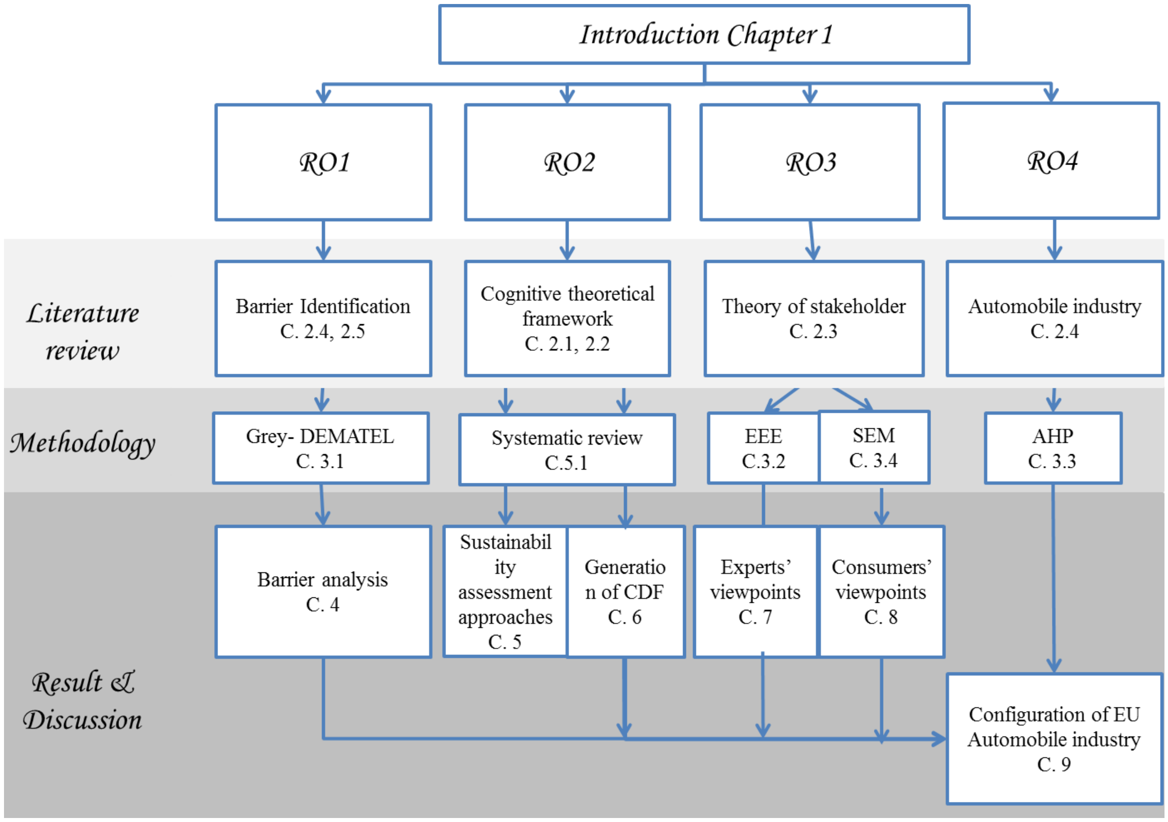

Fig. 2: STRUCTURE AND OUTLINE OF THE THESIS

For example, the first research objective is to identify the barriers that exist between environmentally friendly products and their consumers in the context of European automobile industry. For answering its research questions, firstly, commonly discussed briers in the context of European automobile industry are summarized based on literature in section 2.4 and 2.5. This section of study applies the grey-DEMATEL method that is introduced in section 3.1. Through visualizing their prioritization and influence severity based on empirical data, the interrelationships among the barriers as well as the critical influential factors that affect green purchasing are identified in Chapter 4.

CHAPTER 2: LITERATURE REVIEW

This chapter will present the literature review on several topics that are related to this research. And a systematic review on sustainability assessment approaches will be presented in Chapter 5, based on the logic of research. In the first three sections of the current chapter, the search for literature started from the investigation of the citation databases Science Direct and Scopus. The phrases such as sustainable consumption, green behavior, pro-environmental, stakeholder, and cognitive model were used. The last two sections present the introduction of the automobile industry in Europe, and related barriers were identified based on a separate literature review, which will be shown in section 2.5.

2.1 SUSTAINABLE CONSUMPTION AND PRODUCTION

The term "sustainable consumption" can be traced back to the Agenda 21 document, the main policy output from the UN Earth Summit in 1992. Sustainable consumption was defined at the Oslo Roundtable as: "the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations" (Kongress Oslo, 1994).

Research on sustainable consumption lies at the crossroads between green products and green consumer behavior (Young et al., 2010), which was recently called pro-environmental consumption behavior (Dietz et al., 1998). Green products were initially found in the fields of green manufacturing and green procurement but are now evident in research regarding supply chains (Srivastava, 2007). In modern supply chains, consumers are considered an integral part of it, and hence the concept of green consumerism evolved as a result of downstream information flow through marketing channels (Srivastava, 2007). The consumers are informed about the concept of green products through green marketing initiatives (Peattie and Crane, 2005). Consumers are aware of green issues such as depleting natural resources, global warming, and pollution and consider them when making green products purchase decisions (Banytė et al., 2010; Schlegelmilch et al., 1996; Young et al., 2010). For example, it is commonly believed that food consumption and dietary choices can make a significant contribution towards meeting current environmental challenges (Grunert et al., 2014). Informed choice, such as in the case of nutrition labeling, is meant to empower people to consume more sustainably (European Commission, 2008).

The underlying assumption for sustainable consumption behavior studies (or pro-environmental consumption behavior) (Dietz et al., 1998), is that individuals make rational choices and choose alternatives with the highest benefits against the lowest costs, in terms of money, effort and/or social approval (Wang et al., 2014). To deeply understand the attitude formation in consumers' adoption of green products and behavior, the cognitive and normative behavior theories and models are widely used as the fundamental theories (Ozaki and Sevastyanova, 2011). Such theories and related models will be introduced in next section.

2.2 SUSTAINABLE CONSUMPTION RELATED THEORETICAL FRAMEWORKS

2.2.1 COGNITIVE, NORMATIVE AND PRO-ENVIRONMENTAL BEHAVIOR THEORIES

The cognitive behavior theories such as Theory of Reasoned Action (TRA) states that 'intentions' are the best predictor of behavior (Ajzen and Fishbein, 1980), which means an individual's attitude towards a particular behavior is determined by his/her beliefs about the consequences of performing the behavior. Based on TRA, the Theory of Planned Behavior (TPB) (Ajzen, 1991) focuses on the process by which consumers' beliefs form attitudes towards certain behaviors and lead to their adoption. Later, the theory of Perceived Behavior Control (PBC) incorporates a third variable, "control beliefs", which considers the fact that there are constraints in reality and that intentions are not necessarily translated into behavior. Slightly different from the above theories, the Norm Activation Theory (NAT) that is a normative model for pro-environmental behavior regards "moral obligation" as the only direct determinants of pro-social behavior. The moral obligation represents awareness of the consequences, ascription of responsibility and create personal norms (Schwartz, 1977).

With respect for natural limits and the importance of preserving the balanced integrity of nature, a set of core values were identified in the New Environmental Paradigm (NEP)

(Dunlap and Van Liere, 1978; Dunlap, 2008). Models focusing on pro-environmental consumer behavior subsequently emerged, for example, the Value-Belief-Norm model (Stern et al., 1999) and the Attitude-Behavior-Context model (Stern, 2000). In such models, the importance of value, consequential belief and sense of responsibility are suggested as three elements that influence customer behavior.

2.2.2 COGNITIVE MODELS

Several models were developed for understanding the motivation and patterns of consumption, as shown in Table 1. Importantly, models usually incorporate a third variable as a facilitating factor for helping transit the gap between awareness and behavior. For example, the factor “Opportunities” in the Needs-Opportunities-Abilities (NOA) model (Gatersleben and Vlek, 1998), the factor “Agency” in the Awareness-Agency-Association (AAA) model (Ballard, 2005), the factor “Influence” in the Triple I (Interest-Influence-Instrument) model (Akenji and Bengtsson, 2010) and the factor “Facilitator” in the Attitude-Facilitator-Infrastructure (AFI) framework. The list of such cognitive models is shown in Table 1 along with the definition of each respective factor.

The Needs-Opportunities-Abilities (NOA) model was developed for describing and understanding the motivation for, and patterns of, consumption (Gatersleben and Vlek, 1998). It diagnoses consumer behavior at the micro-level of the household (three elements are identified as the main drivers) and the macro-level of society (such as technology, economy, demography, institutions and culture). More recently, critical issues that need to be addressed if individuals and organizations are to respond to the challenge of sustainable development were identified in the Awareness-Agency-Association (AAA) model (Ballard, 2005). Besides encouraging an increase in green commitment from consumers by persuading people of the importance of climate change, the other important strategy is “to remove barriers obstructing the smooth translation of these values into action” (Shove et al., 2012). A macro-level factors analysis was proposed in the Triple I (Interest-Influence-Instrument) in the context of packaging issues (Akenji and Bengtsson, 2010). It consists of three macro-level factors, in which the factor “Influence” represents the role of each actor, the influence over others, the position and relative importance of actor and in the value chain.

Table 1: LIST OF COGNITIVE MODELS

Abbr.	Factor			Ref.
NOA	**Needs** -individual objectives to attain, maintain or improve the quality of life;	**Opportunities** - external facilitating conditions for consumption;	**Abilities** - the set of internal capacities of the individual to procure desired products;	(Gaterslebeben and Vlek, 1998)
AAA	**Awareness** - the scale, urgency and relevance of the issue, and the awareness of its complexity and of the limits of human agency;	**Agency** - the role and skills to do things meaningful, and how actors can be influenced towards change;	**Association** - with like-minded agents embarking together to achieve meaningful change;	(Ballard, 2005)
Triple I	**Interest** - various stakes in the packaging issue, need, and drivers;	**Influence** - the role of each actor, influences over others, and the actor's position and relative importance in the value chain;	**Instrument** - the mechanisms of operation of each actor;	(Akenji and Bengtsson, 2010)
AFI	**Attitude** - the right attitude from stakeholders;	**Facilitator** -enable actions /reflect attitudes;	**Infrastructure** -would make sustainable lifestyles the easier option;	(Akenji, 2014)

Based on the Triple I model, the Attitude-Facilitator-Infrastructure (AFI) framework was developed (Akenji, 2014), as shown in Fig. 1. This framework shows that facilitator is the key element in the whole system and could properly reflect consumers and other stakeholders' attitudes. The facilitator's functionality is assured with the help of infrastructures. Laws, policies and administrative procedures that were created by governmental policy and business decision makers are included in the definition of facilitator, and they could provide incentives for promoting sustainable consumption. As

Akenji argued, facilitators provide incentives to encourage a particular pattern of behavior or course or place constraints to discourage unwanted outcomes. More critically, facilitators provide agency to stakeholders of sustainable consumption (Akenji, 2014).

Therefore, from the theoretical perspective, it is necessary to strengthen information transition and provide a facilitator to bridge the gap between consumers' attitude and behavior, and further, to help translate their beliefs and values about sustainability into their demands and purchasing behavior.

2.3 THEORY OF STAKEHOLDER

Since the first time Freeman defined stakeholder as "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984), the stakeholder theory has been a popular heuristic for describing the management environment. It also has been applied widely used in the area of normative theories of business, corporate governance and organizational theory, corporate social responsibility and performance, and strategic management (Freeman and McVea, 2001). In the research field of social responsibility and social performance, a more sophisticated model that suggested that companies prioritize the needs and expectations of stakeholders based on their perceived power, legitimacy and urgency (Mitchell et al., 1997). In this way, "the principle of who and what really counts" will show. Stakeholder management calls for an integrated approach to strategic decision making. Rather than set strategy stakeholder by stakeholder, managers must find ways to satisfy multiple stakeholders simultaneously (Freeman and McVea, 2001).

2.4 AUTOMOBILE INDUSTRY IN EUROPE

This research are mainly conducted in the context of the automobile industry that is often described as "the engine of Europe" in the 21st century because it employs more than two million people directly and supports another 11 to 12 million jobs in other allied business sectors (Claros, 2013; Jonnaert, 2014). As the largest manufacturing sector in Europe with a total turnover of €211bn (in 2011), the automobile industry's management practices, organizational forms, and particularly its response to environmental concerns are not only important in their own right, but also for influencing many other business sectors (Orsato and Wells, 2007). The technologies of battery electric, hybrid electric, and plug-in hybrid electric vehicles improve the reduction of energy consumption and pollutant emissions (Bradley and Frank, 2009; Faria et al., 2013). Increasing number of electric vehicles (EVs) coupled with low-carbon electricity sources, such as biofuels and natural gas, are more sustainable from a life-cycle perspective (Hawkins et al., 2013; Shen et al., 2012).

Although EVs are the fastest growing vehicle segment, with a global growth rate of 76 percent in 2014 (ZSW, 2015), their sales are still marginal. During 2014, only five European Union (EU) countries achieved EV sales with a market share higher than 1% of total new car sales: Norway (13.84%), the Netherlands (3.87%), Iceland (2.71%), Estonia (1.57%), and Sweden (1.53%) (OECD, 2015). It is because a number of barriers exist between such environmentally friendly products and their consumers, which makes the promotion of these products challenging.

Previous studies were conducted from consumer or policy implication perspectives. For example, extensive surveys of consumers regarding their buying motivations toward green cars were carried out to understand the influencing factors, such as the financial benefits, social norms and consumers' willingness to purchase products, and practical, experiential information regarding the added value of new technologies or products (Ozaki and Sevastyanova, 2011). The research of Sovacool and Hirsh presented barriers and benefits in the context of plug-in hybrid electric vehicles (PHEVs), besides technical barriers, factors such as social and cultural values, business practices, and political interests might be more difficult barriers to overcome (Sovacool and Hirsh, 2009).

Additionally, most of the studies focused on one or several related barriers that exist in the transition process of environmentally friendly products and their consumers. For instance, one study showed that car buyers have an inadequate knowledge of cleaner car technologies, the environmental impact of road transport, and car ownership costs (Lane and Potter, 2007). Customers' initial unfamiliarity with EVs could be a barrier to wider use, due to inadequate knowledge of best practices to prolong battery life (Ulk, 2009). Several other related barriers are categorized in section 2.5 with detailed information.

However, it is hard for practitioners to address all the proposed barriers simultaneously. In order to promote environmentally friendly products effectively, it is better to focus on some urgent gaps and overcome these key barriers with management strategies that eventually reduce or eliminate their negative effects. Therefore, it is necessary to identify critical influential factors to help industry leaders to accelerate the changes from the present patterns. Nevertheless, all the barriers are interrelated and affect each other, and literature that investigates their prioritization and influence severity is still limited.

2.5 BARRIERS IDENTIFICATION IN CONTEXT OF EUROPEAN AUTOMOBILE INDUSTRY

From the literature on consumer studies, consumers already have an ethical belief while making purchases (Grunert et al., 2014; Heffner et al., 2007; Marucheck et al., 2011; Napolitano et al., 2010). The ethical belief is generated based on their desire to protect the environment or by political reasons, such as opposing war and reducing the dependence on foreign oil to improve national strength and vitality, in addition to embracing new technology.

However, a recent study showed that even consumers who are environmentally concerned did not buy environmentally friendly products with an overwhelming preference for other products (Tseng and Hung, 2013). Their environmental concerns were not necessarily translated into consumer purchase habits because of the attitude-action gap. It was not only found in the study of car buying behavior (Lane and Potter, 2007), but also in some other industries, for example, the organic food industry (Grunert et al., 2014).

Several barriers in the context of the European automobile industry are proposed through empirical studies. Besides studies related to technical and infrastructure obstacles to promoting new models of automobiles, such as batteries of EVs, plug-in hybrid cars, and their auxiliary accessories, this study focuses on the barriers that exist between consumers and these new models of automobiles.

Table 2: LIST OF BARRIERS EXIST BETWEEN GREEN PRODUCTS AND CONSUMERS

No.	Barrier	Description
B1	Unfamiliarity with the market for environmentally friendly products	Inadequate knowledge of the availability of EVs, such as the best practices to prolong battery life (Ulk, 2009).
B2	Inadequate sustainability-related information for products when purchasing	Poor knowledge of cleaner car technologies, in addition to the environmental impact of road transport (Lane and Potter, 2007).
B3	Consumers have a lack of trust	In terms of advertisements and claims from companies (Rex and Baumann, 2007; Lebel and Lorek, 2008; Leire and Thidell, 2005).
B4	Lack of an easily understandable format for information	Difficulties in understanding information of evaluating the savings of environmentally friendly vehicles (Sovacool and Hirsh, 2009) and utilizing related new technology (Kurani, 2007).
B5	Non-competitive price	It is the first-cost hurdle that serves as an economic disincentive in the case of V2G PHEVs (Sovacool and Hirsh, 2009), low-carbon cars (Lane and Potter, 2007).
B6	Weak awareness of the influence of collective green purchasing behavior	General conflict exists between the individual objectives of the consumer and collective long-term environmental protection-related objectives of society (Moisander, 2007).
B7	Gaps between customers' expectations and perceptions	The products in the market do not meet the expectations of customers (Tseng and Hung, 2013).
B8	Consumers have a lack of motivation	Consumers' concerns about their future product's impact on the environment does not necessarily translate into behavioral change (Moisander, 2007; Rokka and Uusitalo, 2008).

An extensive literature review on barriers was conducted based on electronic databases Science Direct and Scopus, with search terms that are consist of a combination of exact phrases and truncation characters. The exact phrases include automobile, consumer behavior, consumer buying, and decision making. The truncation characters, such as words associated with eco, green, label, barrier and marketing were taken into account. In total, eight barriers are categorized in this section and presented in Table 2, with detailed arguments that are found in related empirical studies. It is noted that B6, B7, and B8 are categorized based on general arguments regarding products and consumers because they are mainly concerned with mental and initial factors that influence the purchasing behavior of consumers.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1. RESEARCH OBJECTIVES AND RELATED METHODOLOGIES

This chapter will present several methods that were applied in the various state of research. The research objectives that need to be achieved by such methods are introduced accordingly.

3.1.1 GREY-DEMATEL METHOD

In order to achieve the first research objective, grey-Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was selected to apply in this section of the study. It mainly because by using this method, interrelationships among the barriers categorized in the previous section could be analyzed, and the critical success factors among various barriers identified visually. The technique has proven valuable also for managerial decision-making support for environmental and green-related issues (Fu et al., 2012; Zhu et al., 2008). Compared with other possible approaches, such as interpretative structural modeling (ISM) or the analytical hierarchy process (AHP), the advantage of the DEMATEL method is that it allows for a broader discrimination of measures. For example, ISM only has 0 to 1 levels and multi-directional relationships, fuzzy ISM, which specifies hierarchy in addition to inter-relationship while AHP has a unidirectional relationship and multiple separate matrices requiring integration.

The DEMATEL technique (Fontela and Gabus, 1976; Gabus and Fontela, 1972) is a potent method that helps to gather group knowledge for forming a structural model, in addition to visualizing the causal relationship between sub-systems through a causal diagram (Fu et al., 2012; Wu and Lee, 2007). Additionally, matrices or diagrams portray relationships between system components and the strength of relationships quantitatively. This method has been applied in research areas, such as knowledge management (Wu and Lee, 2007), sustainable production (Dou and Sarkis, 2013), and green supply chain management (Amiri et al., 2011).

The data are accessed through interviews of three industry experts at three European automobile companies. This method could help visualize the structure of complicated causal relationships by portraying them in the matrices or diagrams quantitatively (Fu et al., 2012). Thus, the prioritization and influence severity of each factor and the critical influential factor could be identified. A brief introduction of this technique is provided followed by details of the steps.

3.1.2 STEPS OF GREY-DEMATEL METHOD

Grey system theory is employed in this study to solve uncertainty problems in cases of discrete data and incomplete information. The primary advantage of using grey system theory is that it can generate satisfactory outcomes by using a relatively small amount of data or with great variability in factors (Fu et al., 2012). The analysis is performed based on method guidelines presented in (Fu et al., 2012; Zhu et al., 2008). It should be noted that, from Step 3 to Step 6, MATLAB was employed to analyze data with the following methodology. The program was written according to the formula mentioned in these steps.

Step 1: First, a grey pairwise influence comparison scale for the components is defined. In this study, a five-level scale is used with the following scale items: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence, 4 = very high influence. The linguistic terms are then translated into a range of grey numbers shown in Table 3.

Table 3: THE GREY LINGUISTIC SCALE FOR THE RESPONDENTS' EVALUATIONS

Normal values	Linguistic terms	Grey numbers
0	No influence	[0,0]
1	Very low influence	[0,0.25]
2	Low influence	[0.25,0.5]
3	High influence	[0.5, 0.75]
4	Very high influence	[0.75,1]

Step 2: The grey pairwise direct-relation matrix X is developed. It is an 8×8 matrix whose assessment number is provided by respondents to a questionnaire.

At the beginning of the questionnaire is a description of the primary focus and objective of this study to provide complete information to interviewees. Then the definitions of the barriers are explained and listed. Lastly, respondents are asked to complete the grey pairwise direct-relation matrices, which are the core data required for further DEMATEL analysis. Table 6 shows the list of respondents, and the grey pairwise direct-relation matrices X for companies 1, 2, and 3 are shown in Appendix A.

Step 3: The grey pairwise direct-relation matrix X is transformed into a crisp matrix Z. A defuzzification method is required to deal with the problems of decision-making in a grey environment. An effective defuzzification method of converting fuzzy data into crisp scores (CFCS) is adopted in our grey aggregation procedure (Fu et al., 2012). The modified-CFCS process is used as exemplified by expressions A5 to A9 in Appendix F. As an example, the overall crisp direct-relationship matrix Z for company 1 is shown in Appendix B.

Step 4: The normalized direct-relation matrix N is obtained based on Equations 1 and 2. The normalized direct-relation matrix N for company 1 is shown in Appendix C.

$$N = sZ \qquad (1)$$

$$s = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} z_{ij}} \qquad (2)$$

Step 5: The total relation matrix T is developed based on Equation 3, where I represent an $n \times n$ identity matrix. The total relation matrices T for the companies are shown in Appendix D.

$$T = N + N^2 + N^3 + \cdots \sum_{i=1}^{\infty} N^i = N(I - N)^{-1} \qquad (3)$$

Step 6: The overall importance and the net effect are calculated by applying Equations 4 to 7, where P_i is the prominence value, and E_i is the net effect value. The degree of prominence and net effects in different cases is shown in Table 7 while the rank of prominence and net-cause barriers is summarized in Table 8.

$$R_i = \sum_{j=1}^{n} t_{ij} \qquad \forall i \qquad (4)$$

$$D_j = \sum_{i=1}^{n} t_{ij} \qquad \forall j \qquad (5)$$

$$P_i = \{R_i + D_j | i = j\} \quad (6)$$

$$E_i = \{R_i - D_j | i = j\} \quad (7)$$

After running the MATLAB program, the input data from matrix *X* are transformed into matrix *T*, and the overall importance and net effect values of each barrier are obtained.

Step 7: The DEMATEL prominence-causal graph is developed. Interrelationships between barriers are indicated with arrows. Only relationships that are over the threshold value θ are in bold in matrix *T* (shown in Appendix D) and mapped in Fig. 6-Fig. 8 for the three companies. The threshold equals the sum of the mean and standard deviation of the values from matrix *T* (see the list of threshold values in Appendix E).

Step 8: Overall DEMATEL prominence-causal graphs are developed to achieve aggregated results. Based on the mean of the three cases, the average values of prominence and the net effect of barriers are calculated and shown in last two columns of Table 7. An overall matrix *T* is developed in Appendix D, and the interrelationships are mapped in Fig. 9.

3.2 EXPERT EVALUATION EXERCISE (EEE)

In order to achieve the research objective 3, research questions 7 and 8 need to be answered one by one. In Chapter 6, the selection process of most relevant indicators and the development process of the proposed set of attributes will be introduced (focus on research question 7). And here, we will introduce the methods that were applied in this study to answer the research question 8.1: What attributes are necessary based on viewpoints from multiple stakeholders?

Firstly, as in the early state of this research, the survey method was adopted to gain insights from Expert Evaluation Exercise (EEE), in which experts on behalf of consumers are empowered to conduct an expert–driven process to offer in–depth insights on the importance and applicability of the attributes.

The method was selected mainly because on one hand, after extraction of adequate attributes for providing information for consumers, priorities of these attributes need to be assessed. In order to assure that provided information could fully satisfy consumer needs, consumers' participation and empowerment are necessary. However, most consumers lack corresponding knowledge regarding sustainability assessment. Therefore, expert–driven method is necessary for this research, especially in the early phase of this study. Such expert–driven research is common in research involving local stakeholders who lack corresponding knowledge of sustainability assessment (Vaidya and Mayer, 2013). This method has been applied in the development process of key performance measures for the green supply chain (Olugu et al., 2011).

The EEE analysis focuses on whether the extracted information attributes could meet consumers' preferences, at the same time be applicable in practice considering their measuring costs and benefits at the plant level. Section 3.2 presents the methodology which is used to offer in–depth insights on the importance and applicability of the selected attributes. The questionnaire design and data analysis process for this study is described in the following section.

3.2.1 DESIGN OF THE QUESTIONNAIRE

This survey contains two parts of questions. Part 1 is intended to gain knowledge about the importance of each attribute while Part 2 attempts to evaluate the applicability of each attribute in practice. Respondent selection is crucial in this study, and the requirements are different in each part. In Part 1, respondents should be representatives with consumers' characteristics for the product. There is no specific professional knowledge or consuming experience required for respondents. However, Part 2 requires respondents who are academic/industrial experts and familiar with the manufacturing and disposal process of a product. It requires that the respondents have professional knowledge of energy/material utilization, energy efficiency measuring and an essential understanding of life–cycle assessment. Additionally, in order to assure the consistency of the sample and reliability of the result, respondents should answer the two parts of the survey together.

Before sending out the survey, a content validation is conducted with five experts firstly. These five respondents should be top–level researchers whose research topics must be related, but diverse, and they must have relevant papers published after 2010. After these five experts are satisfied with the content of the list, a five–page questionnaire is sent to selected respondents in the academic research field and practitioners by e–mail. Higher requirements are applied on a selection of academic researchers. The selected academic experts must have at least one published paper in a peer–reviewed journal in the research field of industrial engineering, sustainable manufacturing, green consumption or industrial indicators. In order to increase the response rate, each e–mail is sent containing the target respondent's name and a description of his or her research/working area. Additionally, the e–mail includes a cover letter containing the instructions for the study and a draft of the generation process of the list.

3.2.2 DATA ANALYSIS PROCESS

The data analysis method was selected with regard to the content of the survey and format of data (Olugu et al., 2011). The preliminary method used a scoring scale from 0–5 to indicate the degree of perceived importance/applicability (to which extent it can be applied or used in practice) separately (0 = no idea, 1 = very low, 2 = low, 3 = moderate, 4 = high and 5 = very high). In this case, the data is non–parametric test data and they do not have to form a normal distribution.

Four steps in the data analysis process were conducted as follows:

1) Sorting of importance was carried out based on the mean value of each attribute, comparisons of their commonalities and differences from a different group of respondents was presented. The attributes that have a higher importance value (above 3.5) remained.

2) Sorting of applicability was conducted based on the mean value of each attribute.

3) The values of importance and applicability of each attribute were compared using the Mann–Whitney U–test, which is a non–parametric test conducted using SPSS software.

Whether the mean scores of the two sets of data (importance and applicability) differ significantly was observed based on the p–value of each attribute. A hypothesis was set as: H0–the importance and applicability of the attribute should be statistically the same. If H0 is correct, it means this attribute is important and applicable. Otherwise, it should be re-edited or eliminated.

4) Finally, the first prototype of the list was decided after this phase.

3.3 ANALYTIC HIERARCHY PROCESS (AHP)

In order to achieve research objective 4 that to develop configuration model of European automobile companies, 'numeric weights of importance' are necessary to attach to the various sub-goals and criteria, reflecting the affected stakeholders' judgments of their importance. Several methods, such as equal weight, principal component analysis/factor analysis, multi-criteria analysis (MCA) were employed in developing composite indicators. In this study, the method of Analytic hierarchy process (AHP) was selected to apply since it overcomes shortcomings of other MCA technique, and making assigning weights directly possible. It offers a logical and representative way of structuring the decision problem and deriving priorities.

3.3.1 METHODS OF INDICATOR DEVELOPMENT

Several weighting methods are employed in developing composite indicators. Equal weight is widely used in the development of indicators such as Environmental sustainability index, composite leading indicators. Principal component analysis/factor analysis is also common to be applied for developing the internal market index, business climate indicator, and so on. The multi-criteria analysis (MCA) provides a systematic procedure for identifying the best alternative, the best subset or a ranking of alternatives (Massam 1988). Such methods usually require the decision maker to directly attach weights to the alternatives, such as eigen vector method, weighted least square method, entropy method, and LINMAP techniques, unobserved component models, distance to targets, public opinion, conjoint analysis are applied as well.

However, it is discussed that since humans are inherently incapable of processing the relevant information about all criteria into stable weights, the way of attempting to extract preferences by directly questioning the decision-makers is an innately defective process (Zeleny, 1974). Moreover, methods that directly elicit weights are not proper for group decision making because it is often impossible to forge agreement among the divergent views (Barron and Barret, 1996).

3.3.2 STEPS OF ANALYTIC HIERARCHY PROCESS

Analytic hierarchy process (AHP) is the one of the MCA approaches that overcomes shortcomings of other MCA technique, and making assigning weights directly possible. It offers a logical and representative way of structuring the decision problem and deriving priorities. AHP was devised by Saaty (Saaty, 1980) is commonly used in sustainability assessment research that involving stakeholder participation that seemed as the key to sustainability. It has been applied in the Development of composite sustainability performance index for steel industry (Singh et al., 2007), development process of key performance measures for ELASTIC (Castillo and Pitfield, 2010), EU new economic policy indicators, etc.

AHP explicitly ranks tangible and intangible factors against each other for the purpose of resolving conflict or setting priorities. AHP compares decision factors by pairs and assigns weights to reflect their relative importance (Saaty, 1986). AHP method is that it does not require the very strong assumption that the stakeholders make absolutely no errors in providing preference information (Singh et al., 2007). Therefore, since AHP offers a logical and representative way of structuring the decision problem and deriving priorities, it is specified for use in this work to derive weightings that reflected the preference of each respondent. Especially, AHP is used as a framework for presenting and discussing the various dimensions and criteria for evaluating sustainability performance. This method is theoretically sound and practical approach for selecting, weighing, standardizing and aggregating individual indicators into a composite indicator (Singh et al., 2007).

In this part of the study, it is attempted to assess the relative importance of various dimensions of sustainability. The weights of indicators in each pillar of sustainability are also ascertained using AHP model. The selection of the methodology mainly considered the characteristics of the problem and the advantages and drawbacks of other methods. The decision-maker judges the importance of each criterion in pair-wise comparisons. The research in this study has focused on formulating an AHP-based model to evaluate the sustainability performance of the company. Furthermore, the concepts of the development and the structure of the model will be easily adapted to any industry.

The AHP modeling process involves three phases,

1. Structuring the decision problem,
2. Measurement and data collection,
3. Determination of normalized weights (Tam and Tummala, 2001).

The details will be introduced in the following section. Using this three-phase approach, we first formulate in this section an AHP model.

3.3.2.1 ESTABLISHMENT OF A STRUCTURAL HIERARCHY

Based on the developed set of attributes, the levels for pair-wise comparisons are organized as following:

- **Level 1:** Overall goal
- **Level 2:** Environmental Impact; Social Impact
- **Level 3:** Material and Energy Usage (5 attributes); Air (3 attributes); Water (2 attributes); Noise (1 attributes); Consumer (3 attributes); Employee (2 attributes)

The top element of the hierarchy is the overall goal of the decision model. The hierarchy decomposes to more specific attributes until a level of manageable decision criteria is met. Two dimensions, namely environmental impact and social impact, are identified in the second level of the hierarchy. The AHP analysis is conducted by using Software Super Decisions, and structured as shown in Fig. 3.

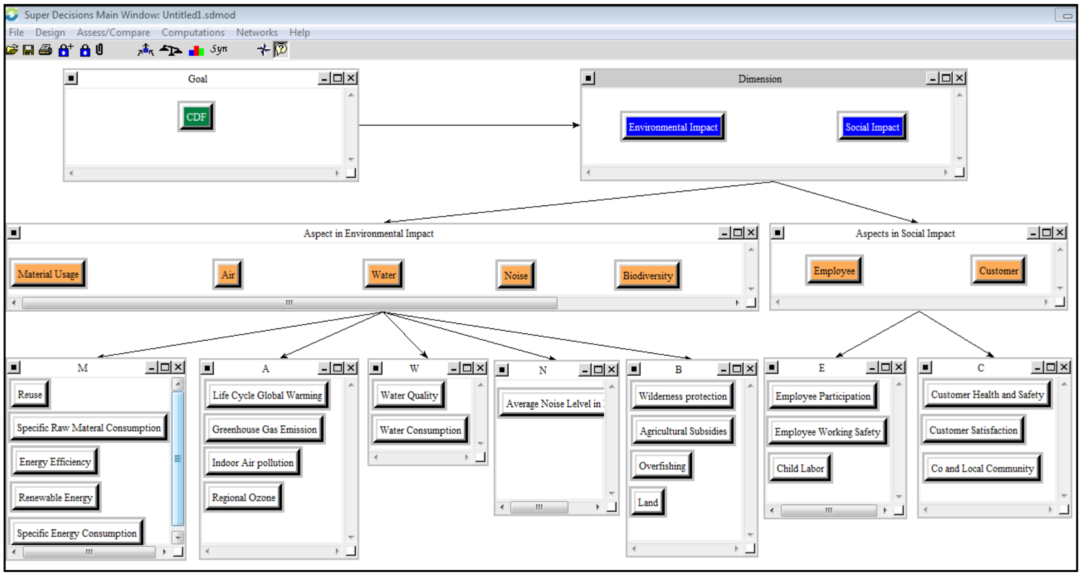

Fig. 3: MODEL FOR AHP ANALYSIS BY USING SOFTWARE SUPER DECISIONS

3.3.2.2 ESTABLISHMENT OF COMPARATIVE JUDGMENTS AND DATA COLLECTION

The AHP compares decision factors by pairs and assigns weights to reflect their relative importance. The process involves structuring a problem from a primary objective to secondary levels of objectives. Once these hierarchies have been established, a matrix is constructed from which elements within each level (and between levels) are compared pairwise. The result is a clear priority statement of an individual or group. The comparisons are made by posting the question which of the two indicators i and j is more important with respect to the sustainable development of the company, respectively (e.g. how important is indicator i relative to indicator j?). The intensity of preference is expressed on a factor scale from 1 to 9, the larger the number, the greater the importance (Saaty, 1980). The definition of the number of the intensity of preference is shown in Table 4.

Table 4: PREFERENCE SCALE FOR PAIRWISE COMPARISONS

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance

9	Overwhelmingly more important
2,4,6,8	Intermediate value to represent shades of judgment between the five basic assessment

This scale was chosen in this way because perception is sensitive enough to make a distinction. For example, Fig. 4 shows the pair-wise comparison of environmental impact & social impact, with factor scale 1-9.

Environmental Impact	1 2 3 4 5 6 7 8 9 8 7 6 5 4 3 2 1	Social Impact

Fig. 4: AN EXAMPLE OF PAIR-WISE COMPARISON

The pair-wise comparisons result in a $(N \times N)$ positive reciprocal matrix A, where the diagonal $a_{ii} = 1$ and reciprocal property $a_{ji} = (1/a_{ij})$, i, j =1, n assuming: if indicator i is "p-times" the importance of indicator j, then, necessarily, indicator j is "1/p-times" the importance of indicator i.

Table 5: PAIR-WISED COMPARISON RESULT FOR ASPECT OF MATERIAL USAGE

	Energy Efficiency	**Renewable Energy**	**Reuse**	**Specific Energy Consumption**	**Specific Raw Material Consumption**
Energy Efficiency	1	3	3	3	7
Renewable Energy		1	1	3	3
Reuse			1	5	3
Specific Energy Consumption				1	1/3
Specific Raw Material Consumption					1

In total, 39 times of pair-wise comparisons are needed for each respondent in this proposed model. An example of data collection from respondent in pair-wised comparison for the aspect of material usage is shown in Table 5.

3.3.2.3 INCONSISTENCY CHECK

After getting the scale on which respondents were requested to base their judgments, the consistency of each matrix needs to be verified and represented as consistency ratio (CR) (Atthirawong and MacCarthy, 2001). During the process of pair-wise comparison, inconsistency might occur when decision-maker makes careless errors or exaggerated judgments. Saaty recommends consistency ratio of 0.1 as the acceptable upper limit. If the consistency ratio is greater than 0.1, re-evaluation must be conducted by the decision-maker until the ratio is less than 0.1. The consistency value could be achieved by applying AHP Software called Super Decisions automatically in each level of comparison.

3.3.2.4 DETERMINATION OF NORMALIZED WEIGHTS

This study conducted three semi-structured interviews with three industrial experts in three European automobile companies in 2015. Detail information of the selected companies and respondents could be seen in Chapter 9. The model uses normalized values for indicators. The normalized weight of each indicator is gained by applying AHP Software called Super Decisions automatically.

3.3.2.5 AGGREGATION OF PREFERENCES AND OBTAINING THE RESULTS

In order to aggregate the ideas by AHP, both geometric and arithmetic means are applicable. The arithmetic mean is what generally referred to as the mean or average and is found more comfortable by most people to be used. However, geometric mean shows more consistency for both judgments and priorities in AHP according to (Forman and Peniwati, 1998). Therefore, the geometric mean was selected to be used for the aggregation of respondents' preferences.

Before applying the geometric mean, the weight of decision-makers' ideas should be investigated. The weight of each respondent must be decided and denoted by λ_i respectively.

At the same time, the summarization of n respondents' weights should be equal to 1, as shown in the following equation:

$$\sum_{i=1}^{n} \lambda_i = 1 \qquad (1)$$

If the set of X = $\{x_1, x_2 \ldots x_n)$ is the set comprising the preferences of three respondents for the first pairwise comparison within the first criterion, the first array of the aggregated matrix within this criterion using the weighted geometric mean is calculated according to the equation

$$\bar{x} = \prod_{i=1}^{n} x_i^{\lambda_i} \qquad (2)$$

The weight of each attribute W_i is calculated based on the prominence of its dimension, D_i, and its aspect, A_i, as well as its own prominence, p_i.

$$P_i = D_i \times A_i \times p_i \qquad (3)$$

$$W_i = P_i \times 100\% \qquad (4)$$

3.4 STRUCTURAL EQUATION MODEL (SEM)

After a review of related indicators, extraction of necessary attributes, and expert evaluation exercise, attributes identified as important when providing sustainability-related information for consumers are integrated as a list. However, what attributes are necessary based on viewpoints from consumers in the context of European automobile (EVs) needs more evidence (research question 8.2). Moreover, how these attributes could be possible to influence the consumers' intentions to conduct green purchasing behavior remains unknown. Therefore, this section of study aims to explore the possible influences of sustainability-related attributes on the intentions of consumers for conducting green purchasing. Methods of factor analysis, as well as Structural Equation Model (SEM), were applied for analyzing data and verifying the hypotheses by following the studies of (Koufteros, 1999) and (Koufteros et al., 2002). It includes exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and test of the structural model.

SEM is suitable to apply in this study since it could represent the causal processes by a series of structural equations. And these structural relations can be modeled pictorially to enable a clearer conceptualization of the theory under study (Byrne, 2010). Furthermore, it concerns the extent to which the observed variables are generated by the underlying latent constructs. Therefore, the strength of the regression paths from the factors to the observed variables (the factor loadings) is of primary interest (Byrne, 2010).

This study is based on an online survey, and the respondents were asked to rate each attribute using five-point Likert scale where 1 represent “not important” and 5 corresponded “very important”. Additionally, the respondents were also required to answer how much percent more would them to pay for a greener product. Firstly, the result of factor analysis shows the mean and standard deviation of attributes. Secondly, through Exploratory factor analysis (EFA), three factors were extracted by applying SPSS v.23, namely, Energy and material usage, Environmental impact and Social impact. These factors are hypothesized to have a direct effect on the intention of paying more for greener products. Furthermore, Confirmatory factor analysis (CFA) was employed using the LISREL program to examine these three categories of factors that are expected to influence the consumers’ intention of paying more for greener products.

3.4.1 INTRODUCTION OF SEM

Structural Equation Model (SEM) is based on a measurement model that could show the relationships between observed variables and their underlying latent factors. It is mainly because latent factors are not observed directly so that they cannot be measured directly. In SEM, the unobserved variable is linked to one that is observable, thereby making its measurement possible. Through a hypothesized model, SEM tests statistically to determine the extent the proposed model is consistent with the sample data (Lei and Wu, 2007; Wisner, 2003). SEM could provide an assessment of predictive validity, specifies the direct and indirect relations among the latent variables, and describes the amount of explained and unexplained variance in the model (Byrne, 2010; Schumacker and Lomax, 2004).

One of the main advantages of SEM is that it can be used to study the relationships among latent constructs that are presented by multiple measures (Lei and Wu, 2007). Experimental, non-experimental data, cross-sectional and longitudinal data could be analyzed by using SEM.

Observed (indicator) and unobserved (latent) factors

SEM incorporates observed (indicator) and unobserved (latent) factors, which are separated into measurement models and a structural equation model. Observed variables can be measured while unobserved factors cannot be directly measured and must be inferred or hypothesized from the observed variables. The measurement models specify how the latent factors are measured in terms of the indicator variables, and present the reliability and validity of the indicator variables for measuring the latent variables or hypothetical constructs.

Exogenous versus endogenous latent variables

Exogenous latent variables are synonymous with independent variables and they "cause" fluctuations in the values of other latent variables in the model. The model will not explain the changes in the values of exogenous. Instead, exogenous latent variables are considered to be influenced by other factors external to the model. Such as some background variables, for example, gender, age, etc.. Compare with exogenous latent variables, the endogenous latent variables are synonymous with dependent variables and they are influenced by the exogenous variables in the model, in the directly or indirectly ways. The model will explain the fluctuation in the values of endogenous variables since all latent variables that influence them are in the model specification (Byrne, 2010).

3.4.2 BRIEF INTRODUCTION OF STEPS

EFA and CFA

There are two basic types of factor analyzes: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In order to minimize the problem of self-perceptual bias, several research methods were applied to develop and evaluate measurement scales. Researchers would conduct correlation analysis and EFA to determine the extent to which the item measurements were related to the latent constructs. In factor analysis, their relations are represented by factor loadings. And then the estimation of reliability is checked by using Cronbach's alpha. However, these traditional techniques do not assess unidimensionality (O'Leary-Kelly and Vokurka, 1998; Segars, 1997), nor can unidimensionality be demonstrated by either mathematical or practical examinations

(Gerbing and Anderson, 1988; Koufteros, 1999). In contrast to EFA, CFA with a multiple-indicator measurement model is appropriate to assess unidimensionality (Anderson, 1987; Segars, 1997) when the researcher has some knowledge of the underlying latent variable structure and then tests this hypothesized structure statistically. The convergent validity, unidimensionality, discriminant validity and construct reliability will be assessed accordingly. The brief steps of conducting SEM are shown in Fig. 5.

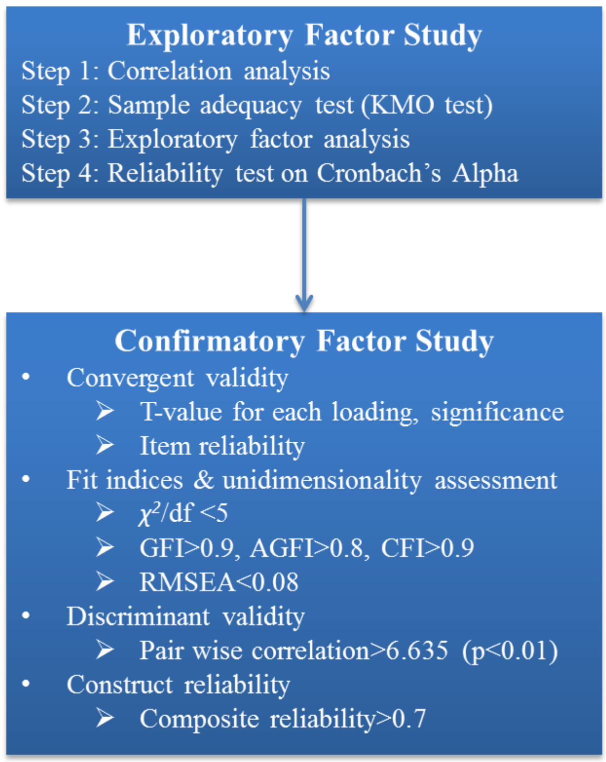

Fig. 5: DATA ANALYSIS PROCESS

Construct validity refers to the extent to which the items in a scale measure the abstract or theoretical construct (Carmines and Zeller, 1979) and includes convergent validity and discriminant validity (O'Leary-Kelly and Vokurka, 1998). Convergent validity means the similarities among different measures of a construct and is achieved when the correlation among variables used to measure the same construct is high. In contrast, discriminate validity refers to the uniqueness of the constructs and is present when the correlation between two constructs designed to measure two distinct concepts is not high (Churchill, 1979).

3.4.3 ANALYZING TOOLS

Factor analysis could be conducted by using AMOS (Arbuckle, 1997) which is a general-purpose SEM package (http://www.smallwaters.com) also available as a component of SPSS statistical analysis software. Other software such as CALIS (Hartmann, 1992) is a procedure available with SAS statistical analysis software (http://www.sas.com). EQS (Bentler, 1989, 1995) is a popular SEM package focusing on estimation with non-normal data (http://www.mvsoft.com). EzPath (Steiger, 1989) provides SEM capability for SYSTAT statistical analysis software (http://www.spssscience.com/systat). LISCOMP (Muthén, 1988) pioneered estimation for non-normal variables and is a predecessor of MPLUS.

CFA model could be constructed by using LISREL (Jöreskog and Sörbom, 1993) which is one of the oldest SEM software packages. It composite with coupled modules PRELIS and SIMPLIS and has been frequently upgraded to include alternative estimation methods and goodness-of-fit tests, as well as graphical interfaces (http://www.ssicentral.com). Some other software are also suit for for statistical analysis with latent variables that includes SEM, such as MPLUS (Muthén and Muthén, 1998) (http://www.statmodel.com/index2.html), Mx (Neale, 1997), (http://views.vcu.edu/mx/), SEPATH for STATISTICA software (http://www.statsoftinc.com/), STREAMS (Structural Equation Modeling Made Simple) (http://www.gamma.rug.nl) and TETRAD software, etc.

In this study, the analysis was carried out by applying SPSS 23.0 for *windows* and LISREL 8.7.

CHAPTER 4: GREY-DEMATEL ANALYSIS ON THE BARRIERS BETWEEN ENVIRONMENTALLY FRIENDLY PRODUCTS AND CONSUMERS

-Practitioners' Viewpoints on the European Automobile Industry

(The content of this chapter has been published in Journal of Cleaner Production)

4.1 DATA COLLECTION

This chapter of study attempts to visualize the prioritization and influence severity of each factor and identify critical influential factors, in order to support managerial decision-making and inform initiatives that facilitate consumer adoption of products. By an extensive review of the literature, eight barriers between environmentally friendly products and their consumers are categorized. Then, the technique of grey-Decision-Making Trial and Evaluation Laboratory (DEMATEL) (Zhu et al., 2011) is adopted to visualize the prioritization and influence severity of each factor. The interrelationships among barriers are illustrated in prominence-causal graphs for three individual European automobile companies, in addition to an aggregated result. The main findings from data analyze result are presented by following a discussion on these findings.

This study is based on interviews with three industry experts from three European automobile companies in 2014. The aim is to investigate the major relationships between barriers that have been identified in the literature. The data of the grey pairwise direct-relation matrix is provided by the selected respondents and the method of grey-DEMATEL is applied to analyze the data. Detailed information of the selected companies and respondents can be seen in Table 6.

According to the manufacturing plants and headquarter locations, this study selected three companies that covered from north to south Europe, since Europe is the strongest automobile manufacturing area, which built approximately 17 million units of automobiles in 2014 (OICA, 2015). Company 1 (C1) is a global multinational automobile manufacturing company that has created motor cars since the beginning of the 20th century. C1 ranks as a top-level company in the Carbon Disclosure Project (CDP) Leadership Index, in addition to the Dow Jones sustainability index. It invested more than

£1,000 million in research and development (R&D) in 2013, of which around two-thirds was aimed at reducing the environmental impact of its products and services. C1 currently holds third-party certification, including Quality ISO 9001 and ISO 14001. Company 2 (C2) is a Swedish automobile manufacturer established in the middle of the 20th century. It is also one of the top companies in the Carbon Disclosure Project (CDP) Leadership Index. It has strong initiatives for developing a corporate responsibility strategy that includes a framework of commitments for achieving business success in a responsible way. Company 3 (C3) is a medium-sized Italian business that designs and manufactures parts and accessories for large trucks and engine manufacturers. It has more than 500 employees globally and has become one of the strongest competitors in international markets.

Table 6: LIST OF RESPONDENTS FOR DEMATEL ANALYSIS

Company	Establishment history	Employee number	Headquarter location	Working experience of respondents
C1	>100 years	1001-5000	UK	8 years
C2	50-100 years	5001-10000	SE	12 years
C3	20-50 years	500-1000	IT	7 years

The selected respondents of these three automobile companies are able to provide a complete picture of environmentally friendly products and their consumers due to their education, job responsibility, and knowledge. Two of the respondents obtained Ph.D. degrees in mechanical engineering, with a main focus on engine and product development in the automobile industry. Both respondents are involved in research in several international and business projects. The other respondent has more than seven years' experience as a sales and marketing manager, and specializes in engineering, tool chain, and consulting business development. The answers from these respondents provide valuable insights from both academic and industrial perspectives.

4.2 RESULTS

The grey pairwise direct-relation matrix X responded by experts from the companies are shown in Appendix A. After calculations that are conducted by using MATLAB, the total relation matrices *T* for the companies are developed, as shown in Appendix D. Additionally, the calculation results of the prominence and net effect values of barriers are summarized in Table 7. Furthermore, based on the mean values of the three cases, the aggregated results of prominence and net effect of barriers are calculated and shown in last two column of Table 7.

Table 7: SUMMARY OF RESULTS REGARDING THE PROMINENCE AND NET EFFECTS OF BARRIERS

	C 1		**C 2**		**C 3**		**Average**	
	Prominence	**Net Effect**	**Prominence**	**Net Effect**	**Prominence**	**Net Effect**	**Prominence**	**Net Effect**
B1	2.590	0.047	17.246	-0.150	5.247	0.226	8.361	0.041
B2	2.469	1.274	17.462	-0.164	5.244	0.569	8.392	0.559
B3	0.958	-0.212	16.423	-0.724	4.351	-0.316	7.244	-0.417
B4	1.556	0.431	15.448	1.391	4.486	-1.103	7.163	0.240
B5	2.352	-1.071	17.134	-0.038	5.096	-0.956	8.194	-0.688
B6	1.533	-0.017	16.102	2.045	5.584	1.421	7.740	1.150
B7	2.081	0.472	18.839	-1.839	6.125	0.125	9.015	-0.414
B8	2.476	-0.923	13.273	-0.521	6.164	0.032	7.304	-0.471

In order to further recognize the barriers with most impact, Table 8 shows the rank of barriers based on their prominence and net-cause values in three cases and the aggregated result. It is noted that the barriers that have a positive net effect on other factors are identified as net-cause barriers.

Table 8: RANK OF PROMINENCE AND NET-CAUSE BARRIERS

Rank of prominence		**Net-cause barriers**	
C1	B1, B8, B2, B5	**C1**	B2, B7, B4, B1
C2	B7, B2, B1, B5	**C2**	B6, B4
C3	B8, B7, B6, B1	**C3**	B6, B2, B1, B7, B8
Average	B7, B2, B1, B5	**Average**	B6, B2, B4, B1

According to the prominence and net effect values shown in Table 7, barriers can be mapped in grey-DEMATEL prominence-causal graphs. Additionally, in order to visualize the interrelationships among barriers, significant interrelationships among barriers are indicated with arrows in Fig. 6-Fig. 8. Only relationships that have two-way significant relationships are plotted using a red line; all the other one-way relationships are represented using a blue line. The significant interrelationships are selected based on the values that are over the threshold value θ in the total relation matrix T (Appendix D). The threshold value θ in each case is calculated and listed in Appendix E.

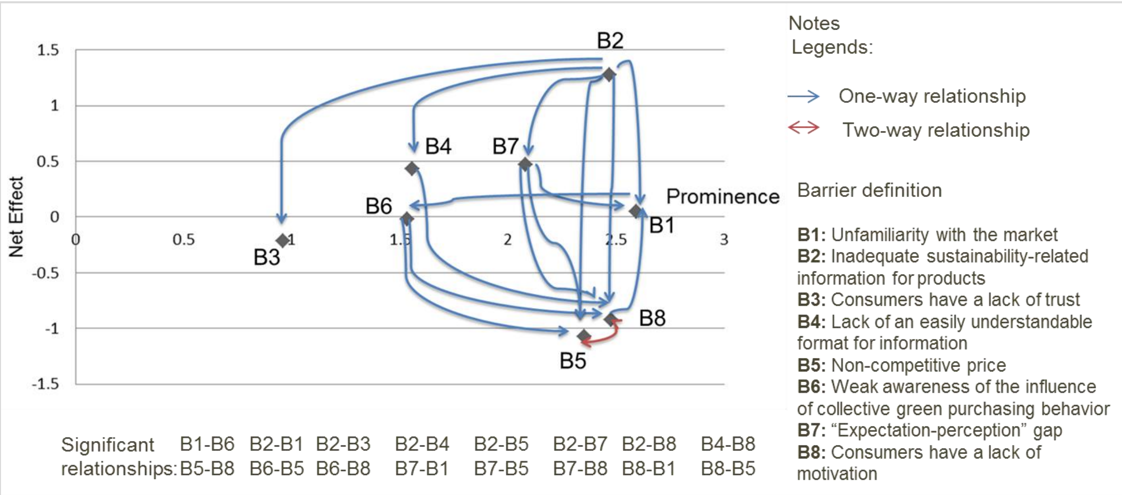

Fig. 6: C1-DEMATEL PROMINENCE-CAUSAL GRAPH

Fig. 6 shows the DEMATEL prominence-causal graph for company 1. Only B5-B8 is two-way significant relationship and all others are one-way relationships.

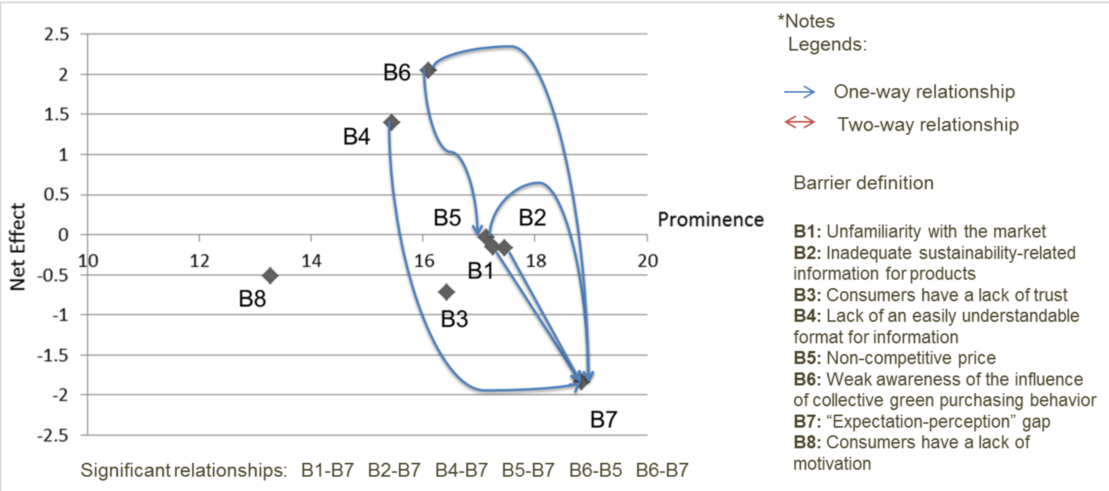

Fig. 7: C2-DEMATEL PROMINENCE-CAUSAL GRAPH

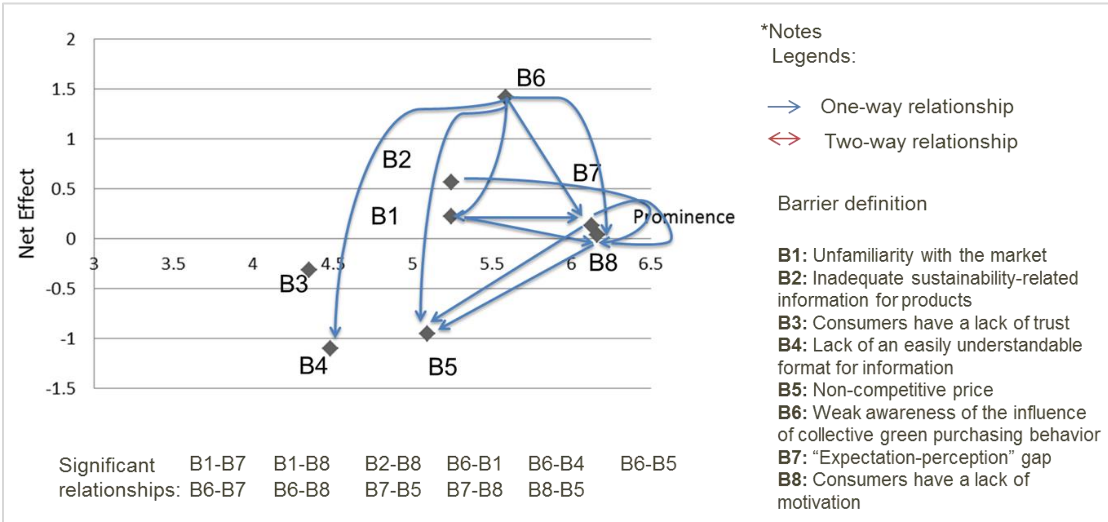

Fig. 8: C3-DEMATEL PROMINENCE-CAUSAL GRAPH

Fig. 7 and Fig. 8 present the DEMATEL prominence-causal graphs for company 2 and company 3, respectively, with only one-way relationships.

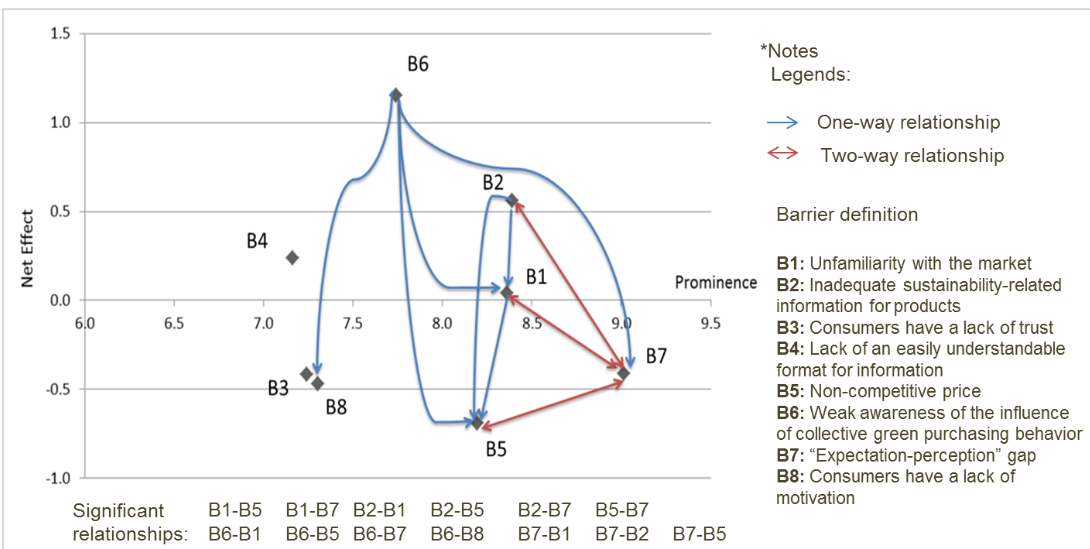

Fig. 9: OVERALL-DEMATEL PROMINENCE-CAUSAL GRAPH

Similarly, Fig. 9 illustrates the DEMATEL prominence-causal graph of aggregated values for the three companies. There are three two-way significant relationships: B1-B7, B2-B7, and B5-B7, while all others are one-way relationships.

4.3 DISCUSSION

From the results presented in the previous section, several barriers are identified as key factors that need to be leveraged to help inform initiatives to facilitate consumer adoption and effective use of products. In this section, the most significant cause factor B2 will be discussed first and it has significant influence on barriers that includes B1, B3, B4, B5, B7 and B8. Meanwhile, B7 is found as the most influential factor and it has the most two-way-relations with the other barriers, B2, B1 and B5. To understand the interrelationships among barriers, B8 is discussed since it is affected by most number of barriers. Among which, B2 and B6 are the barriers that influence B8 dramatically. Then, B6, B1 and B4 are discussed since these factors have relatively higher influence.

First, the results suggest that there is an emerging need for automobile manufacturers to offer adequate sustainability-related information to consumers because this has a very high rank for both the prominence and net effect. As the most significant cause factor, the barrier of "inadequate sustainability-related information for products when purchasing" (B2) shows the highest net effect value (1.274) in case 1, the second highest in case 3 and the second highest in the overall result (shown in Table 7). Meanwhile, B2 significantly influences other barriers of "consumers' lack of motivation" (B8), "non-competitive pricing" (B5), "consumers' unfamiliarity with the market" (B1), "consumers' lack of trust" (B3), and "gaps between customers' expectations and their perceptions" (B7). The result implies that inadequate information on products for customers making purchases is the most prominent barrier that influences and affects other barriers significantly. Its significant influence on other barriers makes offering such information a prerequisite for enabling consumers to purchase environmentally friendly products.

This result is in line with previous studies that suggested that green consumers need knowledge, skills, and information in order to make correct decisions, but information is often confusing. For instance, when automobile consumers are facing a large amount of different information about modules, functions, parameters, and prices, it is often difficult to decide on the correct thing to do (Moisander, 2007). This may either demotivate or serve as an excuse (Moisander, 2007).

Indeed, consumers already have the demands to know more sustainability-related information on products to help them make purchasing decisions because they have moved from satisfying elementary survival needs to representing their lifestyles and other possible meanings through their buying behavior. From a McKinsey survey in 2007, 87% of consumers are concerned about the social and environmental impact of the products they buy (Bonini and Oppenheim, 2008). They demand more information regarding a product's supply chain and production history (Marucheck et al., 2011). By using this information, they tend to mix their green knowledge and attitudes with green brand awareness while choosing green products (Matthes et al., 2014; Zhao et al., 2014). Additionally, recent studies also suggest that, with full transparency for all products, consumers are ready to pay a premium (Owusu and Anifori, 2013; Xu et al., 2012).

However, several studies have discussed that there is still a gap between consumer informational needs and current market offerings (Meise et al., 2014) in terms of a lack of adequate information that allows consumers to obtain reliable information about environmentally and socially-conscious attributes of a product, and make informed purchasing decisions (Meise et al., 2014; Caniato et al., 2012). Therefore, starting by identifying and providing related information to consumers could effectively facilitate consumer adoption and effective use of environmentally friendly automobiles. Companies in the automobile industry are required to originate related sustainability monitoring initiatives, in addition to collaborating with local, regional, national, and public policies, plans, and programs.

Second, the most influential barrier is "gaps between customers' expectations and perceptions" (B7) and it shows the highest prominence value for both the aggregated result and C2, and the second highest for C3. Meanwhile, B7 has the most two-way relations with other barriers: "inadequate sustainability-related information" (B2), "non-competitive pricing" (B5), and "consumers' unfamiliarity with the market" (B1). The result indicates that in order to enable sustainable consumption, the most important task is to dispel the concerns consumers have regarding their expectations and perceptions.

Moreover, an in-depth check of Fig. 6-Fig. 9 shows that B7 is significantly influenced by B2 because the relationship B2-B7 has very high values in matrices *T* for all cases and the aggregated result. This result means that it is more important that manufacturers ensure that they provide adequate environmentally and socially-conscious information for consumers in order to improve their expectations and perceptions of automobile products.

The barrier of “consumers’ lack of motivation” (B8) is affected by the greatest number of barriers, for example, B2, B7, B6, B5, and B4 in case 1, and B6, B2, and B1, in case 3. This topic involves different related research fields that include consumer behavior, social and philosophy studies. The following part will discuss these relationships from these diverse perspectives, and reference the cognitive behavior theories and models to offer a deeper understanding from the theoretical point of view.

“Inadequate sustainability-related information for products (when purchasing)” (B2) and “weak awareness of the influence of collective green purchasing behavior” (B6) are the barriers in common in different cases that influenced B8 dramatically. The result implied that a lack of related information offered for consumers is the main reason that they have a lack of motivation for conducting sustainable consumption. Additionally, another reason lies in the expectation and perception gaps of consumers and a lack of sustainability-related acknowledgment. Just as several researchers argued in the consumer behavior studies that consumers are often assumed to possess a considerable amount of knowledge about complex ecological or ethical issues and their consequences, but indeed, they may not (Grunert et al., 2014; Moisander, 2007).

The topic of transition toward eco-efficient products is also discussed in social and philosophy studies as a social dilemma. It is defined as a collective action situation in which there is a conflict between individual and collective interest (Kollock, 1998). It is a situation in which individuals could do better if they either changed their strategies or changed the rules of the game. Many studies have been concerned with which factors could alleviate the tragedy of the commons, and the most influential theoretical approach is economic game theory, which assumes that individuals are rational actors motivated to maximize their utilities, for example, evolutionary game theory (Gintis, 2000) addresses the subtleties of cooperation among selfish and unrelated individuals. Furthermore, co-evolutionary rules (Zimmermann et al., 2004) may affect the interaction network, reproduction capability of players, their reputation, mobility, or age (Perc and Szolnoki, 2010).

For a deeper understanding on the mechanism of consumer purchasing behavior, cognitive behavior theories and models are widely used (Ozaki and Sevastyanova, 2011). The Theory of Planned Behavior (TPB) states that consumers' beliefs form attitudes toward certain behaviors and lead to their adoption (Ajzen, 1991). Additionally, the theory of Perceived Behavior Control (PBC) incorporates a third variable, "control beliefs", which takes into account the fact that there are constraints in reality and intentions are not necessarily translated into behavior. Corresponding models have been developed to investigate the main factors of control beliefs and motivation, and patterns of consumption. The models usually incorporate a third variable as a facilitating factor for helping to transit the gap between awareness and behavior, for example, the factor "agency" in the Awareness-Agency-Association (AAA) model (Ballard, 2005) and the factor "facilitator" in Attitude-Facilitator-Infrastructure (AFI) framework (Akenji, 2014).

Therefore, from the theoretical perspective, companies need to limit the constraints regarding information transition and provide a facilitator to bridge the gap between consumers' attitudes and behaviors, and help in translating consumers' beliefs and values about sustainability into their demands and purchasing behavior.

Another relatively significant cause factor is the barrier of "weak awareness of the influence of collective green purchasing behavior" (B6), and it shows the highest net effect values in case 2, case 3, and the aggregated result. As shown previously, it also affects a number of other barriers, such as "Consumers' lack of motivation" (B8), "Non-competitive pricing" (B5) and "Gaps between customers' expectations and perceptions" (B7). It could be inferred that companies in the automobile industry should invest more on increasing consumers' knowledge about the influence of collective purchasing behavior. A recent initiative introduced a concept of "willingness to consider a vehicle platform" (WtC) (Struben and Sterman, 2008) and aimed at gaining information and forming emotional attachments when consumers are considering vehicle purchases.

Furthermore, the barrier of "unfamiliarity with the market for environmentally friendly products" (B1) also has a relatively higher influence than other barriers, according to its net effect value in each case. This suggests that unfamiliarity about the market of environmentally friendly products is one of the most obvious barriers in this case. According to previous studies, less familiarity of consumers about environmentally friendly products is mainly attributed to the products' tiny market share (Bonini and Oppenheim, 2008; Röös and Tjärnemo, 2011). This makes them usually hard to find in normal markets. Compared to many other types of products, the market information for low-carbon cars and environmentally friendly automobile design is better accessed by consumers. Most EU governments are developing dense infrastructure networks, in addition to providing financial incentives for consumers in the form of purchase subsidies and tax reliefs (Roland Berger, 2011). However, customers' initial unfamiliarity regarding, for example, the best practices to prolong the battery life of EVs was suggested as a barrier to wider use (Ulk, 2009). Therefore, more efforts need to be emphasized regarding the education of consumers in order for them to gain knowledge from automobile companies, in addition to advertisements about environmentally friendly products and markets.

Additionally, "lack of an easily understandable format for information" (B4) has a positive influence on other barriers, according to its net effect values. Currently, eco-labels are the main approach in marketing to provide sustainability-related information about products. However, such sustainability labels currently do not play a major role in consumers' choices, as shown in findings for the food industry (Grunert et al., 2014). In marketing studies of the automobile industry, utilizing related new technology or properly evaluating the savings from more fuel-efficient vehicles are suggested to be conducted through courses or advanced instrumentation (Kurani, 2007). Therefore, marketing patterns of information provided to the consumer have become one of the key issues in this area. Companies need to find a better approach to present sustainability-related information about their products to consumers in an easily understandable format.

4.4 SUMMARY

This study visualized the prioritization and interrelationships among barriers that exist between environmentally friendly products and their consumers by applying the grey-DEMATEL technique to three cases in the European automobile industry. The views from independent respondents from three companies were explored and their aggregated results provided a slightly broader picture of all three companies. The major contributions of this study include: (1) a clear identification of the barriers consumers are facing regarding environmentally friendly products; and (2) real-world data gathering that explored some of the interrelationships amongst these barriers in the context of the European automobile industry.

The analysis results showed that dispelling the concern consumers have regarding their expectations and perceptions of environmentally friendly products becomes the most important task. To solve this issue, adequate sustainability-related information should be made publicly available by governments or organizations for consumers when purchasing, and it becomes a prerequisite for enabling consumers to purchase environmentally friendly products. How to provide adequate and necessary information still requires further investigation, especially to find a better approach to present above information of products for consumers in an easily understandable format. Education and communication to consumers about the impact of their collective purchasing behavior should be pursued because it could play a very important role in the whole system and would be greatly helpful to automobile manufacturers for addressing other existing barriers.

CHAPTER 5: SYSTEMATIC REVIEW ON SUSTAINABILITY ASSESSMENT APPROACHES

5.1 METHOD OF SYSTEMATIC REVIEW

In this research, a review has been conducted, and several approaches that are being attempted or already implemented to achieve sustainable consumption were analyzed. The study of this chapter did not only focus on the field of industrial engineering but also covered issues ranging from sustainability assessment approaches to sustainable consumption. It focused on the mixing point of research in the areas of production, technology, design and governance, policies, politics, and final consumption. The research range will be discussed in section 5.1.2.

5.1.1 QUESTION FORMULATING

First, in order to have clear criteria for primary study, framed questions must be generated corresponding to the research focus. The research focus of this review was not only limited in approaches of indices development, but also other approaches that have potential to be applied to meet goal of this study. The method used for generating questions was the CIMO acronym, which stands for Context, Intervention, Mechanism, and Outcome and is used for specifying the four critical parts of well-built review questions (Denyer and Tranfield, 2009), as shown in Table 9.

Table 9: LIST OF QUESTIONS IN SYSTEMATIC REVIEW

Component	Questions to ask
Content (C)	What are the available approaches? Which selected approaches could be or already implemented to promote SC?
Intervention (I)	What is the object of each approach when it is designed?
Mechanism (M)	What is the constructing method of each approach?
Outcome (O)	What are the involved dimensions, aspects and attributes?

5.1.2 LOCATING STUDIES

In this study, not only were electronic databases involved, but "grey literature" such as books, websites, conference papers, doctoral theses, and technical reports have been taken into account. The search for literature started from investigation of the citation databases Science Direct and Scopus, and our search method involved a combination of exact phrases and truncation characters. In the domain of SP, exact phrases we used include sustainability assessment, sustainable performance, environmental performance, social performance, and indicator. Additionally, truncation characters such as words associated with environment, sustainability, and assess were considered. In the field of SC, exact phrases included eco-label, environmental label, green marketing, consumer behavior, consumer buying, and decision making, and truncation characters, such as words associated with eco, green, label, marketing, consumer, and buying were taken into account.

Table 10: LIST OF LITERATURES IN SYSTEMATIC REVIEW

Field	Sub-field	Subject	No. of literature
Facilitator			**204(133)**
	Governmental policy		**24**
		ISO standards	10
		Governmental program	14
	Meta-standard schemes.		**8**
	Industrial indicators		**93(22)**
		Sustainable indicators developed by international organizations	25(8)
		Sustainable indicators developed by researchers	47(11)
		Sustainable indicators developed by practitioners	21(3)
	Marketing instruments		**46**
		Eco-labels	32
		Energy Star	12
		Wal-Mart-Sustainable Product Index	2
	Method		**26**
		General	5
		LCA	14
		New methods	7
	Information presenting format		**7**

In order to limit the literature to those that could be used to answer our structured questions, further criteria were applied. First, from the preliminary list of literature, approaches could be mainly categorized into four sub-fields. It includes guidelines & standards approach, meta-standard approaches, marketing focused approach and operation focused approach. Especially in the part of operation focused approaches, numerous indicators developed by researchers and practitioners are collected based on the literature review "An overview of sustainability assessment methodologies" (Singh et al., 2009). This review provided an overview of approaches available and has listed more than 68 indicators that are well-known and applied in the industry. This review seems to be the most comprehensive review that has been done on sustainability assessment approach in academia. In all, 204 works were found relevant in the literature (see Table 10).

5.1.3 CRITERIA OF EXCLUSION AND INCLUSION

In order to select the exact literature that could address the review question, several steps of selection were applied. New methodologies and, specifically, approaches that were developed by researchers and practitioners after 2009 were added to keep the list up to date. Second, a critical mapping tool (Taisch and Shao, 2013) was developed to distinguish the focus area of each indicator. Since the most important factor that has influence on ethical, sustainable consumption is social and environmental effects of technological advance (Harrison et al., 2005), indicators that only consider the economic, social-economic, or environmental-economic performance were excluded. Advisory groups and workshops were employed in the process of refining the critical mapping tool for the sustainability assessment approach. As a result of the literature selection, 22 different kinds of approaches were selected to have further analysis on. Additionally, several literature regarding only method of generating indicator or label are included, such as Sustainability Performance Index (Lundin, 2003). It is because these new literature are attempting to develop a novel method of label for their specific purposes. Although most of them are not in the application presently, they provide extraordinary effort on development of the method of instrument.

5.1.4 ANALYSIS AND SYNTHESIS

5.1.4.1DATA COLLECTION

A comprehensive summary was conducted into constituent parts of each work in the literature and serves to identify associations between these works. It includes the general information (author, time, title, source, publisher), type of study (literature reviews, methods, case studies, policy documents), research domain (standards or EU policies, sustainability assessment methods, consumer awareness and behavior, eco-efficiency, marketing, overall SCP), research questions and main findings, the method or research design, methods of data collection and analysis, and which ways current research could be used to the greatest advantage.

5.1.4.2 MULTI-CRITERIA AND ANALYSIS-SYNTHESIS ON AVAILABLE APPROACHES

In order to transit sustainability information and make energy consumption and environmental impacts visible, a number of indicators have been proposed (Bell and Morse, 2008). In this section, related indicators and eco–labels are reviewed regarding their effectiveness in providing information for consumers. The review of these indicators is based on five consumer–focused criteria, which emphasize meeting consumers' interests. These criteria are determined according to the criteria for developing Household Sustainable Consumption (HSC) indicators (Caeiro et al., 2012).

(a) Integrative domain

The primary content of the assessment should provide information for the target audience, which means meet consumers' preferences. Environmental impact and social impact, such as employee and customer health and safety, should be taken into account. Conversely, the economic impact is not included in the current state of research because market and economy–based indices concern mainly labor, genuine savings and market value, which are not necessarily related to consumers' interests.

(b) Product–based assessment

Only product–level assessment is discussed here, since a product is the interface that consumers are facing and making a purchasing decision upon.

(c) Consumer participation

The participation of consumers, such as considering the views of consumers, should be ensured from the beginning in order to have dynamic interactions (Caeiro et al., 2012; Ramos et al., 2013). Only in this way can the transparency, credibility and robustness of information provision be assured.

(d) Comprehensibility and communication with the target audience–consumers

The target audience, consumers, should be reached and the corresponding preferred language (non–technical) in the indicator system should be used (Caeiro et al., 2012). The approach should support effective communication with stakeholders, non–technical audiences in particular.

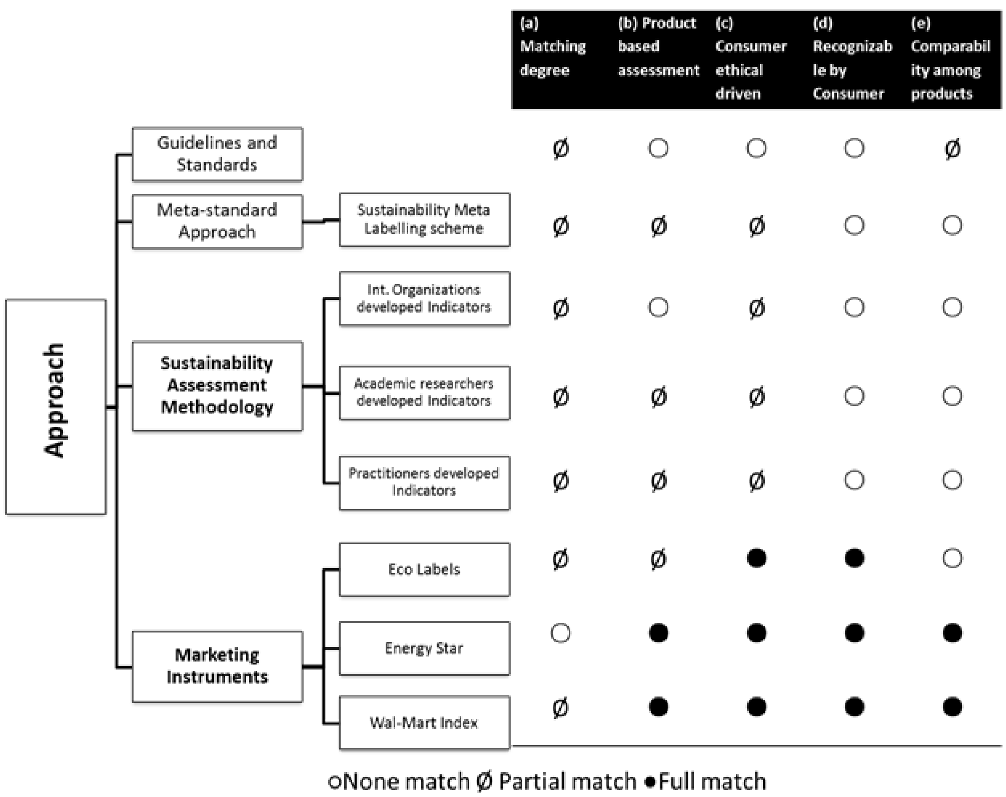

Fig. 10: ANALYSIS ON PROPER TOOLS THAT PROMOTES SUSTAINABLE CONSUMPTION BASED ON MULTI-CRITERIA

(e) Comparability of shared information among the same category of products

Consumers need shared information among the same category of products that provides good comparability in order to make greener buying decisions.

Based on the above five consumer–focused criteria, various types of indicators are categorized and summarized in Fig. 10. The detail will be discussed in the following sections.

5.2 SUSTAINABILITY ASSESSMENT INDICATORS

5.2.1 MATCHING OF SCOPE BETWEEN CHOSEN APPROACH AND CONSUMERS' PREFERENCES

As we discussed above, the indicators that focus on economic performance assessment were excluded. Methodologies generated by different organizations and parties have clear differences in their performance and instruments for sustainability assessment. They are categorized into three types based upon their developers from this phase of the study, which are international organizations, academic researchers, and practitioners (Shao et al., 2014). The collected list of indicators and their reference are shown below in Table 11.

Table 11: LIST OF SUSTAINABILITY ASSESSMENT INDICATORS AND REFERENCES

Name	Abbr.	Reference
Compass of Sustainability	CS	(Atkisson and Hatcher, 2005)
Composite Sustainability Performance Index	CSPI	(Singh et al., 2007)
Consultative Group on Sustainable Development Indicators	CGSDI	(IISD, 2001)
Eco-Efficiency Indices	EEI	(Lehni, 1999)
Eco-Indicator 99	E99	(PR é Consult, 2001)
Ecological Footprint	EF	(Wackernagel, M., Rees, 1996)
Economic Aspects of Welfare	EAW	(Zolotas, 1981)
Environment Performance Index	EPI	(WEF, 2006)
Environmental Press Indicator	EPI'	(EU, 1999)

Environmental Sustainable Index	ESI	(WEF, 1999)
Ford of Europe's Product Sustainability Index	F-PSI	(Fleming, 2007)
G Score	G	(Jung et al., 2001)
Genuine Saving Index	GSI	(Everett and Wilks, 1999)
Human Development Index	HDI	(UNDP, 1990)
Index of Social Progress	ISP	(Estes, 1974)
Index of Sustainable Economic Welfare	ISEW	(Daly and Cobb, 1989)
ITT Flyg Sustainability Index	ITT	(Pohl, 2006)
Life Cycle Index	LInX	(Khan et al., 2004)
Measure of Economic Welfare	MEW	(Nordhaus and Tobin, 1972)
Physical Quality of Life Index	PQLI	(Morris, 1978)
Social-Ecological Indicator	SEIs	(Azar et al., 1996)
Sustainability Performance Index	SPI	(Lundin, 2003)
Sustainable Progress Index	SPI'	(Krotscheck and Narodoslawsky, 1996)
Total Material Requirements	TMR	(EEA, 2001)
Barometer of Sustainability	BS	(Prescott-Allen, 1997)

Analysis on each category of methodologies is shown in Table 12.

Table 12: ANALYSIS ON DIFFERENT CATEGORIES OF SUSTAINABILITY ASSESSMENT INDICATORS

	Developer			**Assessment Scope**			**Product based assessment**
	International org. developed	**Researchers developed**	**Practitioners developed**	**Environmental**	**Social**	**Economic**	
Consultative Group on Sustainable Development Indicators	√			√	√	√	
Eco-Efficiency Indices	√			√		√	
Environment Performance Index	√			√			
Environmental Sustainable Index	√			√			
E 99	√			√			√
Human Development	√				√		

Index							
Total Material Requirements	√			√		√	
Environmental Press Indicator	√			√			
Compass of Sustainability		√		√	√	√	
Composite Sustainability Performance Index		√		√	√	√	
Sustainability Performance Index		√		√	√	√	
Measure of Economic Welfare		√			√	√	
Eco-Indicator 99		√		√			
Ecological Footprint		√		√			
Physical Quality of Life Index		√			√		
Index of Social Progress		√			√		
Life Cycle Index		√		√	√		
Social-Ecological Indicator		√		√	√		
Barometer of Sustainability		√		√	√		
ITT Flyg Sustainability Index			√	√			
G Score			√	√			
Ford of Europe's Product Sustainability Index			√	√	√	√	√

Sustainability indicators developed by international organizations, such as the Environment Performance Index (EPI), Environmental Sustainable Index (ESI), Eco-Indicator 99 (E99), etc., are generated in line with international standards and EU policies. Their sustainability assessments function on the level of a company or an organization. Some of these assessments are applied to scale the environmental performance of a set of companies, even nations. None of them face to consumers, and they have limited potential to be further explored to promote sustainable consumption.

In the category of indicators that were developed by researchers and practitioners, only three indicators were found that focus on the environmental and social performance impact of products. In these, the barometer of sustainability evaluates both the environmental and social components of sustainable development (Prescott-Allen, R., 1995). This barometer consists of two components: ecosystem well-being and human well-being. Both components have to be improved for achieving sustainable development. Social-Ecological Indicators (SEIs) developed with respect to four principles of sustainability, which deal with the societal use of lithospheric material, emissions of compounds produced in society, societal manipulation of nature and the long-term productivity of ecosystems, and the efficiency of internal societal resource use (Azar et al., 1996). LInX is comprised of four important sub-indexes, and they are environment, health and safety (EHS) cost, technical feasibility, and socio-political factors (Khan et al., 2004). The attributes domain refers to environmental and social impacts of a process or product in its manufacturing phase. These three indicators are the most relevant in the literature related to our study purpose, but they also have the purpose of aiding the selection and design of processes or products.

5.2.2 PRODUCT BASED ASSESSMENT

The object of a consumer's buying decision is a product. The indicator whose assessment unit is an organization or company, or even a nation, could hardly be able to apply to consumers. Throughout the reviewed literature, indicators have been categorized regarding their assessment unit, whether that is a product, an organization, a process, or a country. We found that few of the indexes focus on a type of a specific product for which overall sustainability is assessed holistically. Only Ford of Europe's Product Sustainability Index (Ford's PSI) and Eco-Indicator 99 (E99) launch assessment based on a unit of a product. Ford's PSI evaluates eight product attributes identified as key sustainability elements of a vehicle. E99 is a single score that shows the environmental load of a product.

Ford's PSI evaluates all three dimensions of sustainability and is based on product level. Of course, this indicator design is only applicable for a specific type of product: automobiles. Further research could extend the evaluation focus from vihicles to general products. Additionally, since the present indicators and assessment approaches are based on lists of technical terms and complex calculation formulas, it has been discussed widely in academic circles that limited transition could be provided from the industrial sector to consumers (Caeiro et al., 2012).

In summary of the analysis results of these two requirements, indicators that were developed by international organizations are not facing to consumers and have limited possibility to be further explored to promote sustainable consumption. We found academic researchers developed three indicators that focus on environmental and social performance impact, but their assessment unit is not a product.

5.2.3 INVOLVEMENT OF CONSUMERS

Present sustainable consumption is promoted mainly by three enablers: governmental policies, profit, and consumer ethical consumption. Companies predominantly consider governmental policies or profit gained from applying greener technologies. Rarely do measures originate by considering making use of consumer ethical consumption. Analysis on promoting enablers of sustainable consumption is shown in Fig. 11.

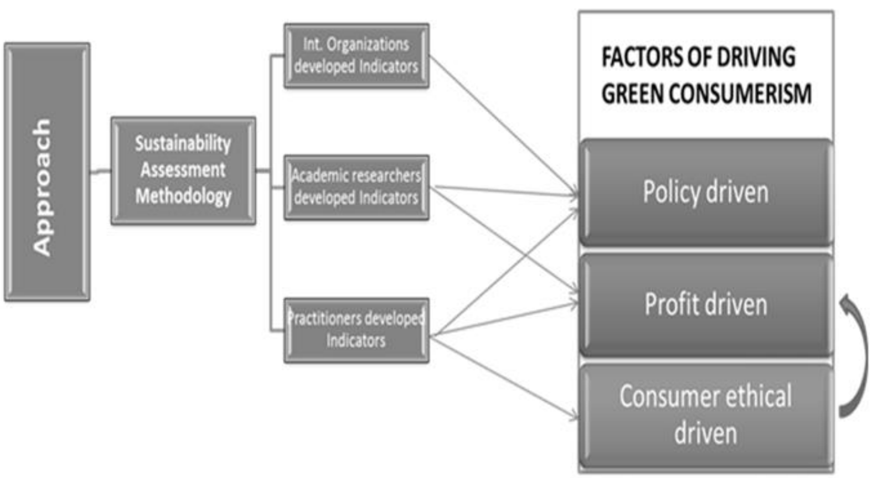

Fig. 11: DEVELOPING DRIVERS OF SUSTAINABILITY ASSESSMENT METHOD

(1) Governmental policies

Governmental management of environmental protection is represented in various ways through schemes, standards, policies, and local effort on management. Besides international guidelines and standards that we will discuss in section 5.3, numerous indicators are generated correspondingly. Nonetheless, the impact that government-involved approaches have in promoting sustainable consumption are limited. Also, these approaches are not directly facing to consumers. They are mainly addressing green technology for efficient production and operation processes by evaluating their environmental performance, especially from the perspective of controlling carbon emissions. These approaches include indicators that have been developed by international organizations, worldwide carbon offset, and the carbon trading market.

i. Numbers of indicators or approaches are oriented in terms of evaluating sustainable level or environmental performance of a company/ an organization/a nation. They are applied for further developing into governmental management tools or policies. For instance, Environment Performance Index (EPI) focuses on a set of companies or nations and offers a method of evaluating and numerically scaling the environmental performance of them. Environmental Sustainable Index (ESI) made cross-country comparisons possible and helps to warn the member countries about potential problems (WEFORUM, 2014). Additionally, Ecological Footprint (EF) provides a comprehensive view from a single product to address "to what extent a nation uses more (or less) than is available within its territory" (Wacker, 1998).

ii. Carbon offset is developed to "reduce emissions of carbon dioxide, or greenhouse gasses made in order to compensate for or to offset an emission made elsewhere" (Impact-globale-mission-solutions, 2014). Offsets have been seemed as an important policy tool to maintain stable economies. But the problem caused by unequal prices of carbon can result into economic collateral damage in some places.

iii. Carbon trading market was designed based on the idea that, companies need to pay for the extra emission or buy for offset, unless the emitters decrease the amount of emission to the certain given goal (Jeswiet and Kara, 2008). This market is being promoted as a mean for big emitters of greenhouse gas to meet the requirements from government.

(2) Profit

Companies are busy in meeting the requirements of government and getting certification of international standards, but lack of voluntary of conducting cleaner production techniques. Most of the reasons belong to lack of monetary benefits in the short term or long term. After Eco-labeling and Eco-efficiency have been introduced, businesses started to change their thinking toward these kinds of profit-oriented methodologies. Eco-efficient production standards and process certifications are summarized as one of the most visible approaches for promoting sustainable consumption (Akenji, 2014).

The definition of Eco-efficiency was developed in recent years, and it is the first time to show there is a link established between environmental improvements and economic benefits (WBCSD, 2000). Organization for Economic Cooperation and Development (OECD) report highlighted that Eco-efficiency can exist in an advanced management model that "encourages the companies to improve their competitiveness, innovation capacity and responsibility towards the environment" (OECD, 1997). After decades, Eco-efficiency became adopted by numerous companies by using as an integral culture element in companies policy or mission statement. It is a useful tool to monitor and report performance of the company and for helping the firms' communication with its stakeholders.

Economic-ecological efficiency is the ratio between the change in value and change in environmental impact added. Economic-ecological efficiency is often referred to as Eco-efficiency. The difference between Ecological-efficiency and Eco-efficiency is that, Ecological-efficiency considers output while Eco-efficiency regards monetary value added. It requires financial information that provided by finance staffs about the numbers in Eco-efficiency calculations, rather physical information is provided by natural scientists (Burritt and Saka, 2006). From this definition, Eco-efficiency is in the overlap area of ecologic and economic elements. It was integrated by two elements out of three of sustainability pillars.

Numbers of companies adopt Eco-efficiency based on the role of business that is to satisfy human needs, and at the same time, it expected to be rewarded with profits for doing so. Moreover, responsible business uses Eco-efficiency as a tool to improve the quality of life which means to become more sustainable.

Indicators of eco-efficiency assessment still have not considered consumers' interests, and they are originally designed from the perspective of companies. So barriers exist to apply these measures for consumers directly. Indicators in measuring of Eco-efficiency are useful for presenting information to consumers, but with further developed into a simpler format to be understood.

(3) Consumer ethical consumption

Except approaches relate to tax and subsidies that are the most common ways to enable the ethical purchasing behavior, business, academic researchers and policy makers began to put their attention on developing innovative methods that are originated by consumer ethical consumption. Nevertheless, it is still in the discussion phase and rare examples could be found properly.

An example is F-PSI that was developed as a sustainability management tool in Ford. It can be easily used by vehicle development engineers and their management. Although one of prepositions of F-PSI addressed that "consumer are not ready to compromise price or performance for green", it still has big potential to become a consumer ethical oriented method in many ways, such as its designing principles and methodologies.

Therefore, presently, consumer ethical driven approaches are remaining highly related to monetary benefits that bring to consumers or business.

5.2.4 DEGREE OF RECOGNITION BY CONSUMERS AND COMPARABILITY AMONG THE SAME TYPE OF PRODUCTS

Currently, eco-labeling is the primary approach in marketing to provide consumers with the sustainability information of products. Environmental impact is commonly assessed by following the LCA method when an assessment unit is a function of the unit of a product, such as 1kg of the final product. Environmental impact has been grouped into several categories, such as environmental change, primary energy consumption, acidification, aquatic eutrophication, formation of trophospheric ozone, etc. Some studies have more impact categories, including global warming potential, photochemical smog, and human toxicity (Djekic et al., 2014). Their common presenting patterns are shown in Fig. 12, Fig. 13 (González-García et al., 2013), and Fig. 15 (Djekic et al., 2014).

Environmental results associated to the production of 1 kg of San Simon cheese (base scenario). Impact category acronyms: ADP = Abiotic Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, GWP = Global Warming Potential, ODP = Ozone Layer Depletion Potential, POFP = Photo-Oxidants Formation Potential and CED = Cumulative Energy Demand.

Impact category	Unit	Dairy farm	Dairy factory	WWTP	Total
ADP	kg Sb_{eq}	0.019	0.010	0.001	0.030
AP	kg SO_{2eq}	0.091	0.010	0.002	0.103
EP	kg PO_{4eq}^{3-}	0.057	0.002	0.006	0.064
GWP	kg CO_{2eq}	8.52	1.62	0.30	10.44
ODP	kg CFC-11_{eq}	$3.14 \cdot 10^{-7}$	$1.34 \cdot 10^{-7}$	$2.07 \cdot 10^{-8}$	$4.69 \cdot 10^{-7}$
POFP	kg C_2H_{4eq}	$1.50 \cdot 10^{-3}$	$4.79 \cdot 10^{-4}$	$2.66 \cdot 10^{-5}$	$2.01 \cdot 10^{-3}$
CED	MJ_{eq}	45.29	23.88	2.81	71.98

Fig. 12: ENVIRONMENTAL RESULTS ASSOCIATED TO THE PRODUCTION OF 1 KG OF SAN SIMON CHEESE

SOURCE: (GONZÁLEZ-GARCÍA ET AL., 2013)

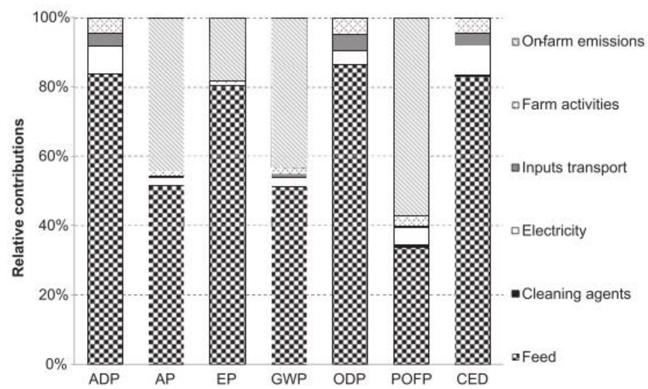

Fig. 5. Results (in %) for each impact category and activity involved in the dairy farm (Subsystem 1). Impact category acronyms: ADP = Abiotic Depletion Potential, AP = Acidification Potential, EP = Eutrophication Potential, GWP = Global Warming Potential, ODP = Ozone Layer Depletion Potential, POFP = Photo-Oxidants Formation Potential and CED = Cumulative Energy Demand.

Fig. 13: RESULTS (IN %) FOR EACH IMPACT CATEGORY AND ACTIVITY INVOLVED IN THE DAIRY FARM

SOURCE: (GONZÁLEZ-GARCÍA ET AL., 2013)

Furthermore, the relative contribution of the impact category in each phase has been shown in Fig. 13. In this case, the contributions are displayed in relative percentage from different processes or steps. This format helps people to identify the main environmental hotspots in the entire process, and then conduct measures to improve the process's environmental performance. However, the relative contribution of the impact category in each phase, such as manufacturing, does not help consumers to make a comparison between environmental performances of similar products, and thereby make a greener buying decision. The information that consumers need is a fast and clear comparison between two or more products regarding their environmental and social performance in its production phase, or even its overall life-cycle.

Environmental impact assessment results associated with the production of 1 kg of various dairy products from seven dairy plants.

Impact category	Unit	Pasteurized milk	UHT milk	Yoghurt	Cream	Butter	Cheese
Global warming potential	kg CO_2 eq	1.25–1.67	1.24–1.38	1.42–2.63	3.52–4.53	20.69–21.30	6.73–9.47
Acidification potential	kg SO_2eq	0.0139–0.0156	0.0137–0.0141	0.0144–0.0195	0.0434–0.0574	0.2636–0.2658	0.0696–0.0894
Eutrophication potential	kg PO_4eq	0.0064–0.0066	0.0064–0.0065	0.0065–0.0070	0.0203–0.0270	0.1245–0.1248	0.0324–0.0413
Ozone layer depletion potential	kg R11	$1.01 \cdot 10^{-5}$	$1.01 \cdot 10^{-5}$	$1.01 \cdot 10^{-5}$	$(3.24–4.32) \cdot 10^{-5}$	$2.0 \cdot 10^{-4}$	$(5.0–6.56) \cdot 10^{-5}$
Photochemical smog potential	kg C_2H_4	$(3.47–4.86) \cdot 10^{-4}$	$(3.21–3.49) \cdot 10^{-4}$	$(3.81–6.92) \cdot 10^{-4}$	$(1.01–1.31) \cdot 10^{-3}$	$(5.89–6.02) \cdot 10^{-3}$	$(1.66–2.12) \cdot 10^{-3}$
Human toxicity potential	kg DCB	0.0092–0.0325	0.0067–0.0123	0.0164–0.0847	0.1491–0.1643	0.0267–0.0572	0.0449–0.1581

Fig. 14: ENVIRONMENTAL IMPACT ASSESSMENT RESULTS (ASSOCIATED WITH THE PRODUCTION OF 1 KG OF VARIOUS DAIRY PRODUCTS FROM SEVEN DAIRY PLANTS).

SOURCE: (DJEKIC ET AL., 2014)

In Fig. 14, environmental impact assessment results associated with 1kg of six types of dairy products following six impact categories are shown. Difficulties still exist when consumers try to compare the digital information in each category.

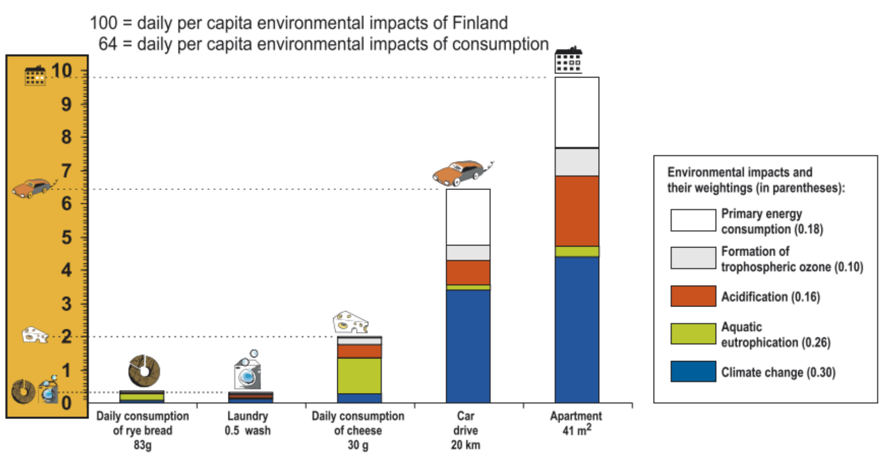

Fig. 15: THE ELEMENTS OF THE BENCHMARKING: THE RULER, THE SCALE, AND THE BENCHMARK PRODUCTS

SOURCE: (NISSINEN ET AL., 2007)

A benchmark of a product was developed by Nissinen, as shown in Fig. 15 (Nissinen et al., 2007). The benchmark makes a comparison of different types of products according to the percentage of daily, per capita impact they have in Finland. In the future, such bar charts could provide a possible way for consumers to understand the different environmental performance of different products.

5.3 MARKETING INSTRUMENTS

Some instruments applied in the market provide a way to deliver sustainability information to consumers. The following section analyzes whether these marketing instruments could properly satisfy consumers' needs.

5.3.1 ECO-LABELING

Besides industrially applied instruments, some methods are introduced as commercial tools applied widely in marketing. Through eco-labels, consumers could get more information on the environmental performance of a product when they are buying it. Eco-labeling has raised a wide debate about whether providing consumers with better information about the green properties of products will influence their buying decisions. Similar assumptions have been proposed in many studies (Amacher et al., 2004; Bleda and Valente, 2009; Luskin and Del Matto, 2007; Rex and Baumann, 2007). On the other hand, "customer request and preference" was the most important factor that influenced companies to take climate change into consideration in 2013 (Kiron et al., 2013).

Now, eco-labeling is one of the promising market-based approaches for improving the environmental performance of products through consumer choice (Banerjee and Solomon, 2003; Amacher et al., 2004). The most successful eco-labels currently include Nordic Swan, EU Flower, Environmental Choice (Canada), Eco-Mark (Japan), and Green Seal (USA). Because eco-labels are authenticated and monitored by third-parties, they seem to be one of the most promising forms of environmental information for consumers. More importantly, EU eco-labeling has significantly contributed to changing consumption and production patterns. But as ECO-LABEL-INDEX (Ecolabelindex, 2014) recorded, 458 eco-labels in 197 countries and 25 industry sectors have been tracked through 2014, and the traced number of labels is increasing. Problems that occurred after eco-labels emerged in the last decade were analyzed in (Shao et al., 2014) and include the following:

a) Numerous and miscellaneous labels

b) Specific application area

c) Polarity as well as repeated or incomplete information provided

d) Very weak comparability among similar products

As discussed above, companies have many reasons to choose eco-labeling, but the most important motivation is that such labeling "can always be translated into traditional business criteria, and aimed at short-term and long-term profits" (Boer and Amsterdam, 2003).

Therefore, as the most widespread marketing tool presently used in this field, eco-labeling is serving consumers with sufficient information from various perspectives and in a number of ways. Because of their diversity, the most apparent weakness of eco-labels is their weak comparability among similar products. At the same time, because the system remains profits-based, eco-labeling is not as consumer-ethics driven as it may seem.

5.3.2 ENERGY STAR

Energy Star provides consumers an overview about the energy consumption of the product in its use phase. Furthermore, Energy Star ratings are designed to make consumers aware of the relative energy-efficiency of appliances in the use phase. It was a voluntary energy efficiency-labeling program launched in the US. In 1992, the EU Directive on Energy Labeling of Household Appliances ("Labeling Directive") required retail stores to provide household appliances with energy labels at the point of sale. And now, Energy Star has become a leading international brand for labeling energy- efficient products (Sanchez et al., 2008). Consumer awareness of Energy Star labeling has grown significantly to more than 75% of the population in 2008 according to a report from the Environmental Protection Agency of the US (Sanchez et al., 2008). And the presence of an Energy Star rating causes consumers to shift from non-Energy Star appliances to Energy Star appliances when they are making decisions about what products to buy.

As discussed, Energy Star labeling has only considered the index that is based on the annual energy consumption in the usage state after purchase, but it lacks information about the energy consumption in the process of manufacturing and transportation. Similar to Energy Star, a “GHG” label (Green House Gas) on a product helps enable customers to make their decisions based on carbon emission during process of using a product (Jeswiet and Kara, 2008). Obviously, these forms of limited information about resource consumption and carbon emission are insufficient.

In summary, Energy Star and “GHG” labels face consumers and provide them recognizable information with good comparability. The weakness of this kind of labeling is that it is too limited in the information and assessments being provided. Their focus scope is limited and a future model would need to be broadened to better match consumers’ interests.

5.3.3 WAL-MART-SUSTAINABLE PRODUCT INDEX

Recently, through an awareness of the growing consumer demand for environmentally responsible products, Walmart created its sustainable product index program, which was started in 2009 and continues till now (Reuben, 2012). Approaches such as the recently designed Walmart sustainability index attempt to promote consumer ethical consumption. This index will rank products on multiple measures of environmental impact and offer customers a better way of attaining information that could help them make better buying choices. The index is expected to be posted as a single number or symbol next to the item’s price tag. This project is presently in the middle phase of “Creation of a Lifecycle Analysis Database” that is quite difficult to accomplish in a short time since little information is available. Walmart’s sustainable product index fulfilled almost every requirement mentioned above. Nonetheless, this index only requires suppliers to provide an examination of their supply chains, and the assessment of information as well as the management of all the suppliers are challenging to Walmart. No information regarding the production processes are included, and the attention to green manufacturing levels are lost.

In summary, marketing instruments, such as eco-labels, all face to consumers in order to show sustainability properties of products from various perspectives. They are labels signaled on the product and are easy to notice, which is one of the strongest reasons that eco-labels have become successful in the last few years. But too many kinds of eco-labels confuse consumers and make it difficult to draw comparisons between the same types of products.

5.4 NATIONAL OR INTERNATIONAL GUIDELINES AND STANDARDS

Tools and approaches for pursuing and managing industrial sustainable practices have been emerging in the last several years. Each of them has various characteristics and different modes of application. Several lists of appropriate indicators or key determinants for promoting sustainable consumption have been selected (CSD, 2001a; EEA, 2011; OECD, 1999). Unfortunately, the lists are still originated from techniques for controlling and auditing, which are not proper for applying to consumers. Among all available standards, the most representative international adopted standards are ISO 14000 and Life-cycle assessment (LCA).

5.4.1 ISO STANDARD

ISO 14000 series provide a relatively flexible way for firms to develop their environmental management systems (EMS) which is appropriate to their situations. Some standards in the ISO 14000 series which related to environmental performance provided guidelines from various perspectives and listed in Table 13.

Table 13: LIST OF ISO STANDARDS THAT RELATED TO ENVIRONMENTAL PERFORMANCE ASSESSMENT

ISO 14000	**ISO 14001**	Environmental Management Systems (EMS)
	ISO 14010	Environmental Auditing (EA)
	ISO 14020	Environmental Labelling (EL)
	ISO 14031	Environmental Performance Evaluations (EPE)
	ISO 14040	Life- ISO14040. Principles and framework; 1997.

	Cycle Assessment (LCA)	ISO14041. Goal and scope definition and inventory analysis; 1998.
		ISO14042. Life cycle impact assessment; 2000.
		ISO14043. Life cycle interpretation; 2000.
ISO 14060	Product Standards	

Theoretically, ISO 14001 could be seemed as a comprehensive framework for significantly improving performance in a firm with minimal environmental management. Or to say, as a set of common sense guidelines for enhancing performance in a firm with regulatory compliant practices (Rondinelli and Vastag, 2000). Many companies have certified or in the progress in certifying their environmental management system underlines the ISO 14001 or European Eco-Management and Audit Scheme (EMAS). Unfortunately, some firms may, indeed, simply use ISO 14001 as a ‘label’ for image-building and have not completely alleviated all the potential negative environmental impact manufacturing plant have, as in Mt Holly case conducted by Rondinelli, D (Rondinelli and Vastag, 2000).

5.4.2 LCA

LCA (Life-cycle Assessment) so-called “from-cradle-to-grave” technique, is an environmental management tool in the product development process and is applied to assess environmental impact associated in the whole life of product (ISO14040, 2006). It is a standardized method and has been endorsed by many international organizations. The concept of life-cycle management was suggested as the way a company organizes itself in response to environmental life-cycle thinking. Life cycle thinking integrates effectively into existing business routines and is argued to be the most critical step for more sustainable business models (Junnila, 2008; Löfgren and Tillman, 2011). LCA models have been implemented to waste management and waste water systems, chemical production, agricultural pesticide emissions and cement production (Junnila, 2008; Löfgren and Tillman, 2011; Moeller et al., 2009; Nissinen et al., 2007). And there are still increasing calls to use LCA in business and policy makers.

The whole LCA usually consists of four stages in which phases of life cycle impact assessment (LCIA) is the most important one and launched by following three steps:

selection of impact categories, classification characterization, normalization and weighting. The environmental impacts and the "caused" by the act of consuming per functional unit could be fully addressed through LCIA.

It is concerned that LCA has the potential to reveal the 'world behind the product' and empower consumers to make more responsible decisions based on environmental performance of a product. However, LCA provides intensive data with technical terms, such as long lists of environmental pollutants (Finnveden et al., 2009). This highly inaccessible data could not provide a quick overview of most important issues to consumers who make decisions every day (Nissinen et al., 2007). So the key priority in academia should be to develop information accessible, and further to evaluate the usability of the information. Another important focus should be put on the usability of the information: how well it works in the context of different decision-making situations (Leire and Thidell, 2005).

Benchmark method is a common method in LCA community. Avoiding the long list of technique terms, "eco-benchmark" is an LCA-based information communication tool for consumers (Nissinen et al., 2007). A project launched by OECD (Organisation for Economic Co-operation and Development) from 2009 to develop a toolkit that aims to help business benchmark performance and improve their production processes and products (OECD, 2009).

Benchmarking tools are useful for presenting information but not always applicable. It based on the expectation that the results would be easier to understand. For example, the information could link to a familiar frame of reference, and compared to an everyday object. Benchmark Value could be defined as a targeted value of the indicator. An example would be that the limit of the quantity of CO_2 in kg emitted by a factory in a year is chosen by the factory management to limit the CO_2 emission from the factory. Benchmarking tools should be carefully considered from the perspective of format of information, and it is promising to be further developed to be full filled the requirements.

5.5 META-STANDARD APPROACH

The meta-standard approach started from the motivation that many conflicts exist in legitimacy constructions, and as a result, a scheme was developed that condenses existing product-labels and other communication measures into a sustainability message. This message aims to enable consumers to align purchase decisions with sustainable development goals (Dendler, 2014; Kaphengst et al., 2009). Sustainability meta-labels highlight the most sustainable products based on a summary of existing labeling schemes (Dendler, 2014).

Furthermore, over the last years, several initiatives have emerged that address part of sustainability meta-label. Some examples include the "Internationally coordinated eco-labeling system" (GEN, 2014), a novel approach into a "Global Standard-Setting Scheme for Natural Resources" (Schlegel et al., 2008), NGO "People4Earth" (People4Earth, 2014), and the Sustainability Consortium (Sustainabilityconsortium, 2014).

These meta-standard approaches are still in the proposal stage, but they have the potential to be applied for consumers. Arguably, the mere existence of product labeling schemes in general and such meta-initiatives in particular do not guarantee that individuals and organizations will, in fact, align with these schemes (Dendler, 2014).

5.6 DISCUSSION AND SUMMARY

This section of study involved a broad range of available approaches comprised of guidelines and standards, meta-standard labeling schemes, sustainability assessment methodologies, and marketing instruments. From the analysis of the review, current approaches rarely focus on one product that the consumers are facing. And very few approaches include sustainability-related information related to the production and supply chain of the product, while consumers are generating higher demand for this information. Clear environmental- and social-conscious information need to be fully clarified after adjusting the focus scope and assessment methods of present approaches.

Additionally, the information presentation pattern for consumers is one of the most important factors for influencing the result of the transition. Besides benchmarking that could be a possible way of presenting information, developing a better and simpler presenting method is necessary. As discussed above, further research needs to take place on how to decrease the confusion brought from present eco-labels and how to avoid scattered sustainability-related information. Also, how this information could provide a clear purchasing guide for consumers and then translate to their buying habits needs to be further discussed.

The indicators developed by companies, such as ITT Flygt Sustainability Indicator (ITT) (Pohl, 2006) and G–Score (Jung et al., 2001), consider environmental impact only. Ford of Europe's Product Sustainability Index (F–PSI) considers all three pillars of impact at product level (Fleming, 2007). However, the scope of its application is limited since it was developed specifically for automobile production for Ford.

Some indicators were generated in line with international standards and EU policies, for example, Total Material Requirements (TMR) (EEA, 2001), Environment Performance Index (EPI), Environmental Sustainable Index (ESI) (WEF, 2002), etc.. However, their sustainability assessment functions are not at product level. For instance, EPI was developed to scale environmental performance at the level of a set of companies or nations (Henri and Journeault, 2008). Differing from the above indicators, the Eco–Indicator 99 (E99) showed the environmental load on the basis of product level (PRé Consult, 2001), but it was not consumer–oriented. Most of the indicators seldom take stakeholder/consumer involvement into account. Such indicators are scarcely adapted for promoting sustainable consumption.

In addition to indicators, eco–labeling is also commonly used to offer sustainability–related information in the marketing field. Concerned with consumer choice, eco–labeling is seen as a promising market–based approach for improving the environmental performance of products (Banerjee and Solomon, 2003; Amacher et al., 2004). As successful cases in the EU and United States markets, Energy Star Label provides clear and comparable energy consumption information for consumers (Sanchez et al., 2008). However, only the annual energy consumption in the usage state after buying is considered, not the energy consumption and environmental impact during the process of manufacturing. Eco-labels are recorded by Eco label Index, and the number of eco–labels increase to 458 at the end of 2014 (Ecolabelindex, 2014). However, it has also been widely criticized because some of the products marked with eco–labels may be exaggerated or contain misleading claims, such as their polarity, incomplete information or specific application area, resulting in consumers being confused with eco–labels on products due to inconsistent evaluation systems.

In summary, most indicators are less effective for supporting communication with consumers due to their underestimation of consumer information needs.

This part of study is an important fundamental study in the research domain of SCP and provides added-value that benefits both academic researchers and decision-makers. It scanned various available approaches and explored the extent to which these sustainability assessment approaches could meet the requirements of promoting sustainable consumption. The study suggests that necessary attributes could be extracted from current assessment methodologies, after which the full involvement and empowerment of public stakeholders, especially consumers, should be considered. This study suggests that the focus scope and assessment methods of the present approaches need to be modified to meet stakeholders' needs. Furthermore, information presentation patterns need to be improved in order to better enable consumers to align purchase decisions with sustainable development goals.

CHAPTER 6: DEVELOPMENT OF LIST OF NECESSARY ATTRIBUTES

(The content of this chapter has been published in Journal of Cleaner Production)

This chapter aims to propose a complete set of product-level sustainability attributes. Since the indicators are comprised of various dimensions and attributes, sufficient and effective information attributes that meet consumers' interests must be extracted from most relevant indicators. The proposed set of attributes should capture key factors for success transferring from consumers' motivation and behavior, and plays the role of facilitator in AFI framework. The following paragraphs will describe the selection process of most relevant indicators and development process of proposed set of attributes.

First, the most relevant indicators will be selected based on five consumer–focused criteria as the foundation of list development. Then, appropriate attributes are extracted according to their assessment content and mapped in a novel metric. To meet consumer's information preferences, the attributes that are in the dimensions of social and environmental impacts are integrated into the proposed set of attributes.

6.1 SELECTION AND COMPARISON OF MOST RELEVANT INDICATORS

Based on the review of indicators regarding their effectiveness in providing information for consumers in the previous chapter, six publicly available indicators are selected as a foundation to extract information attributes from. It includes CS, CSPI, F–PSI, EPI, G–Score and E99. The assessment dimensions of these indicators are shown in Table 14 and

Table **15** in details and summarized briefly in Table 16. The related definitions of dimensions and attributes can be seen in the literature (CSD, 2001b).

Table 14: ATTRIBUTES COMPARISON OF INDEX, PART 1- LIFE CYCLE

Dimension	Aspects	Attributes	F-PSI	G-score	E99	Other
Production (Production	Input/Types and weight of materials	Raw material		√		
		Energy consumption,		√		

of raw material, processing and manufacturing of these materials)	used in the product	electricity, gas, oil				
	Process/operation/Identify processes involved in manufacturing to process these materials	Product design change		√		
		Process improvement		√		
		Package/transportation change		√		
		Employee training/participation		√		
		Reuse/recycling of resource (energy, material, product)		√		
		Installation of new equipment/adoption of new technology		√		
		Green supplier management		√		
		Raw Material Extraction	√			
		Material Production	√			
		Material Processing	√			
		Paint and Assembly Process				√
		Energy Process	√			
		Waste Management	√			
	Transportation involved in handling the materials for production				√	
	Outcome from production	Avoided costs/benefits of pollution prevention measures		√		
		Information on environmental liability		√		
		Fines and penalties		√		
		Environmental capital/operation expenditures		√		

		Contribution to local community: education program, foresting		√	
		Complaints, lawsuit		√	
		The press, environmental related reports		√	
Use (Transportation, energy and consumables during the life span of a product)	Transportation involved in delivering the product				√
	Energy consumption throughout the product lifespan	Fuel Production and Consumption	√		
		Maintenance Material Production	√		
		Other Maintenance Processes	√		
		Vehicle Taxation and insurance	√		
		Energy Process	√		
		Waste Management	√		
End-of-Life (Disposal and recycling)	Disposal process of the product	Recovery/Recycling Processes	√		
		Disposal Process	√		
		Energy Process	√		
		Supplementary Materials	√		
		Residual value	√		
		Shredding	√		
		Dismantling	√		
	Transportation involved in handling the materials for disposal				√

Source: self-elaborate

Table 15: ATTRIBUTES COMPARISON OF INDEX, PART 2- THREE SUSTAINABILITY PILLARS

Dimension	**Aspects**	**Attributes**	**F-PSI**	**G score**	**EPI**	**Other**
Social	Private-sector responsiveness	Suppliers & contractors practices				√
		Child , forced labor & human rights issues			√	
		Customer health & safety				√
	Environmental health	Reducing environment-related natural disaster vulnerability		√	√	
	Science and technology					√
	Participation in international collaborative					√
	Mobility Capability		√			
	Adequate Sanitation				√	
	Working place Safety		√	√		
	Local community			√		
	Lawsuit			√		
Nature/ Environment	Sustainable Energy	Energy Efficiency			√	
		Renewable Energy			√	
		CO2 per GDP			√	
	Eco-efficiency				√	
	Reducing air pollution	Life cycle global warming	√			
		Greenhouse gas emissions				√
	Air Quality	Indoor Air pollution		√	√	
		Regional Ozone			√	
		Nitrogen Loading			√	
		Life cycle Air Quality		√		
	Water	Water quality/Drinking Water		√	√	

	Water Consumption		√	√	
	Reducing water stress		√		
Biodiversity and Habitat/ Natural resource management	Wilderness Protection			√	
	Eco-region Protection			√	
	Timber Harvest Rate			√	
	Agricultural Subsidies			√	
	Overfishing			√	
	Urban Particulates			√	
Land			√		
Reducing ecosystem stress	Reducing trans boundary environmental pressures				√
Reducing waste and consumption pressures	Percent utilization of total solid wastes		√		
	Specific energy consumption				√
	Specific Raw material consumption				√
	Percentage green cover of total plant area				√
Sustainable Material					√
Noise	Average noise level in the periphery of plant dB(A)		√		
	Noise- in -use	√	√		

Source: self-elaborate

In selected six indicators, two main types of indicator generation methods can be observed from Table 16. Type 1 indicators generate results in line with the three pillars of sustainability (WCED, 1987), which assess the impact of the social, environmental and economic performance. Some indicators add extra dimensions, such as “well–being” (e.g., CS), “technical aspects” and “organizational governance” (e.g., CSPI), to provide a complementary list of assessment measures.

Table 16: COMPARISON OF DIMENSIONS OF THE INDEX

	CS	CSPI	F-PSI	EPI	G-Score	E99
Environmental Health	√	√	√	√		
Societal	√	√	√			
Economics	√	√	√			
Organizational Governance		√				
Well-being	√					
Technique		√				
Production Phase			√		√	√
Use Phase			√			√
End of Life			√			√

Type 2 indicators assess the sustainability of a product by following its life–cycle, including E99, F–PSI and G–Score. These indicators regard production, using and disposal phases of a product as three dimensions. Moreover, E99 adds two transportation phases among three dimensions mentioned before (PRé Consult, 2001). Meanwhile, G–Score assesses environmental impact with a focus on the production phase of a product. F–PSI considers two streams of the generation approach and combines sustainability dimensions with life–cycle dimensions.

6.2 LIFE–CYCLE INTEGRATED METRIC

Based on comparisons of the selected indicators, assessment aspects, and attributes of six indicators are mapped as a novel metric, shown in Table 17. They comprise social and environmental impact attributes, along with the entire life–cycle of a product. It should be emphasized that the transportation phase is considered to exist both in the process from manufacturing to using, and that between using and the disposal phase of the life–cycle. Since long–term consideration is required, the attributes with respect to nature should be assessed through the entire life–cycle, as shown in the last column of Table 17.

Table 17: LIFE–CYCLE INTEGRATED METRIC

<table>
<tr><th>Phase</th><th>Social Impact</th><th colspan="2">Environmental Impact</th></tr>
<tr><td>Production</td><td>Human:
Employee Training
Employee Participation
(Human Rights)
Child Labor
Working Safety

Company Image:
Lawsuit
Local Community</td><td>Material:
Reuse/Recycling of
Resource (Energy,
Material, Product)
Raw Material Extraction
Specific Raw Material
Consumption

Energy Using:
Energy Efficiency
Renewable Energy
Specific Energy
Consumption</td><td rowspan="5">Nature:
Life Cycle Air
Quality

Water
Consumption

Regional Ozone

Urban
Particulates

Biodiversity and
Habitat

Average Noise
Level In the
Periphery of Plant</td></tr>
<tr><td>Transportat
ion</td><td></td><td></td></tr>
<tr><td>Using</td><td>Customer Health &
Safety</td><td>Fuel Production And
Consumption
Maintenance Material
Production
Noise–In–Use</td></tr>
<tr><td>Transportat
ion</td><td></td><td></td></tr>
<tr><td>Disposal</td><td></td><td>Waste Management
Energy Process
Supplementary Materials
Residual Value
Shredding
Dismantling</td></tr>
</table>

Practically, it is very challenging for practitioners to count and provide all the information listed above, especially when following the entire life–cycle or supply chain. The most effective information should be selected and extracted from a large number of issues, eventually providing guidance for practitioners during the cleaner production process and access to transparent sustainability information. In the current study, only aspects and attributes in the production phase are considered, as shown in the grey area of Table 17.

6.3 PRELIMINARY RESULT OF PROPOSED SET OF ATTRIBUTES

The information attributes for the social and environmental dimensions in the above metric are integrated, with a focus on the production phase of a product. The proposed set of attributes should only be comprised of the most effective information, and would eventually play the role of facilitator in the FAI framework originating from sustainable consumption behavior theories.

Table 18: PRELIMINARY LIST OF ATTRIBUTES

Dimension	Aspect	Sub–Aspect	Attribute	Abbr.
Social Impact	Human	Employee	Training	ET
			Participation (human rights)	EP
			Child labor	CL
			Working Safety	EW
		Customer	Satisfaction	CS
			Health and Safety	CH
	Company Image		Law Suit	LS
			Local Community	LC
Environmental Impact	Material Usage		Reuse/recycling of resource (energy, material, product)	RU
			Raw Material Extraction	RM
			Specific Raw material consumption	SR
	Energy Usage		Energy Efficiency	EE
			Renewable Energy	RE
			Specific energy consumption	SE
	Nature	Air	Life cycle global warming	LG
			Greenhouse gas emissions	GG
			Indoor Air pollution	IA
			Regional Ozone	RO
			Nitrogen Loading	NL
			Life cycle Air Quality	LQ
		Reducing	Water quality/Drinking Water	WQ

	water stress	Water Consumption	WC
	Noise level	Average noise level in plant	AN
	Biodiversity	Eco region Protection	ER
		Timber Harvest Rate	TH
		Agricultural Subsidies	AS
		Overfishing	OF
		Land	LD

Table 18 shows the detailed list of extracted information attributes and structures them in the list. This preliminary list contains two dimensions: environmental impact and social impact. Aspects of energy usage, material usage and nature are included in the dimensions of environmental impact. The social impact dimension is comprised of the aspects of human and company image.

CHAPTER 7: IMPORTANCE EVALUATION OF ATTRIBUTES-VIEWPOINTS FROM ACADEMIC AND INDUSTRY EXPERTS

(The content of this chapter has been published in Journal of Cleaner Production)

This chapter will present the results of EEE and provide in–depth insights on the importance and applicability of the selected attributes. The first prototype of the proposed set of attributes is decided based on this result.

The survey was conducted from March to June 2014. First, 10 surveys were sent and five replies obtained. According to suggestions from experts, some attributes in the survey were adjusted and combined with others, and the sequences and logic of the list were also reframed.

Table 19: RESPONDENTS' PROFILE IN EEE ANALYSIS

Research/working Field	**Working Experience**			**Research/working Industry**		
	Time(years)	**Amount**		**Name**	**Amount**	
Sustainable production	1–5 years	10	21%	Aerospace industry	4	9%
Sustainable product, service, and system development	5–10 years	9	19%	Automotive industry	8	17%
Energy efficiency in manufacturing	10–15 years	2	4%	Chemical industry	3	6%
Green manufacturing	> 15 years	26	55%	Computer industr y	4	9 %
Eco–design				Electronic industry	5	11%
Sustainability assessment				Energy industry	9	19%
Eco–innovation				Food industry	5	11%
Sustainable supply chains				Others	9	19%

Next, 176 surveys were sent with a cover letter and draft of the generation process of the proposed list of attribute and 47 replies were received, of which 32 samples were from academic researchers (68%), and 15 samples were from practitioners (32%). The response rate (26.7%) is relatively high due to sufficiently attached information regarding the development process of the proposed set of attributes. The research or working fields for respondents are mainly sustainable production, sustainable product, service and system development, energy efficiency in manufacturing, green manufacturing, eco–design, sustainability assessment, eco–innovation and sustainable supply chains. Respondents with work experience of more than 10 years occupied 59% of the total and are mainly from seven industries that include energy industry (19%), automotive industry (17%), food industry (11%) and electronic industry (11%), etc. Detailed information about the profiles of respondents is listed in Table 19.

Table 20: DATA SUMMARY OF ATTRIBUTES IN EEE ANALYSIS

Dimension	Aspect	Sub-aspect	Attribute	Abbr.	Mean of Importance by Academic Researchers	Mean of Importance by Practitioners	**Mean of Importance**	Applicability By Academic Researchers	Applicability By Practitioners	**Mean of Applicability**	**Exact Sig. (2-tailed)**
Social Impact	Human	Employee	Training	ET	3.292	4.222	**3.545**	3.591	3.556	**3.581**	**0.918**
			participation (human right)	EP	3.833	4.444	**4.000**	3.773	4.000	**3.839**	**0.488**
			Child labor	CL	4.542	3.778	**4.333**	4.273	3.111	**3.935**	**0.132**
			Working safety	EW	4.625	4.444	**4.576**	4.000	3.778	**3.935**	**0.006**
		Customer	Satisfaction	CS	3.708	4.556	**3.939**	3.591	3.778	**3.645**	**0.350**
			Safety & health	CH	4.458	4.556	**4.485**	3.727	4.444	**3.935**	**0.072**
	Co and Local Communit		Law suit	LS	3.333	3.889	**3.485**	3.000	3.444	**3.129**	**0.290**
			Local community	LC	3.667	3.667	**3.667**	3.318	3.556	**3.387**	**0.373**
Environmental Impact	Material Using		Reuse/recycling of resource (energy, material, product)	RU	4.333	4.222	**4.303**	4.000	3.000	**3.710**	**0.250**
			Raw Material Extraction	RM	3.333	3.556	**3.394**	3.091	3.111	**3.097**	**0.277**
			Specific Raw material consumption	SR	3.875	3.556	**3.788**	3.636	2.889	**3.419**	**0.288**
	Energy Using		Energy Efficiency	EE	4.417	4.333	**4.394**	4.227	3.778	**4.097**	**0.190**
			Renewable Energy	RE	3.833	4.333	**3.970**	3.545	4.111	**3.710**	**0.262**
			Specific energy consumption	SE	3.917	4.222	**4.000**	3.682	3.444	**3.613**	**0.172**
	Nature	Air	Life cycle global warming	LG	3.833	3.889	**3.848**	3.182	3.625	**3.300**	**0.061**
			Greenhouse gas emissions	GG	4.000	4.111	**4.030**	3.773	3.778	**3.774**	**0.313**
			Indoor Air pollution	IA	3.875	4.333	**4.000**	3.455	3.556	**3.484**	**0.101**
			Regional Ozone	RO	3.625	4.111	**3.758**	3.364	3.222	**3.323**	**0.214**
			Nitrogen Loading	NL	3.333	3.444	**3.364**	3.182	3.333	**3.226**	**0.703**
			Life cycle Air Quality	LQ	3.208	4.000	**3.424**	3.273	3.778	**3.419**	**0.944**
		Reducing water stress	Water quality/Drinking Water	WQ	4.261	4.556	**4.344**	3.682	3.333	**3.581**	**0.077**
			Water Consumption	WC	3.833	3.889	**3.848**	3.762	3.556	**3.700**	**0.503**
		Noise level	Average noise level in plant	AN	3.583	4.222	**3.758**	3.818	3.556	**3.742**	**0.881**
		Biodiversity	Wilderness Protection (Eco region Protection)	ER	3.708	4.333	**3.879**	3.318	3.556	**3.387**	**0.068**
			Timber Harvest Rate	TH	3.565	3.111	**3.438**	3.333	3.000	**3.233**	**0.744**
			Agricultural Subsidies	AS	3.542	3.000	**3.394**	3.200	3.000	**3.138**	**0.560**
			Overfishing	OF	3.792	3.222	**3.636**	3.238	2.778	**3.100**	**0.245**
			Land	LD	3.792	3.778	**3.788**	3.727	3.111	**3.548**	**0.552**

Table 20 shows 28 selected attributes integrated with values received from the survey. It includes the mean scores of importance (from both academic researchers and practitioners), mean scores of applicability and their exact significant value [2*(1–tailed Sig.)] while the complete data summary for each attribute can be seen.

7.1. EVALUATION OF THE ATTRIBUTE IMPORTANCE

The first part of the result focused on the importance of the attributes. The ranking of attributes and the comparison result from the different respondent group will be present in this section.

7.1.1 IMPORTANCE RANKING OF ATTRIBUTES

According to the average value of importance value, attributes are categorized into three levels (above 4, 3.5-4, below 3.5), as shown in Table 21.

Table 21: RANK OF IMPORTANCE OF ATTRIBUTES IN EEE ANALYSIS

Mean of Importance above 4		**Mean of Importance between 3.5–4**		**Mean of Importance below 3.5**	
Attribute	**Importance**	**Attribute**	**Importance**	**Attribute**	**Importance**
Employees' Working Safety	4.576	Renewable Energy	3.970	Law Suits	3.485
Customer Health and Safety	4.485	Customer Satisfaction	3.939	Timber Harvest Rate	3.438
Energy Efficiency	4.394	Eco-Region Protection	3.879	LC Air Quality	3.424
Water Quality	4.344	LC Global Warming	3.848	Raw Material Extraction	3.394
Child Labor	4.333	Water Consumption	3.848	Agricultural Subsidies	3.394
Reuse	4.303	Specific Raw Material Cons	3.788	Nitrogen Loading	3.364
Greenhouse Gas Emissions	4.030	Land	3.788		
Employees' Participation	4.000	Regional Ozone	3.758		
Specific Energy Consumption	4.000	Average Noise	3.758		
Indoor Air Pollution	4.000	Company and Local Community	3.667		
		Overfishing	3.636		
		Employees' Training	3.545		

It can be seen that the importance value of all 28 attributes is higher than 3 while 22 attributes have importance values above 3.5. Six attributes show importance values below 3.5. This implies that consumers have less interest in the six items that may be considered to be eliminated later. Most surprisingly, “Employees’ Working Safety” (EW–4.576) ranked the highest among all attributes, with an even higher value than the items of “Customer Health and Safety” (CS–4.485) and “Energy Efficiency” (EE–4.394). This implies that consumers are starting to be concerned, with a high level of interest, about the working safety and conditions of employees in the process of production. Therefore, the enlightening aspect for us is that manufacturers should pay more attention to improving their staff working environment in order to increase market share, rather than merely valuing “Customer Health and Safety” and “Energy Efficiency”. Detailed analysis will be conducted in the following section.

Table 22: SUMMARY OF THE MOST IMPORTANT ATTRIBUTES IN EEE ANALYSIS

Five Most Important Attributes					
By Academic Researchers		**By Practitioners**		**Average**	
Attribute	**Importance**	**Attribute**	**Importance**	**Attribute**	**Importance**
Employees’ Working Safety	4.625	Customer Satisfaction	4.556	Employees’ Working Safety	4.576
Child Labor	4.542	Customer Health and Safety	4.539	Customer Health and Safety	4.485
Customer Health and Safety	4.458	Water Quality	4.501	Energy Efficiency	4.394
Energy Efficiency	4.417	Employees Participation	4.444	Child Labor	4.333
Reuse	4.333	Employees’ Working Safety	4.444	Reuse	4.303

For a deeper analysis of the attributes of importance, Table 22 summarizes the most important attributes evaluated by academic researchers and practitioners respectively. It can be seen that social impact attributes, such as “Employees’ Working Safety”, “Child

Labor", "Customer Health & Safety" and "Customer Satisfaction" have relatively higher importance values from academic researchers and practitioners. This implies that from experts' perspectives, including both academic researchers and practitioners, consumers are increasingly aware of the social impact of a product in its production phase and require more related information. Traditionally, water quality and energy efficiency are considered to have a high level of importance, which is also reflected in this survey, as shown in Table 22.

7.1.2 COMPARISONS OF ATTRIBUTES IMPORTANCE

The importance values provided by two groups of respondents are relatively different for some attributes, and this reveals their different cognitions regarding the attributes. For a better understanding of the importance of attributes, comparisons of their commonalities and differences are conducted.

In order to perform comparisons clearly, 28 attributes are grouped into four categories according to dimensions and aspects of assessment. Fig. 16 shows the importance comparisons of attributes in the dimension of social impact and the other three categories of environmental impact attributes are shown in Fig. 16 to Fig. 18 respectively. The importance of attributes in the same category is compared in a bar chart, so different values provided by academic researchers and practitioners for each attribute can be observed clearly.

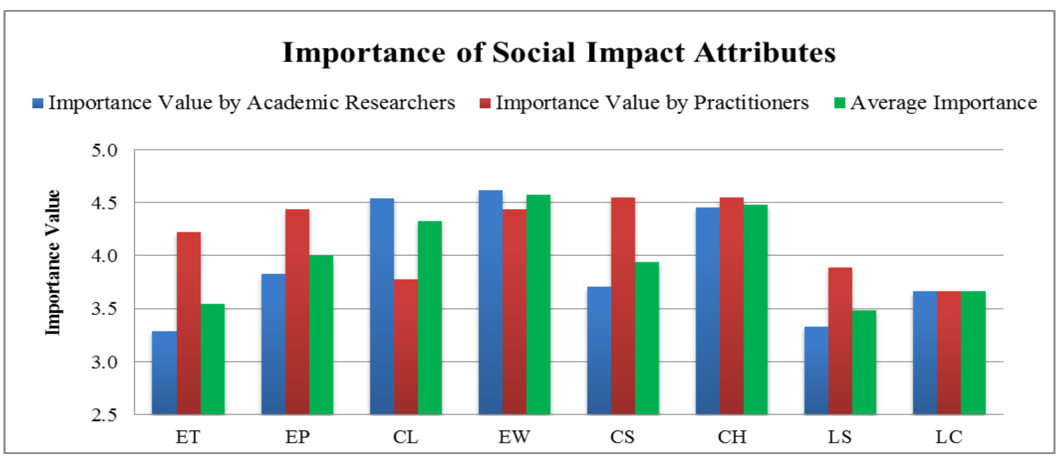

Fig. 16: IMPORTANCE OF SOCIAL IMPACT ATTRIBUTES IN EEE ANALYSIS

Fig. 16 plots the importance comparisons of eight attributes in the dimension of social impact. The importance value of attributes provided by academic researchers is presented with a blue bar while a red bar is used for practitioners and green for the average value. It can be observed that not every attribute has consistent importance values from researchers and practitioners. Understanding such differences is advantageous for identifying insufficiencies in the research or practices. For example, "Employees' Training" (ET) does not show a considerable high level of importance from academic researchers' perspectives (3.292) compared to practitioners (4.222). Conversely, the attribute "Child Labor" (CL) is more important in the views of academic researchers (4.542) than those of practitioners (3.778). Additionally, the attribute "Law Suits" (LS) has the lowest importance value from academic researchers (3.333), and the mean of this attribute from all respondents is 3.485, which is lower than 3.5. This implies that legal issues and such forms of internal management practices of companies are not of interest to consumers.

Fig. 17 shows eight attributes for the aspects of materials and energy, in the dimension of environmental impact. In this part, the importance values provided by academic researchers and practitioners are quite consistent.

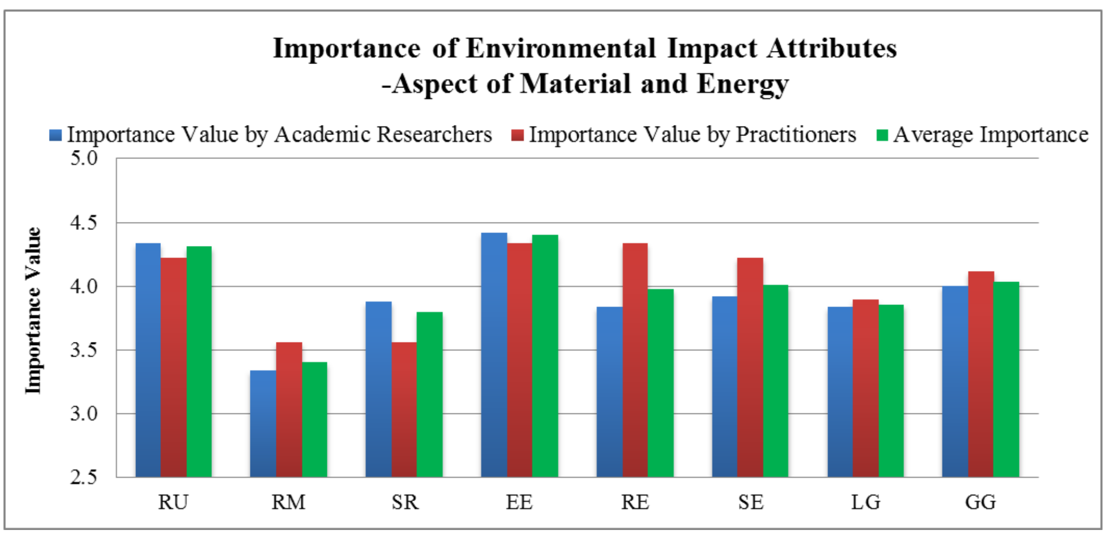

Fig. 17: IMPORTANCE OF ENVIRONMENTAL IMPACT ATTRIBUTES IN EEE ANALYSIS —ASPECT OF MATERIAL AND ENERGY

Only the attribute "Raw Material Extraction" (RM–3.394) shows a relatively lower level of importance, which means that consumers pay less attention to the materials used, extraction and reuse issues, accordingly, this attribute will not occur in the further version of the list. Other attributes have relatively higher mean values of importance, and they are also normally considered as the primary evaluation content for sustainability assessment measures. Moreover, the results reveal that information about materials and energy usage are very important for consumers. Among this aspect, "Energy Efficiency" (EE–4.394) and "Reuse of Sources" (RS–4.303) achieved higher importance from both academic researchers and practitioners. This suggests that companies might enhance their competitive advantage if they start by adopting cleaner technologies in energy efficiency and sources reuse.

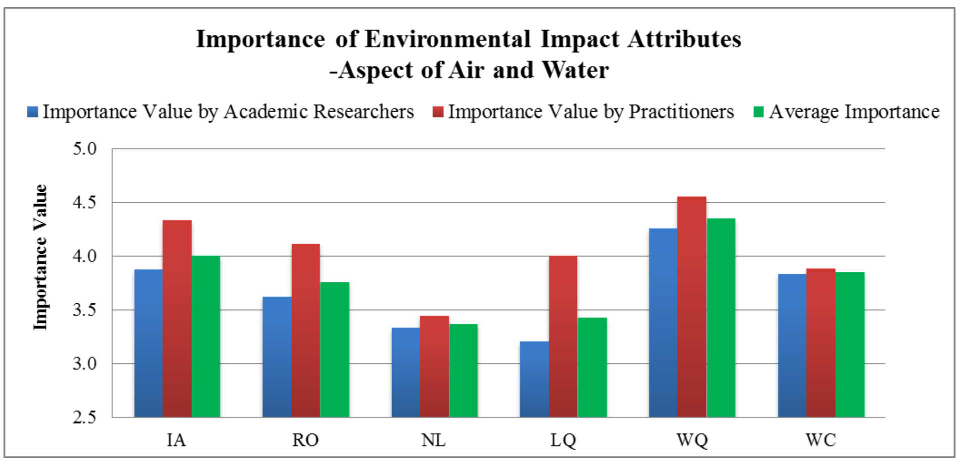

Fig. 18: IMPORTANCE OF ENVIRONMENTAL IMPACT ATTRIBUTES IN EEE ANALYSIS —ASPECT OF AIR AND WATER

Fig. 18 illustrates a comparison of six attributes in the aspects of air and water. Importance values in the aspects of air and water show almost the same trend from both academic researchers and practitioners. For these six attributes, "Nitrogen Loading" (NL) and "Life Cycle Air Quality" (LC) obtain relatively lower importance values. "Nitrogen Loading" (NL) ranks as the least important attribute among all attributes taken into account by all respondents, with a value of 3.364. The result shows that consumers might care more about carbon emissions, but are less concerned about nitrogen emissions in the production phase, or have fewer acknowledgments of it.

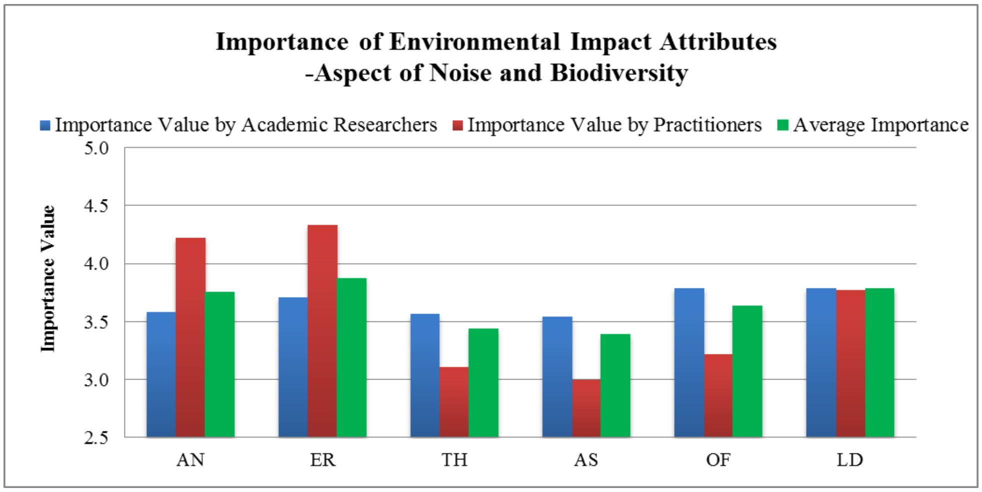

Fig. 19: IMPORTANCE OF ENVIRONMENTAL IMPACT ATTRIBUTES IN EEE ANALYSIS —ASPECT OF NOISE AND BIODIVERSITY

Fig. 19 illustrates six attributes in the aspects of noise and biodiversity. In the aspects of noise and biodiversity, the importance values of attributes from academic researchers are mostly between 3.50 and 4.00, while they fluctuate for practitioners. The attributes "Timber Harvest Rate" (TH–3.111) and "Agricultural Subsidies" (AS–3.000) have the lowest importance value from practitioners. This makes the mean values of these attributes lower than 3.5. This implies that consumers might less concern about the potential environmental impact of the product be able to cause, especially in wood and paper industry. Additionally, consumers might not take into account the agricultural impact (regarding the material/source used for production) or the use of agricultural pesticides.

7.2 EVALUATION OF THE ATTRIBUTE APPLICABILITY

The second part of the survey evaluates the applicability of attributes. According to the survey feedback, 17 out of 28 attributes have applicability values of more than 3.5, and all of these attributes obtained applicability values of more than 3.

7.2.1 LESS APPLICABLE ATTRIBUTES

"Energy Efficiency" (EE) achieves the highest value (4.097) of applicability, while "Raw Material Extraction" (RM) achieves the lowest (3.097). This means the attribute "Energy Efficiency" is the most applicable term, as the numbers of methods and approaches are initiated and addressed on. On the other hand, the associated techniques for assessing raw material extraction are not so well established.

Table 23: LIST OF LESS APPLICABLE ATTRIBUTES IN EEE ANALYSIS

Least Applicable Attributes	Applicability
Regional Ozone	3.323
Lifecycle global warming	3.300
Timber Harvest Rate	3.233
Nitrogen Loading	3.226
Agricultural Subsidies	3.138
Law Suits	3.129
Overfishing	3.100
Raw Material Extraction	3.097

Table 23 lists the least applicable attributes according to the survey. It can be seen from Table 21 and Table 23, with the exception of the attribute "Overfishing" (OF), that attributes with lower applicability are also those of less importance. This means that they will be disregarded in the future version of the list.

7.2.2 COMPARISON OF ATTRIBUTE APPLICABILITY

The applicability of each attribute was evaluated by academic researchers and practitioners. Their average value is shown in Fig. 20.

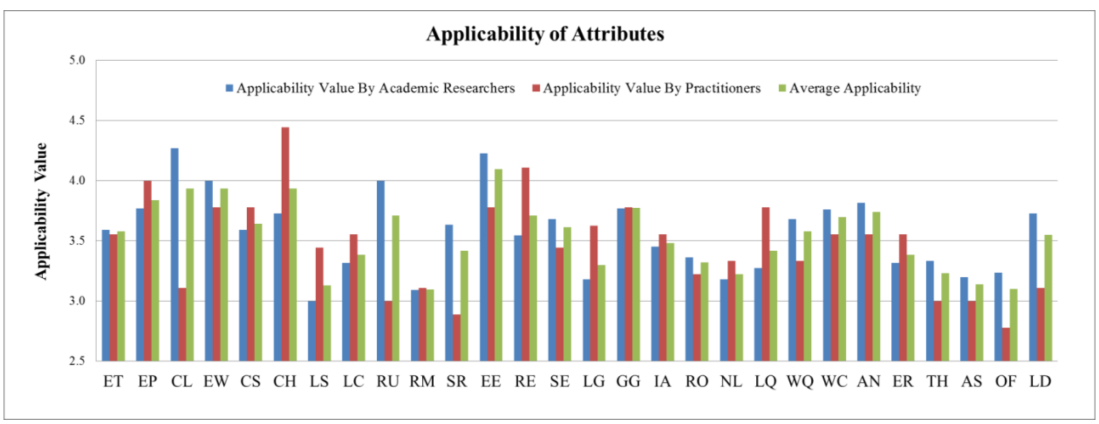

Fig. 20: MEAN VALUE OF APPLICABILITY OF ATTRIBUTES IN EEE ANALYSIS

With regard to applicability, all measures showed a considerably high score. The attitudes of academic researchers and practitioners show relatively large differences for three attributes. “Child labor” (CL) is considered as an applicable attribute by academic researchers (4.273) while practitioners provide a much lower value (3.111). Similarly to “Child Labor”, both “Reuse of Resources” (RR)–(4.001 vs. 3.002) and “Specific Raw Material Consumption” (SR)–(3.636 vs. 2.889) achieved a much higher applicable value from academic researchers than practitioners. Conversely, practitioners have much higher confidence than academic researchers in the measure “Customer Health and Safety” (CH)–(4.444 vs. 3.727). This result suggests that companies probably need to exert more effort on the development of measurement methods for child labor, reuse of resources and specific raw material consumption.

7.3 COMPARISON BETWEEN IMPORTANCE AND APPLICABILITY OF ATTRIBUTES

Importance and applicability of each attribute are compared using the Mann–Whitney U–test. After comparing the p–value of each attribute, whether the mean values of the two sets of data (importance and applicability) differ significantly is observed in Fig. 21. The results suggest that all attributes (except for “Employees’ Working Safety”) are as important as they are applicable.

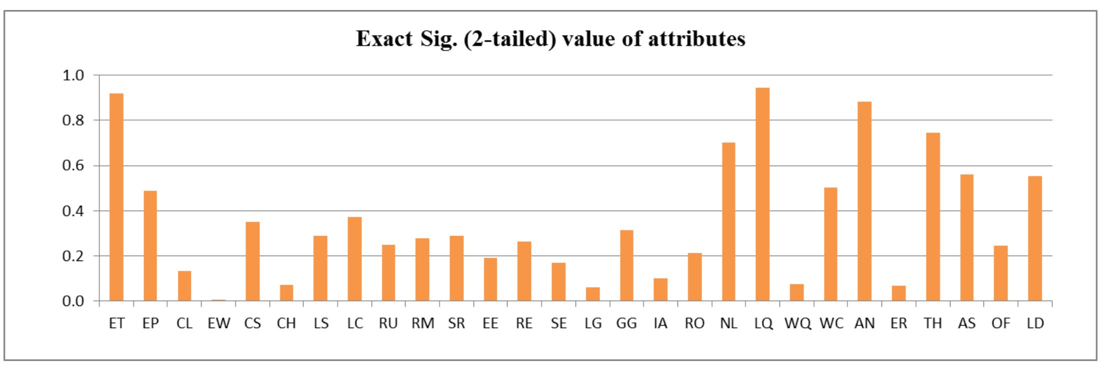

Fig. 21: EXACT SIG. [2*(1–TAILED SIG.)] VALUE OF ATTRIBUTES IN EEE ANALYSIS

It is found that the attribute “Employees’ Working Safety” (EW–0.006) achieved an Exact Sig. [2*(1–tailed Sig.)] value less than 0.05, and its mean value of importance was 4.64, ranking the highest attribute of all. This means that from experts’ opinions, it is very difficult to evaluate and visualize the issues related to the working safety of employees, although it is a very important attribute for consumers to consider. Additionally, indicators can rarely be found in the literature to evaluate the working safety conditions of employees. Further studies should be conducted to develop relevant assessment methods.

7.4 FINAL LIST OF PROPOSED ATTRIBUTES

According to the analysis above, six attributes are eliminated due to their relatively low importance, while most attributes remain in this list. The unconsidered items are "Law Suits" (LS–3.485), "Timber Harvest Rate" (TH–3.438), "LC Air Quality" (LA–3.424), "Raw Material Extraction" (RW–3.394), "Agricultural Subsidies" (AS–3.394) and "Nitrogen Loading" (NL–3.364). Additionally, the attribute "Employees' Working Safety" is kept in the list after consideration of its significant high value of importance. In total, five aspects and 22 attributes are included in the final list of key aspects and attributes, as shown in Table 24.

Table 24: FINAL LIST OF ATTRIBUTE

Dim.	Aspect	Sub–Aspect	Attribute	No.
Environmental Impact	Material Usage		Reuse/recycling of resource (energy, material, product)	1
			Specific Raw material consumption	2
	Energy Usage		Energy Efficiency	3
			Renewable Energy	4
			Specific energy consumption	5
	Nature	Air	Lifecycle global warming	6
			Greenhouse gas emissions	7
			Indoor Air pollution	8
			Regional Ozone	9
		Water	Water quality/Drinking Water	10
			Water Consumption	11
		Noise	Average noise level in plant	12
		Biodiversity	Wilderness Protection (Eco-region Protection)	13
			Overfishing	14
			Land	15

Social Impact	Human	Employee	Training	16
			Participation (human rights)	17
			Working safety	18
			Child labor	19
		Customer	health and Safety	20
			Satisfaction	21
	Company and Local community*			22

*Note: When "Law Suits" was eliminated, the aspect of company image could be combined with local community relationships to create one aspect.

It should be stated here that economic impact is not included in the current state of research, since market and economy–based indices mainly concern labor, genuine savings, and market value. For example, Economic Aspects of Welfare (EAW) (Zolotas, 1981) and Genuine Saving Index (GSI) (Hamilton, 2000) involve only economic impact, Index of Sustainable Economic Welfare (ISEW) contains economic and social impacts (Daly and Cobb, 1989), while Measure of Economic Welfare (MEW) (Nordhaus and Tobin, 1972) and Total Material Requirements (TMR) (Adriaanse et al., 1997) comprise both economic and environmental impact. Additionally, rare indicators include economic impact on the product level. Only life–cycle cost is taken into account in F–PSI. It is more reasonable to evaluate on the national level than the product level. However, further research could consider the potential or indirect economic impact, such as potential economic loss for consumers on healthcare issues caused by using or producing the product.

7.5 DISCUSSION AND SUMMARY

By providing information on the social and environmental impact of a product in its production phase to consumers, this chapter of study proposed a list of attributes to address the information transition gap. With an emphasis on meeting consumers' interests, social impact related to health and safety of employees and customers were considered in this list. The findings from the Man–Whitney U–test showed that, except for "Employees' Working Safety", the importance and applicability of all other attributes do not differ statistically. Furthermore, the data received from the survey strongly suggested that consumers are increasingly aware of the social impact of a product in its production phase and require more related information. The proposed list contributes to studies in the field of development of information transition from cleaner production to sustainable consumption.

The proposed set of attributes could fully meet the consumer–focused criteria raised previously. It comprises the social and environmental impact information and conducts evaluation at the product level. The proposed list of attribute could be applied to fundamental study for further investigations configured to specific industries and developed in relation to local/regional/national public policies, plans, and programs, including existing sustainability monitoring initiatives. It could also be integrated into management and policy procedures with the goal of developing more sustainable cities.

CHAPTER 8: IMPORTANCE EVALUATION OF ATTRIBUTES - VIEWPOINTS FROM AUTOMOBILE CONSUMERS

From the previous study, a set of necessary attributes was identified with 22 attributes. However, the attributes of Eco-region protection, Overfishing and Land are far from the consideration of auto purchasing for consumers. Therefore, these three attributes that fall in the aspect of biodiversity are excluded in this phase of research. Moreover, as more than five experts suggested in the previous survey, we combined the attribute of Employee training into the attribute of Employee participation. Therefore, in total 18 attributes, as shown in Table 25, are considered to have a further study in factor analysis and structural equation model whose steps were illustrated in Fig. 5.

Table 25: 18 ATTRIBUTES FOR STRUCTURAL EQUATION MODEL

No.	Attribute
X1	Reuse/recycling of resource (energy, material, product)
X2	Specific Raw material consumption
X3	Energy Efficiency
X4	Renewable Energy
X5	Specific energy consumption
X6	Life cycle global warming
X7	Greenhouse gas emissions
X8	Indoor Air Pollution
X9	Regional Ozone
X10	Water quality/Drinking Water
X11	Water Consumption
X12	Average noise level in plant
X13	Employee Participation (human rights)
X14	Employee working safety
X15	Child labor
X16	Customer health and Safety
X17	Customer Satisfaction
X18	Company and Local community

As the previous chapter introduced, the survey method is adopted to gain insights from experts, and an expert evaluation exercise is used to evaluate the importance and applicability of the attributes, in order to ensure the content validity. 176 surveys were sent with a cover letter and draft of the generation process of the list and 47 replies were received, of which 32 samples were from academic researchers (68%), and 15 samples were from practitioners (32%). The questionnaire's items were judged to be relevant, and minor modifications were subsequently made to some items that were finally accepted as possessing content validity. The refined measurement items were included in the survey.

18 attributes identified as important when providing sustainability-related information for consumers are integrated as a list. However, how these attributes could be possible to influence the consumers' intentions to conduct green purchasing behavior remains unknown. Therefore, this study aims to explore the possible influence of sustainability-related attributes on the intentions of consumers for conducting green purchasing.

8.1 DATA COLLECTION

8.1.1 RESPONDENTS' PROFILE

This study is based on an online survey which is conducted from June to September of 2015. In total, 686 samples have been received, and the complete sample number is 582. A comparison of early and late respondents was carried out to test for non-response bias. The 582 samples were dived into two groups based on their respond time (before or after the end of July). A t-test was performed on the two groups' responses, and at the 5% significance level there was no significant difference between the two groups' of responses. Although results did not rule out the possibility of non-response bias, they suggested it was not a problem since late respondents' responses appeared to be similar to those of earlier respondents.

The detail of respondents is shown in Table 26. The results shows that 49.48% of respondents are female, and 50.52% are male; 42.44% of respondents are from age range 18-29, and decreased gradually to 30.58%, 14.60%, 7.22%, 4.64%, 0.52% in different age group 30 to 39, 40 to 49, 50 to 59, 60 to 69 and the cluster of more than 70.

Table 26: RESPONDENTS' PROFILE IN SURVEY OF CONSUMERS

Gender		
Options	Response Count	Response Percent
Female	288	49.48%
Male	294	50.52%
answered question	582	
Age		
Options	Response Count	Response Percent
18 to 29	247	42.44%
30 to 39	178	30.58%
40 to 49	85	14.60%
50 to 59	42	7.22%
60 to 69	27	4.64%
more than 70	3	0.52%
answered question	582	
How much more you would like to pay for greener product?		
Answer Options	Response Count	Response Percent
0	41	7.04%
10%	116	19.93%
20%	120	20.62%
30%	73	12.54%
40%	45	7.73%
50%	52	8.93%
60%	41	7.04%
70%	39	6.70%
80%	26	4.47%
90%	12	2.06%
100%	17	2.92%
answered question	582	

Respondents are also required to answer how much percent more would them to pay for a greener product. 20.62% of respondents are willing to pay 20% more (120 sample), and followed by 19.93% of respondents are willing to pay 10% more (116 sample), 12.54% of respondents are willing to pay 30% more (73sample); around 7% of respondents are willing to pay either 40%, 50%, 60%, 70% more for green products (45, 52, 41, 39samples), and also there are 8% of respondents are willing to pay more than 80% more. About 7.04% of respondents would not pay more for green products (41 samples).

8.1.2 MEAN AND STANDARD DEVIATION OF ATTRIBUTES

An evaluation of respondents' aggregated perceptions of the importance level of attributes is shown in Table 27.

Table 27: MEAN AND S.D. OF ATTRIBUTES IN SURVEY OF CONSUMERS

Rank	Items	Mean	S.D.
1	Customer Health and Safety	4.25	0.95
2	Energy Efficiency	4.24	0.87
3	Employee Working Safety	4.24	0.93
4	Customer Satisfaction	4.15	0.90
5	Water quality/Drinking Water influence	4.11	1.02
6	Child Labor	4.02	1.24
7	Renewable Energy	4.00	0.97
8	Company and Local Community	3.95	0.95
9	Employee Participation	3.91	1.02
10	Greenhouse gas emissions	3.90	1.06
11	Specific energy consumption	3.87	0.97
12	Water Consumption in production	3.85	1.05
13	Indoor Air pollution	3.80	1.07
14	Reuse	3.77	1.10
15	Lifecycle global warming	3.75	1.11
16	Regional Ozone	3.73	1.07
17	Specific Raw material consumption	3.54	1.04
18	Noise level in production plant	3.23	1.27

The results indicate that four of six attributes that have average importance more than 4.00 are in the social sustainability field. The result shows that consumers have much higher awareness of the attributes that are in the domain of social sustainability. Furthermore, in average, consumers would pay 34.7% more for greener products, with S.D. = 26.2%.

8.2 EXPLORATORY FACTOR ANALYSIS

Generally SEM analysis goes through the steps of model specification, data collection, model estimation, model evaluation, and (possibly) model modification (Lei and Wu, 2007).

8.2.1 STEP 1- CORRELATION ANALYSIS

The strength of the inter-correlations among the 18 drivers is tested through a correlation matrix. It is has been widely used in the psychology, marketing, and manufacturing literature. Bivariate relationships between the separate dimensions are presented as Pearson correlation coefficients, and the results indicate that x and x have high correlation value at the 0.01 level of statistical significance. The coefficients that are greater than 0.3 means adequate co-efficiency they obtain.

8.2.2 STEP 2- SAMPLE ADEQUACY TEST (KMO TEST)

The size of the sample and the strength of the relationship among the variables are two main issues that need to consider when determining whether a particular data is suitable for factor analysis. The general recommendation of how large a sample should be is the larger, the better. SEM is a large sample technique, usually N>200 (Kline, 2005, pp. 111, 178) and the sample size required is dependent on model complexity, the estimation method used, and the distributional characteristics of observed variables (Kline, 2005, pp. 14-15). A general rule is that the minimum sample size should be no less than 200 or 5–20 times the number of parameters to be estimated, whichever is larger (Kline, 2005, pp. 111, 178).

In SPSS, Kaiser-Meyer-Olkin (KMO) is a common measure of sampling adequacy (Kaiser, 1970). The KMO index ranges from 0 to 1, with 0.6 suggested as the minimum value for a good factor analysis (Tabachnick and Fidell, 2001). Bartlett's test of sphericity should be significant ($p < 0.05$) for appropriate factor analysis. The value of KMO and Bartlett's Test is 0.897 in this study.

8.2.3 STEP 3- EXTRACTING FACTOR

From the scree test (see elbow point), several factors will be extracted. For parallel analysis, plus software called Monte Carlo PCA is used. Rotated Component (Factor) Matrix is necessary if the result is not appropriate enough. It is to reduce the number factors on which the variables under investigation have high loadings. Rotation does not actually change anything but makes the interpretation of the analysis easier.

Table 28: ROTATED COMPONENT MATRIX

	Drivers	Component		
		1	2	3
X1	Reuse	0.688		0.322
X2	Specific Raw material consumption	0.732		
X3	Energy Efficiency			0.661
X4	Renewable Energy	0.564		0.366
X5	Specific energy consumption	0.632		
X6	Lifecycle global warming	0.718		
X7	Greenhouse gas emissions	0.678		
X8	Indoor Air pollution	0.438	0.622	
X9	Regional Ozone	0.555	0.591	
X10	Water quality/Drinking Water influence		0.744	0.307
X11	Water Consumption in production	0.382	0.698	
X12	Noise level in production plant	0.574	0.326	
X13	Employee Participation	0.301	0.471	0.392
X14	Employee Working Safety		0.338	0.742
X15	Child Labor			0.611
X16	Customer Health and Safety		0.393	0.792
X17	Customer Satisfaction		0.466	0.558
X18	Company and Local Community		0.574	0.435
Eigen value Percentage variance				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

In this study, first 3 factors are extracted. Considering the three highest eigenvalues 7.64, 1.75, 1.06 (after rotation, the sums of squared loadings are 4.003, 3.256, 3.185) are all greater than 1.00. Results revealed these three factors accounted for 58.02% of the total variance and could be considered to represent all the criteria. The loadings for the first factor (Energy) range from 0.56 to 0.74, the second factor (Environmental impact) range from 0.57 to 0.75 while the third factor (social impact) ranges from 0.55 to 0.80. It is critical to overserve whether the cross-loadings are high enough to be alarming.

Finally, 3 factors consisted of eighteen drivers are labeled (see table above) and described below:

1) Factor 1 consists of seven drivers, namely, Material Reuse, Specific Raw material consumption, Energy Efficiency, Renewable Energy, Specific energy consumption, Lifecycle global warming and Greenhouse gas emissions. These factors are related to material and energy usage. Therefore, this factor was identified as Energy factor. Specific Raw material consumption has the highest factor loading on this factor. Factor 1 accounted for 22.24% of the total variance.

2) Factor 2 consists of six drivers, Indoor Air pollution, Regional Ozone, Water quality/Drinking Water influence, Water Consumption in production, Noise level in production plant and Company and Local Community. These attributes are related to the environmental impact of a product. Thus, factor 2 was identified as environmental impact. Water quality/Drinking Water influence gained the highest factor loading and followed by water consumption and indoor air pollution. Factor 2 accounted for 18.09% of the total variance.

3) Factor 3 comprised of five drivers, namely, Employee Participation, Employee Working Safety, Child Labor, Customer Health and Safety and Customer Satisfaction. These attributes are related to the social impact of a product, so factor 3 was named as social impact. Among five attributes, Customer Health and Safety is ranking highest and followed by Employee Working Safety. It accounted for 17.69 % of the total variance.

8.2.4 STEP 4- RELIABILITY CHECK

Composite reliability and AVE / Cronbach's α

A composite reliability measure for a construct (Fornell and Farhoomand, 1981) may be estimated using LISREL output. Composite reliability means that a set of latent construct indicators are consistent in their measurement. In more formal terms, this reliability is the degree to which a set of two or more indicators share in their measurement of a construct (Koufteros, 1999). Highly reliable constructs are those in which the indicators are highly inter-correlated, indicating that they are all measuring the same latent construct.

Table 29: CRONBACH'S ALPHA VALUE OF EACH FACTOR

Factor	Driver	Cronbach's Alpha
ξ1	Reuse Specific Raw material consumption Energy Efficiency Renewable Energy Specific energy consumption Lifecycle global warming Greenhouse gas emissions	0.843
ξ2	Indoor Air pollution Regional Ozone Water quality/Drinking Water influence Water Consumption in production Noise level in production plant Company and Local Community	0.849
ξ3	Employee Participation Employee Working Safety Child Labor Customer Health and Safety Customer Satisfaction	0.781

The ranges of values for reliability are between 0 and 1. However, there is no generally acceptable standard for reliability although values above 0.80 are considered adequate. Cronbach's α is one of the most widely used metrics for reliability evaluation. The value of Cronbach's α is 0.70, or higher indicates good reliability (Skipper and Hanna, 2009). In this research, as shown in Table 29 all estimates exceed the 0.780 critical values providing further evidence of reliability.

8.3 CONFIRMATORY FACTOR ANALYSIS

8.3.1 RESEARCH HYPOTHESIS

Based on the previous literature, this study examines three categories of factors that are expected to influence the consumers' intention of paying more for greener products. The research model of this study is illustrated in Fig. 22. It shows the impact of three antecedent factors- Energy and material usage, Environmental impact, Social impact- on the attention to pay more. These factors are hypothesized to have a direct effect on the intention of paying more for greener products.

H1: The sustainability performance attributes related to energy and material usage of a product in production phase has a positive effect on the willingness of paying more for greener products.

H2: The sustainability performance attributes related to the environmental impact of a product in production phase has a positive effect on the willingness of paying more for greener products.

H3: The sustainability performance attributes related to the social impact of a product in production phase has a positive effect on the willingness of paying more for greener products.

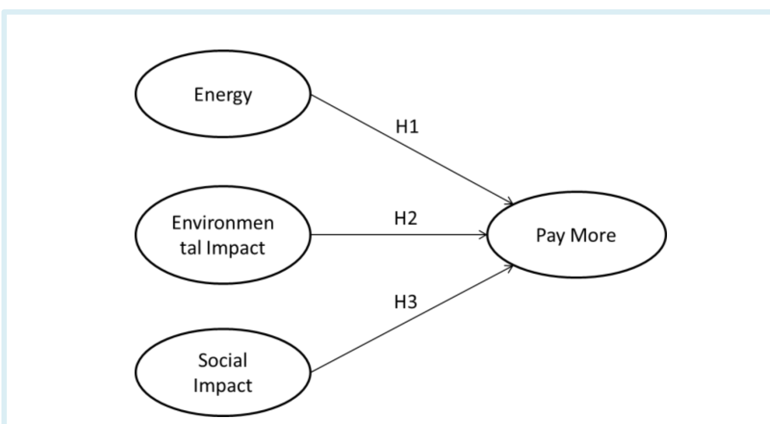

Fig. 22: CONCEPTUAL MODEL

Next, we constructed a Confirmatory Factor Analysis (CFA) model using the LISREL program to assess convergent validity (O'Leary-Kelly and Vokurka, 1998). Each item was linked to its corresponding construct, with the covariance freely estimated.

The path diagram presented in Fig. 23 implies a measurement model where there are three latent variables (constructs) and corresponding multiple indicators (measures or items). Following the convention of LISREL analysis (Joreskog and Sorbom, 1993), observed indicators (Xs) are enclosed in squares. Latent variables ξ is enclosed in circles, whereas measurement errors δ are enclosed. The Greek letter Φ_{ij} represents the correlation between latent variables, and λ coefficient is the factor loadings of the observed indicator on the latent variable. The curved arrows between two latent variables indicate that those variables are correlated. It's noted that one of the loadings in each construct can be set to a fixed value of 1.0 in order to make the constructs comparable (Koufteros, 1999).

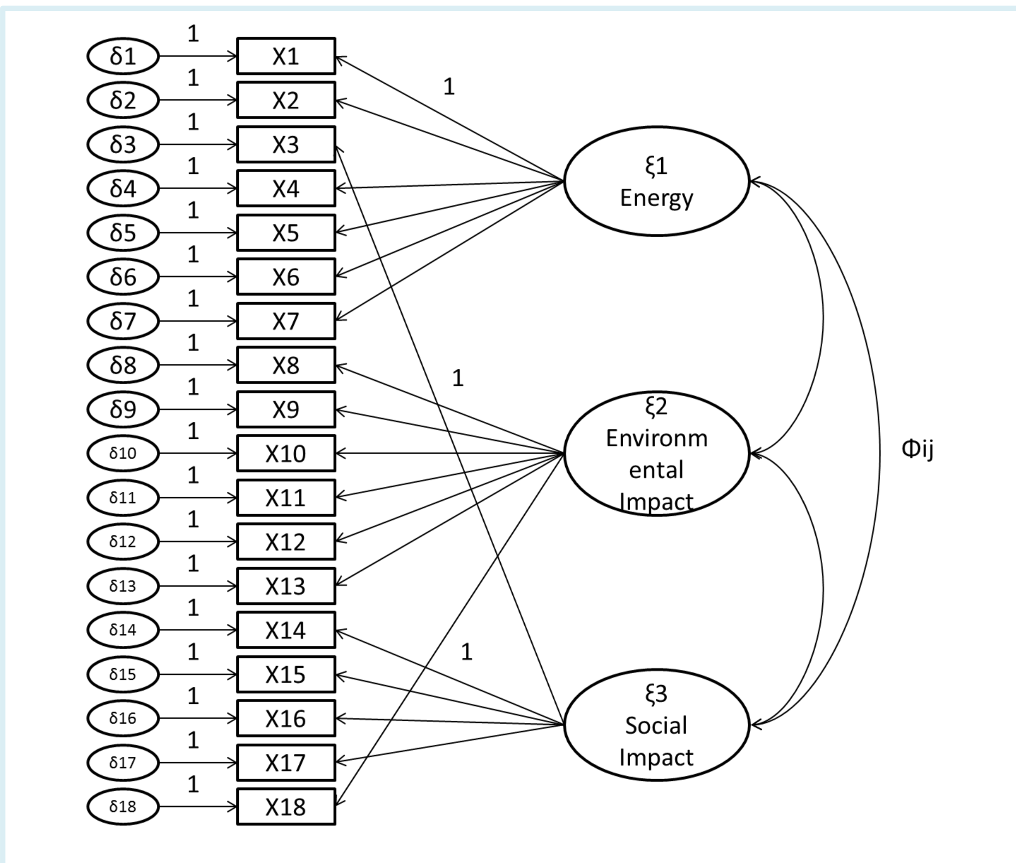

Fig. 23: PATH DIAGRAM REPRESENTING THE MEASUREMENT MODEL

With respect to fit indices, the LISREL program using as input 291 samples demonstrates a strong fit for the trimmed model of 16 items. The X^2 estimate is non-significant (χ^2=408.36 (p>0.05); df=114; χ^2 /df=3.3) which indicates good fit. The CFI and NNFI indices are both 0.96 while the χ^2 per degree of freedom is 3.1. All fit indices are well within acceptable limits providing strong evidence of model fit, and consequently, internal and external consistency.

Two variables X9 (Regional Ozone), X13 (Employee Participation) are considered to be eliminated, since they have very similar values in two clusters of factors, according to Table 28.

The final model consisted of 16 drivers and presented in the table below. It provides an adequate model fit (χ^2 (114) =354, p >0.05) (as shown in Table 30), indicating that the hypothesized model is acceptable.

8.3.2 CONVERGENT VALIDITY AND ITEM RELIABILITY CONVERGENT

The t-value, in the AMOS text output file, is the critical ratio (C.R.), which represents the parameter estimate divided by its standard error.

Table 30: PARAMETER ESTIMATES, T-VALUE, AND R^2 FOR THE PROPOSED MODEL

Latent factor	Driver	Unstandardized Factor loading	Standardized factor loading	Standard error	T-value	R^2
ξ1	Reuse	1.00	0.77	-	-	0.60
	Specific Raw material consumption	0.88	0.71	0.071	12.35	0.50
	Energy Efficiency	0.62	0.62	0.059	10.59	0.38
	Renewable Energy	0.85	0.75	0.064	13.33	0.57
	Specific energy consumption	0.74	0.65	0.065	11.25	0.42
	Lifecycle global warming	0.88	0.69	0.073	12.12	0.48
	Greenhouse gas emissions	0.98	0.77	0.072	13.65	0.59
	Indoor Air pollution	0.79	0.63	0.073	10.79	0.39
ξ2	Water quality	1.00	0.73	-	-	0.54

	Water Consumption in production	1.16	0.80	0.089	12.94	0.64
	Noise level in production plant	0.94	0.55	0.11	8.85	0.30
	Company and Local Community	0.88	0.69	0.078	11.22	0.48
ξ3	Employee Working Safety	1.00	0.81	-	-	0.66
	Child Labor	0.90	0.55	0.097	9.26	0.30
	Customer Health and Safety	1.08	0.86	0.072	14.94	0.73
	Customer Satisfaction	0.75	0.62	0.070	10.67	0.39

Goodness-of-fit statistics
χ^2=354(p>0.05); df=114; χ^2/df=3.1; GFI=0.86; AGFI= 0.81; CFI=0.95; RMSEA=0.086; RMR=0.064; PGFI=0.64; NFI=0.93

T-value:

In CFA, factor loadings can be viewed as regression coefficients in the regression of observed variables on latent variables. The larger the factor loadings or coefficients, as compared with their standard errors and expressed by the corresponding t-values, the stronger is the evidence that the measured variables or factors represent the underlying constructs (Bollen, 1998). There is no generally accepted cut-off value for factor loadings, but convergent validity can be assessed by calculating the ratio of factor loadings to their respective standard errors. In general, either a factor loading of least 0.50, or a significant t-value (t >2.0), or both, is considered to have convergent validity (Chau, 1997). In our model, as Table 30 shows, all the t-values of drivers are above 8.80, which implies convergent validity was achieved.

8.3.3 ASSESSMENT OF THE FIT AND UNIDIMENSIONALITY OF THE MODEL

R^2: On the first-order level of measurement models, the proportion of variance R^2 in the observed variables which is accounted for by the latent variables influencing them can be used to estimate the reliability of a particular observed variable (item). The R^2 values typically above 0.3 provide evidence of acceptable reliability (Carr and Pearson, 1999; Hair et al., 1998). In classical test score theory, the reliability of a variable is a measure of the degree of the true-score variation relative to the observed score-variation. Reliability can also be interpreted as the proportion of the observed variable that is free from error (Lord and Novick, 1968). It would be difficult to justify a proposed indicator of a latent variable in research if its reliability was less than 0.50 for in that case 50% of its variance would be error variance (Hughes et al., 1986). As Table 30 shows, all the squared correlations are above 0.30 and t-values are higher than 8.85, providing evidence of convergent validity.

χ^2: The ratio of χ^2 to the degrees of freedom provides information on the relative efficiency of competing models in accounting for the data (Joreskog and Sorbom, 1993). Researchers have recommended using ratios of less than 5 to indicate a reasonable fit (Marsch and Hocevar, 1985). Most current research suggests the use of ratios less than 2 as an indication of a good fit. Models exhibiting CFI and NNFI indices greater than 0.90 have adequate fit. These critical values indicate that one expects any model that adequately explains the variances and covariance in the observed data to reflect at least a 90% improvement over the null model. The result shows some support for believing that differences in the predicted and actual matrices are non-significant, indicative of acceptable fit.

Other indices: The Goodness of Fit Index (GFI) was 0.86, and Adjusted Goodness of Fit Index (AGFI) was 0.81, and they are closing to the recommended level of 0.90. Therefore, marginal acceptance can be given to this measure. This translates to 81.0% of the variances and covariance in the data observed were predicted by the estimated model. The Comparative Fit Index (CFI) was 0.95 that is exceeded the recommended level of 0.90. Other supporting acceptance of the model are shown in Table 30, Normed Fit Index (NFI) = 0.93, Root Mean Square Error of Approximation (RMSEA) = 0.086, Root Mean Square Residual (RMR)=0.064, Parsimony Goodness of Fit Index (PGFI) = 0.64. This fall well within the recommended range for conditional support to be given for model parsimony.

In summary, the various measures of overall goodness-of-fit for the model lent sufficient support for the results to be deemed an acceptable representation of the hypothesized constructs.

8.3.4 DISCRIMINANT VALIDITY

The test of discriminant validity is one of the important analyzes to be performed (Koufteros, 1999). Table 31 reports the results of six pair-wise discriminant validity tests between the three latent constructs. The pair-wise correlation need to be >6.635 means the validity is satisfied. As Table 30 shows, the $\Delta\ \chi^2$ values for all the tests confirm discriminant validity is satisfied.

Table 31: CORRELATIONS AND SQUARED CORRELATION BETWEEN FACTORS

	AVE[a]	ξ1	ξ2	ξ3
ξ1	0.562	1.0		
ξ2	0.488	0.85(0.03)[b]	1.0	
ξ3	0.521	0.6(0.05)	0.75(0.04)	1.0

[a] Average variance extracted (AVE)= (sum of squared standardized loadings) / [(sum of squared standardized loadings)+(sum of indicator measurement error)]; indicator measurement error can calculated as 1-(standardized loadings)^2 .

[b] Squared correlation.

It is also possible to test discriminant validity by comparing the average variance extracted (AVE) with the squared correlation between constructs. Discriminant validity exists if the items share more common variance with their respective construct than any variance that construct share with other constructs (Fornell and Farhoomand, 1981; Koufteros, 1999).

As can be seen in Table 31, the AVE for a construct should be substantially higher than the squared correlation that between the construct and all other constructs. Evidence of discriminant validity is also provided by the AVE method presented. The highest squared correlation was observed between market and investment intention, and it was 0.05. This was significantly lower than their individual AVE values 0.562 and 0.521, respectively. The results have demonstrated evidence of discriminant validity for the study variables.

8.3.5 CONSTRUCT RELIABILITY AND VARIANCE EXTRACTED MEASURES

To assess whether the specified indicators sufficiently represent the constructs, estimates of the reliability and variance extracted measures for each construct were conducted. The reliability of construct can be estimated and shown in Table 32. Construct reliability means that a set of latent indicators of the construct is consistent in their measurement. In more formal terms, this reliability is the degree to which a set of two or more indicators share the measurement of a construct. Highly reliable constructs are those in which the indicators are highly inter-correlated, indicating that they are all measuring the same latent construct. The range of values for reliability is between 0 and 1. In this study, scales of measures were 0.885, 0.789 and 0.808, respectively. All constructs exceeded the recommended level of 0.70 in this study (Hair et al., 1998).

Table 32: DESCRIPTIVE STATISTICS AND CONSTRUCT RELIABILITY FOR EACH MEASURE

Measures	Mean[a]	S.D.[b]	Construct reliability [c]
ξ1	3.857	1.032	0.885
ξ2	3.806	1.105	0.789
ξ3	4.139	1.015	0.808

[a] Average of measures based on a five-point scale where 1= not important to 5=very important.

[b] Standard Deviation.

[c] Construct reliability = (sum of squared standardized loadings)^2 / [(sum of squared standardized loadings) ^{2}+(sum of indicator measurement error)]; indicator measurement error can calculated as 1-(standardized loadings)^2.

The average variance extracted statistics measures the amount of variance in the specified indicators accounted for by the latent construct. Higher variance extracted values occur when the indicators are truly representative of the latent construct. The variance extracted measure is a complementary measure to the construct reliability value. Typically, recommendations suggest that the variance extracted value should exceed 0.50 for a construct (Hair et al., 1998). Table 31 shows that among the AVEs of the measures, ξ2 had the lowest value of 0.488, indicating that 48.8% of the variance in the specified indicators was account for by the construct. It shows that the results are marginally acceptable as all constructs had a variance extracted value higher than 0.488. To summarize, the overall results of the goodness-of-fit of the model and the assessment of the measurement model lend substantial support to confirming the proposed model.

8.4 RESULTS OF HYPOTHESES TESTING

As discussed in section 8.3 about confirming the fitness of the proposed model, we proceeded to examine the hypothesized relationships. Fig. 24 shows the estimates of covariance results for the modified model.

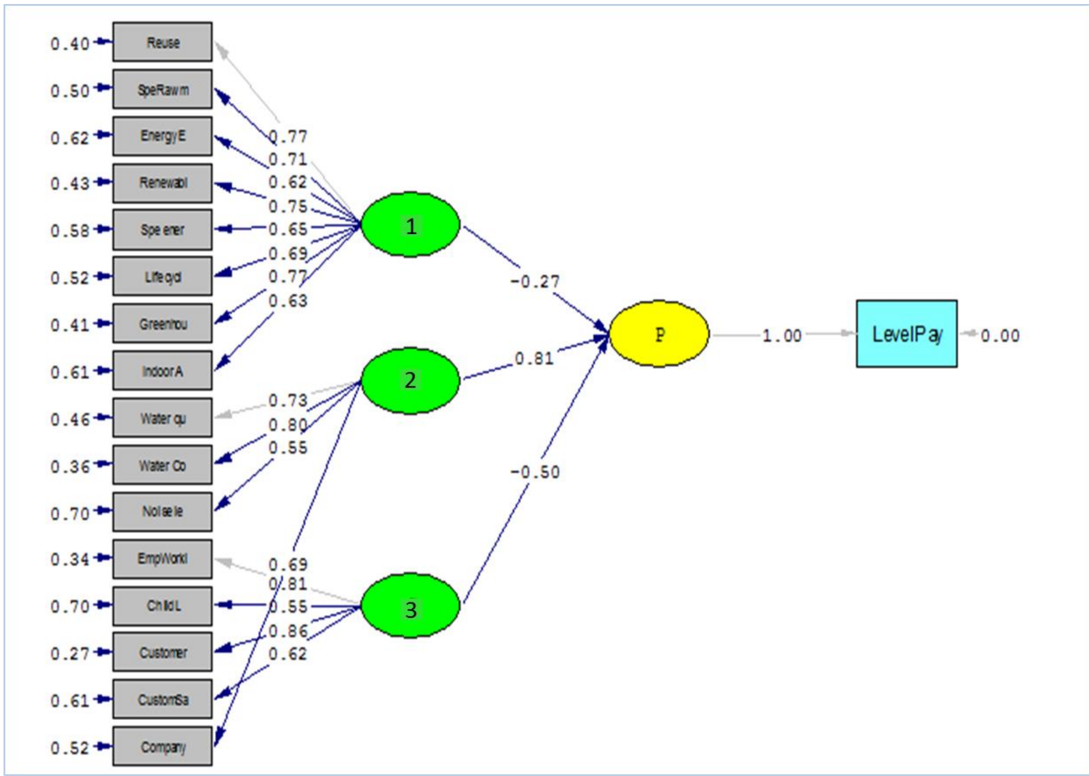

Fig. 24: STRUCTURAL EQUATION MODELING RESULT

Factor 2 (estimate 0.81, C.R. 3.30>1.96) and factor 3 (estimate -0.5, C.R.-4.16>1.96) were found to have significant relationships with consumers' intention in paying more for greener products. On the contrary, factor 1 (estimate 0.27, C.R.-1.44<1.96) did not show close relationship to consumers' intention. From the detailed assessment, it is evident that environmental impact related sustainability assessment attributes are the most important determinants for consumers currently.

8.5 DISCUSSION AND SUMMARY

Interestingly, we found the social impact of related sustainability assessment attributes currently have not positive impact on promoting green purchasing of consumers. However, from the result shown in the previous section, consumers scale attributes of the social impact of the product as a priority, but not the significant factor for them to pay more for a greener product. The reason remains unknown from this study and requires further research on it, probably from the consumer phycology perspective.

However, the result brings evidence again for our research and gives in-depth insights on the inter-relationships between the barriers (see Chapter 4). It implies again that the consumers are aware of the importance of social sustainability performance of a product, but such information currently has not become useful for them to make a purchasing decision. On one hand, the information is not present generally, and consumers are not used to taking these aspects into account; on the other hand, the format of presentation of such information become extremely importance, and it decides how much percent the consumers will consider it. At the macro level, systematic changes are needed to avoid the oversimplified label and enhance the information transparency through providing more detail information. It might be conducted through the collaboration of governmental policies and industrial participation. Policy makers should notice it is an emergency issue to be addressed, as well as support the industrial partners to apply more information regards social sustainability performance of their products. At the same time, consumers still need more incentives to take social sustainability performance into account, such as promotions, media, monetary or moral encouragements.

CHAPTER 9: CONFIGURATION OF AUTOMOBILE INDUSTRY-VIEWPOINTS FROM EUROPEAN AUTOMOBILE INDUSTRY EXPERTS

This chapter of study will present configuration model of the automobile industry in the context of Italian companies. This study is based on the interviews with three industry experts from three European automobile companies in Italy in 2015. The aim is to conduct AHP analysis on the set of attributes and gain the weight of each attribute. The original data, that provided by respondents are input into AHP software so-called Super Decisions. And the prominence of each attribute could be gained directly, as well as the inconsistency values. Detailed information of the selected companies and respondents can be seen in Table 33.

9.1 DATA COLLECTION

According to the manufacturing plants and headquarter locations, this study selected three companies that covered from north to south Europe, since Europe is the strongest automobile manufacturing area, which built approximately 17 million units of automobiles in 2014 (OICA, 2015). The list of respondents and their companies are shown in Table 33.

Table 33: LIST OF RESPONDENTS IN AHP ANALYSIS

Res	Com pany	Establishment history	Employee number	Working experience of respondents	Working position of respondents
1	**C1**	50-100 years	1001-5000	15 years	Managing director
2	**C2**	>100 years	5001-10000	28 years	Benchmarking expert
3	**C2**	>100 years	5001-10000	12 years	Area manager

Company 1 (C1) is an Italian truck manufacturer established in the middle of the 20th century. It designs and manufactures parts and accessories for large trucks and engine manufacturers. It has more than 500 employees globally and has become one of the strongest competitors in international markets. Company 2 (C2) is a global multinational automobile manufacturing company that has created motor cars since the beginning of

the 19th century. It ranks as CDP Italy 100 Climate Disclosure Leadership Index (CDLI) and Climate Performance Leadership Index (CPLI) for 2013. It also received the highest score overall for transparency in disclosure (99/100) as well as the maximum score (score A) for its commitment toward reducing carbon emissions. The Group received a score of 89/100 of Dow Jones Sustainability Indices (DJSI) World and Europe, compared with an overall average of 61/100 for companies evaluated in the Automobiles sector.

The selected respondents of these three automobile companies are able to provide a complete picture of environmentally friendly products and their consumers due to their education, job responsibility, and knowledge. The first respondent is the managing director and has experience in production and plant logistic for more than 15 years. The second respondent has more than 28 years' experience as a benchmarking expert and specializes in engineering, manufacturing and production process. The third respondent is specialized in marketing and business plan coordination and works as area manager for more than five years. Two of the respondents obtained MBA/EMBA degrees in the Europe, with the main focus on business administration, management economics. The answers from these respondents provide valuable insights from both academic and practical perspectives. Thus, based on the description of respondents before, the judgments of those two respondents should receive more weight, and they could be formulated as following: and denoted by λ_1, λ_2, λ_3 respectively.

$$\lambda_1 = 2\lambda_2 = \lambda_3$$

$$\sum_{i=1}^{3} \lambda_i = 1$$

Therefore, in this study, $\lambda_1 = \lambda_3 = 0.4$, and $\lambda_2 = 0.2$. According to the value provided by three respondents, the aggregated importance for each pair-wised comparison could be calculated. For example, the aggregated importance of a set of preferences of Greenhouse Gas Emission & Indoor Air pollution by using WGMM would be $\left(1^{0.4} \times 3^{0.2} \times \frac{1}{3}^{0.4}\right) = 0.803$. The rest of preferences are calculated in the same way and comprised as **Error! Reference source not found.** as below. Since the consistency level of judgments was initially acceptable, the consistency check for the data in **Error! Reference source not found.** was not needed.

9.2 AGGREGATE RESULTS

After inputting the aggregate value of each pair comparison into software, the prominence value of each dimension and attribute could be gained, and showed in the last column of **Error! Reference source not found.**.

Table 34: AGGREGATE RESULT AND PROMINENCE OF ATTRIBUTE IN AHP ANALYSIS

Comparison between two dimensions

	Environmental Impact	Social Impact	Prominence
Environmental Impact	1	1.122	0.580
Social Impact		1	0.470

Comparison of four aspects in dimension of environmental impact

	Air	Material Usage	Noise	Water	Prominence
Air	1	0.135	1.335	0.725	0.128
Material Usage		1	2.713	1.246	0.501
Noise			1	0.983	0.150
Water				1	0.221

Comparison of two aspects in dimension of social impact

	Customer	Employee	Prominence
Customer	1	0.725	0.42
Employee		1	0.58

Comparison among three attributes in aspect of Air

	Greenhouse Gas	Indoor Air Pollution	Life Cycle Global	Prominence

	Emission		Warming	
Greenhouse Gas Emission	1	0.802	1.016	0.311
Indoor Air Pollution		1	0.802	0.333
Life Cycle Global Warming			1	0.356

Comparison among five attributes in aspect of Material Usage

	Energy Efficiency	Renewable Energy	Reuse	Specific Energy Consumption	Specific Raw Material Consumption	Prominence
Energy Efficiency	1	2.371	1.246	2.371	4.210	0.352
Renewable Energy		1	1.246	1.552	1.246	0.171
Reuse			1	2.371	3.000	0.247
Specific Energy Consumption				1	0.802	0.109
Specific Raw Material Consumption					1	0.122

Comparison among two attributes in aspect of Water

	Water Consumption	Water Quality	Prominence
Water Consumption	1	1	0.5
Water Quality		1	0.5

Comparison among three attributes in aspect of Consumers

	Co. and Local	Customer	Customer	Prominence

	Community	Health and Safety	Satisfaction	
Co. and Local Community	1	0.517	1.127	0.273
Customer Health and Safety		1	1.207	0.433
Customer Satisfaction			1	0.294

Comparison among two attributes in aspect of Employee

	Child Labor	Employee Working Safety	Prominence
Child Labor	1	2.178	0.686
Employee Working Safety		1	0.314

The weight of each attribute is calculated accordingly. For example, the weight of attribute Energy Efficiency would be $0.58 \times 0.501 \times 0.352 = 0.1023$, and it has 10.23% of all weights. Table 35 shows the prominence and weight of each attribute in AHP analysis.

Table 35: PROMINENCE AND WEIGHT OF ATTRIBUTE IN AHP ANALYSIS

Dimension	Prominence	Aspect	Prominence	Attribute	Prominence	Weight	%
Environmental Impact	0.58	Material Usage	0.501	Energy Efficiency	0.352	0.10228	10.23
				Renewable Energy	0.171	0.04969	4.97
				Reuse	0.247	0.07177	7.18
				Specific Energy Consumption	0.109	0.03167	3.17
				Specific Raw Material Consumption	0.122	0.03545	3.55
		Air	0.128	Greenhouse Gas Emission	0.311	0.02309	2.31

				Indoor Air Pollution	0.333	0.02472	2.47
				Life Cycle Global Warming	0.356	0.02643	2.64
		Water	0.221	Water Consumption	0.500	0.06409	6.41
				Water Quality	0.500	0.06409	6.41
		Noise	0.150	Noise	0.135	0.01175	1.17
Social Impact	0.47	Employee	0.580	Child Labor	0.686	0.18700	18.7
				Employee Working Safety	0.314	0.08560	8.56
		Customer	0.420	Co. and Local Community	0.273	0.05389	5.39
				Customer Health and Safety	0.433	0.08547	8.55
				Customer Satisfaction	0.294	0.05804	5.80

Table 36 shows the rank on the weight of attributes and illustrate the result correspond lying in Fig. 25.

Table 36: RANK ON WEIGHT OF ATTRIBUTE IN AHP ANALYSIS

Attributes	Weights	Level	Attributes	Weights	Level
Child Labor	18.70	L5	Co. and Local Community	5.39	L4
Energy Efficiency	10.23	L5	Renewable Energy	4.97	L3
Employee Working Safety	8.56	L5	Specific Raw Material Consumption	3.55	L3
Customer Health and Safety	8.55	L5	Specific Energy Consumption	3.17	L3
Reuse	7.18	L4	Life Cycle Global Warming	2.64	L2
Water Consumption	6.41	L4	Indoor Air Pollution	2.47	L2
Water Quality	6.41	L4	Greenhouse Gas Emission	2.31	L2

Customer Satisfaction	5.80	L4	Noise	1.17	L1

11 out of 19 attribute weight higher than 4%, with the highest weight of child labor (12.49%). All top three attributes are within the dimension of social impact, with weights that are higher than 8%. Generally, weights of above attributes could be divided into five levels, as for L1 (1%-1.99%), L2 (2%-2.99%), L3 (3%-4.99%), L4 (5%-7.99%), L5 (>8%).

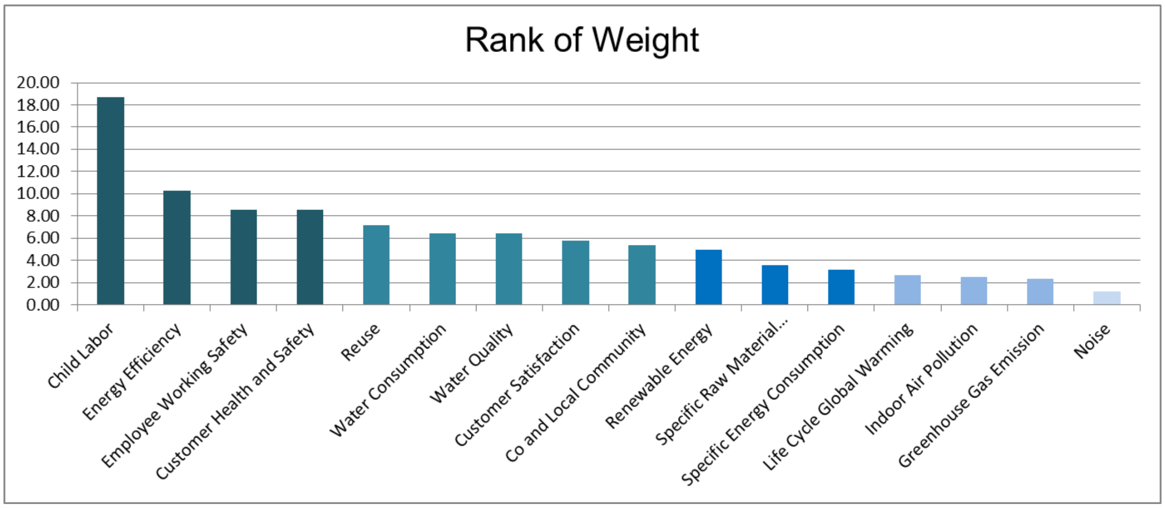

Fig. 25: RANK OF WEIGHT OF ATTRIBUTE IN AHP ANALYSIS

After data analysis, the weights of attributes are obtained separately. By applying their weights integrally, the general list is transformed towards a configuration of the automobile industry. This study is the most important step for obtaining weights from experts in the process of developing the proposed set of attributes. The proposed configuration model is expected to contribute to the studies in the field of developing an information transition approach for sustainable consumption and production. The effectiveness of the proposed arrtributes will be evaluated in case studies in further research.

CHAPTER 10: DISCUSSION AND CONCLUSION

This chapter will present the summary of the findings from previous work, and perform a discussion on the comparison results. The fulfillment of research objective will be discussed as well as the contribution of this research. The limitation of this study and the suggestion for further study will be summarized at the end.

10.1 SUMMARY OF THE FINDINGS AND DISCUSSION

This first part of result in this study visualized the prioritization and interrelationships among barriers that exist between environmentally friendly products and their consumers by applying the grey-DEMATEL technique to three cases in the European automobile industry (Chapter 4). The analysis results showed that dispelling the concern consumers have regarding their expectations and perceptions of environmentally friendly products becomes the most important task. To solve this issue, adequate sustainability-related information should be made publicly available by governments or organizations for consumers when purchasing, and it becomes a prerequisite for enabling consumers to purchase environmentally friendly products. How to provide adequate and necessary information still requires further investigation, especially to find a better approach to present above information of products for consumers in an easily understandable format. Education and communication to consumers about the impact of their collective purchasing behavior should be pursued because it could play a very important role in the whole system and would be greatly helpful to automobile manufacturers for addressing other existing barriers.

From the review of current sustainability assessment approaches (Chapter 5), the result shows most indicators are less effective for supporting communication with consumers due to their underestimation of consumer information needs. Furthermore, the study suggests that necessary attributes could be extracted from current assessment methodologies, after which the full involvement and empowerment of public stakeholders, especially consumers, should be considered. This part of study suggests that the focus scope and assessment methods of the present approaches need to be modified to meet stakeholders' needs.

Continuously, 28 attributes were extracted (Chpater 6) from the current indicators and captured key factors for success transferring from consumers' motivation and behavior, and plays the role of facilitator in AFI framework. Chapter 7 presented the results of Expert Evaluation Exercise (EEE) and provided in–depth insights on the importance and applicability of the selected attributes. The first prototype with 22 attributes was decided based on EEE and they could fully meet the consumer–focused criteria. It comprises the social and environmental impact information and conducts evaluation at the product level. The proposed list of attribute could be applied to fundamental study for further investigations configured to specific industries and developed in relation to local/regional/national public policies, plans, and programs, including existing sustainability monitoring initiatives. It could also be integrated into management and policy procedures with the goal of developing more sustainable cities.

From Chapter 8 to Chapter 9, the viewpoints from various stakeholders were provided in the study, in the context of automobile industry. A survey of 682 consumers was conducted and the method of SEM was applied to analyze the data (Chapter 8). Besides gaining the importance value of attributes, it is evident that environmental impact related sustainability assessment attributes are the most important determinants for consumers currently. Interestingly, we found the social impact of related sustainability assessment attributes currently have not positive impact on promoting green purchasing of consumers.

Chapter 9 presented configuration model of the automobile industry in the context of Italian companies. This study is based on the interviews with three industry experts from three European automobile companies in Italy in 2015. The aim is to conduct AHP analysis on the set of attributes and gain the weight of each attribute. The prominence of each attribute was gained from the industry experts directly. By applying their weights integrally, the general attribute list is transformed towards a configuration of the automobile industry. This study is the most important step for obtaining weights from experts in the process of developing the proposed set of attributes. The proposed configuration model is expected to contribute to the studies in the field of developing an information transition approach for sustainable consumption and production. The effectiveness of the proposed attributes will be evaluated in case studies in further research.

10.1.1 WEIGHTS AND IMPORTANCE VALUES FROM VIEWS OF MULTI-STAKEHOLDERS

From the studies in previous chapters, the importance values of attributes were provided by multi-stakeholders. For overviewing the similarity and differences from different stakeholders, the data of importance value of each attribute are summarized in Table 37. It includes the average values on selected 16 attributes provided by consumers, academic experts, and industrial experts, respectively.

Table 37: AVERAGE IMPORTANCE VALUE BY MULTI-STAKEHOLDERS

No.	Attribute	Average importance value by consumers	Average importance value by academic experts	Average importance value by industrial experts
1	Reuse	3.77	4.333	4.222
2	Specific Raw material consumption	3.54	3.875	3.556
3	Energy Efficiency	4.24	4.417	4.333
4	Renewable Energy	4.00	3.833	4.333
5	Specific energy consumption	3.87	3.917	4.222
6	Lifecycle global warming	3.75	3.833	3.889
7	Greenhouse gas emissions	3.90	4.000	4.111
8	Indoor Air pollution	3.80	3.875	4.333
9	Water quality	4.11	4.261	4.556
10	Water Consumption in production	3.85	3.833	3.889
11	Noise level in production plant	3.23	3.583	4.222
12	Employee Working Safety	4.24	4.625	4.444
13	Child Labor	4.02	4.542	3.778
14	Customer Health and Safety	4.25	4.458	4.556

15	**Customer Satisfaction**	4.15	3.708	4.556
16	**Company and Local Community**	3.95	3.667	3.667

In order to visualize the values clearly, the average importance values of attributes provided by consumers are shown in Fig. 26. As discussed in section 8.1, consumers have a much higher awareness of the attributes that are in the domain of social sustainability. It's noted that the mean of importance value of social impact attributes is above 4.1.

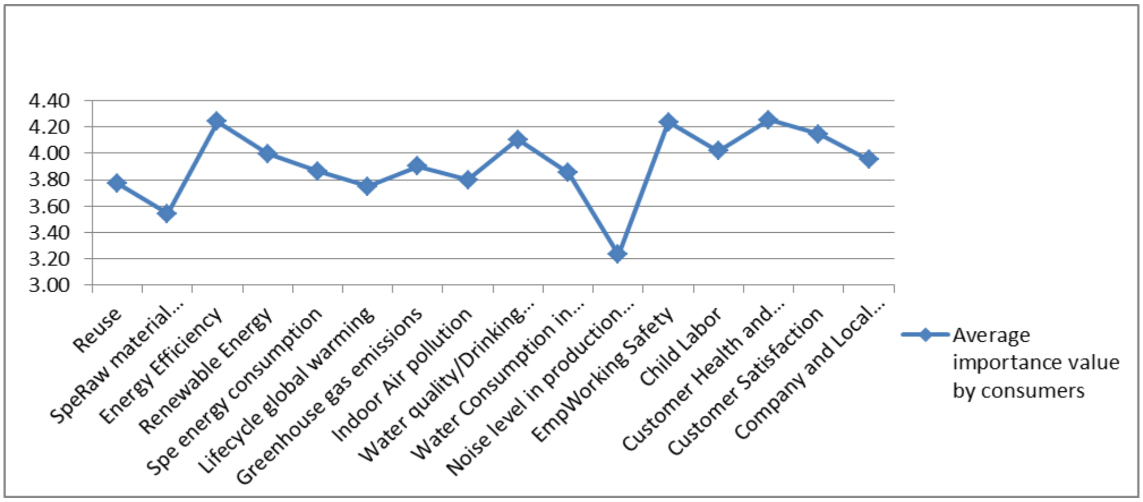

Fig. 26: AVERAGE IMPORTANCE VALUES OF ATTRIBUTES PROVIDED BY CONSUMERS

The Comparison between with the importance values that were provided by experts (that was illustrated in section 7.1) and consumers is shown in Fig. 27.

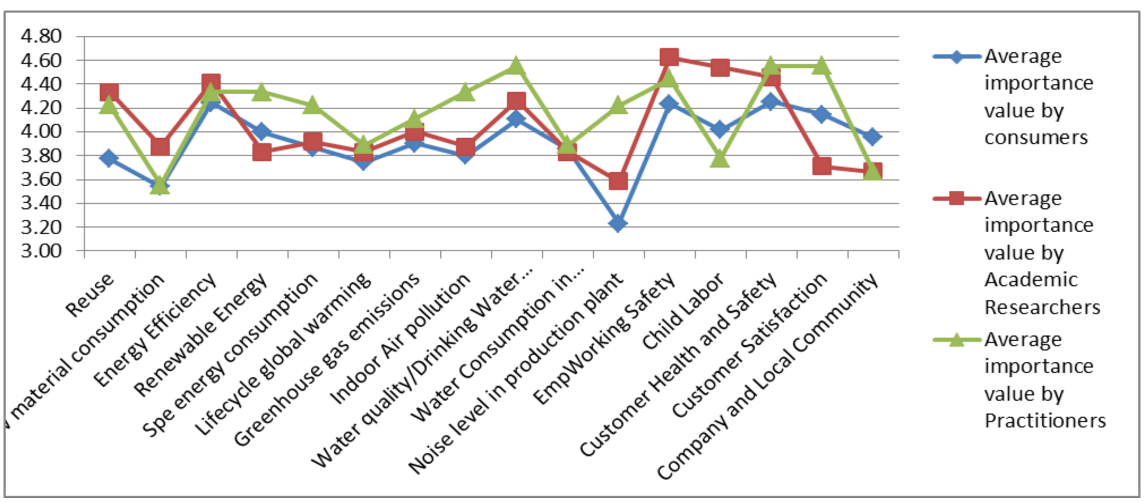

Fig. 27: COMPARISON BETWEEN IMPORTANCE VALUES PROVIDED BY MULTI-STAKEHOLDERS

The results indicate that the importance level of attributes from consumers' survey is quite in line with the outcome from academic and industrial experts. Most of the attributes have very similar importance level, besides "Noise level in production plant". Consumers evaluate it much less important than the experts. It mainly subjects to the unfamiliarity of consumers about the working environment of production plants. However, the experts, especially the industrial experts are aware of the situation the employees are having, and consider it more important to be considered in the sustainability assessment process.

10.1.2 COMPREHENSIVE ANALYSIS ON VIEWS FROM DIFFERENT STAKEHOLDERS

From barriers analysis, we found that it is necessary to provide sustainability-related information of a product for consumers, however, from the survey of consumers through SEM analysis, we found the social sustainability currently have not positive impact on promoting green purchasing of consumers. It indicates that further systematical change of infrastructures, as well as related laws and regulations, are in urgent need to developed and applied to promote sustainable consumption at the macro level.

10.2 FULFILLMENT OF RESEARCH OBJECTIVES

This research starts from the empirical study on barrier analysis between environmentally friendly products and their consumers in the context of European automobile industry. The critical influential factors that influence green purchasing were identified through visualizing their prioritization and influence severity by employing grey-Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. The results suggested that the primary focus should move to how to provide advanced measures as a facilitator to promote sustainable consumption. After a systematic review of possible approaches that assess sustainability performance of the product in industrial engineering and marketing science fields, and analyze their feasibility for providing sustainability information for consumers, a general set of necessary product-level sustainability attributes were extracted according to preferences of consumers. It consists of social and environmental impacts of a product to provide by companies towards successful presenting sustainability information of the product to their consumers. It captures critical factors for success from consumers' motivation and behavior and plays the role of facilitator in the AFI framework. In order to gain comprehensive insights from different stakeholders, such as academic and industry experts, and consumers, several studies were conducted based on viewpoints from multiple stakeholders. Firstly, the survey method was adopted to gain insights from experts, and an expert evaluation exercise (EEE) was used to evaluate the importance and applicability of the attributes. Unnecessary attributes and the ones that could not be measured properly at plant level are eliminated. And then, the importance of attributes were evaluated and ranked based on a survey of 683 European respondents' by employing structural equation modeling (SEM) approach. As the result, numeric weights of the importance of attributes are gained from the configuration model for the automobile industry in the context of Italian case, by employing Analytic Hierarchy Process (AHP) method.

10.3 ACHIEVED CONTRIBUTIONS

Theoretical contribution:

Based on cognitive consumer behavior model, this study developed a set of necessary attributes that could adequately meet the consumer–focused criteria, and play the role of facilitator in AFI framework. The proposed set of attributes could fully reach the consumer–focused criteria raised previously. It comprises social and environmental impact information and conducts an evaluation at the product level. This study provides empirical insights on importance and weights of numbers of necessary attributes from multi-perspective and highlights the different viewpoints that might exist among various stakeholders.

In the context of European automobile industry, this study firstly visualized the prioritization and interrelationships among barriers that exist between environmentally friendly products and their consumers by applying the grey-DEMATEL technique. The results provided the major contributions of this study include: (1) a clear identification of the barriers consumers are facing regarding environmentally friendly products; and (2) real-world data gathering that explored some of the interrelationships amongst these barriers. After the general list of attributes development, the configuration model based on European automobile industry was developed.

This study contributes to the research fields of developing an information transition approach from cleaner production to sustainable consumption, as well as marketing instrument development. The proposed attributes could serve as a fundamental study for developing related governmental/regional public policies, including existing sustainability monitoring initiatives. It could also be integrated into management and administration procedures with the goal of developing more sustainable cities. Furthermore, it is also very beneficial and constructive for practitioners to provide consumers with product-level sustainability information. Such environmentally and socially–conscious information will provide an effective way for consumers to facilitate product comparisons and choose products with more transparent information, resulting in increased market share and profit for practitioners. Consequently, it will provide a long–term competitive advantage due to increased differentiation.

10.4 LIMITATIONS OF THE STUDY AND FUTURE WORK

The method of AHP was applied in the development process of configuration model of European automobile companies. Besides gaining prime importance of attributes, developments of better aggregation methodology are expected to provide less subjective results. Of course, by using the similar methods, a comprehensive result in different contexts could also be interested in conducting. At the same time, the results observed in the automobile industry may not be consistent with other industries in Europe.

The determinant factors in promoting green purchasing are in need to be explored. Based on the data achieved already, several research topics could be further studied, for example, the main drivers for conducting green purchasing, the role that social sustainability attributes could play for promoting sustainable consumption, as well as the different preferences of consumer to perform green purchasing regarding their diverse characteristics of consumers, such as gender, age, location, education level.

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APPENDIX

Appendix A (C1) Grey pairwise direct-relation matrix *X*

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	x	2	3	3	2	3	2	2
B2	3	x	4	4	4	1	4	4
B3	1	1	x	0	3	0	0	2
B4	2	1	1	x	1	3	3	3
B5	2	0	1	0	x	1	2	4
B6	2	0	0	1	4	x	0	4
B7	3	3	0	0	4	1	x	3
B8	4	1	0	0	4	1	1	x

Appendix A (C2) The grey pairwise direct-relation matrix *X*

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	x	3	2	2	3	2	3	2
B2	3	x	3	2	3	2	3	1
B3	2	3	x	2	3	2	2	2
B4	2	2	2	x	2	3	3	3
B5	3	3	2	2	x	2	3	2
B6	2	2	2	3	3	x	3	3
B7	3	3	3	2	2	2	x	2
B8	2	1	3	2	1	2	3	x

Appendix A (C3) The grey pairwise direct-relation matrix *X*

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	x	1	2	3	3	3	4	4
B2	2	x	0	4	3	4	3	4
B3	0	0	x	4	3	3	4	1
B4	3	3	1	x	1	2	2	2
B5	2	2	2	1	x	1	4	4
B6	4	4	4	3	4	x	3	3
B7	3	3	4	3	4	2	x	4
B8	4	4	4	3	4	2	2	x

Appendix B (C1) The overall crisp direct-relationship matrix *Z*

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	0	0.5000	0.6500	0.6500	0.3500	0.9167	0.3500	0.3500
B2	0.6500	0	0.9500	0.9500	0.9500	0.0833	0.9500	0.9500
B3	0.0500	0.0833	0	0	0.6500	0	0	0.3500
B4	0.3500	0.0833	0.0500	0	0.0500	0.9167	0.6500	0.6500
B5	0.3500	0	0.0500	0	0	0.0833	0.3500	0.9500
B6	0.3500	0	0	0.0500	0.9500	0	0	0.9500
B7	0.6500	0.9167	0	0	0.9500	0.0833	0	0.6500
B8	0.9500	0.0833	0	0	0.9500	0.0833	0.0500	0

Appendix C (C1) The normalized direct-relation matrix *N*

Barriers	B1	B2	B3	B4	B5	B6	B7	B8
B1	0	0.0912	0.1185	0.1185	0.0638	0.1672	0.0638	0.0638
B2	0.1185	0	0.1733	0.1733	0.1733	0.0152	0.1733	0.1733
B3	0.0091	0.0152	0	0	0.1185	0	0	0.0638
B4	0.0638	0.0152	0.0091	0	0.0091	0.1672	0.1185	0.1185
B5	0.0638	0	0.0091	0	0	0.0152	0.0638	0.1733
B6	0.0638	0	0	0.0091	0.1733	0	0	0.1733
B7	0.1185	0.1672	0	0	0.1733	0.0152	0	0.1185
B8	0.1733	0.0152	0	0	0.1733	0.0152	0.0091	0

Appendix D (C1) Total relation matrix *T*

	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.1060	0.1300	0.1570	0.1556	0.2101	**0.2212**	0.1269	0.2114
B2	**0.2661**	0.0792	**0.2238**	**0.2195**	**0.3580**	0.1123	**0.2561**	**0.3561**
B3	0.0432	0.0241	0.0108	0.0094	0.1502	0.0133	0.0186	0.1031
B4	0.1513	0.0589	0.0388	0.0300	0.1344	0.2061	0.1526	**0.2215**
B5	0.1258	0.0301	0.0301	0.0205	0.0786	0.0460	0.0866	**0.2227**
B6	0.1321	0.0221	0.0220	0.0289	**0.2422**	0.0351	0.0334	**0.2424**
B7	**0.2256**	0.2069	0.0659	0.0633	**0.3032**	0.0763	0.0794	**0.2557**
B8	**0.2215**	0.0464	0.0368	0.0349	**0.2351**	0.0644	0.0512	0.0866

Appendix D (C2) The total-relation matrix *T*

	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
B1	1.0276	1.1925	1.0958	0.9093	1.1613	0.9093	**1.3637**	0.8885
B2	1.1911	1.0630	1.1655	0.9189	1.1825	0.9189	**1.3741**	0.8348
B3	1.0299	1.1052	0.9228	0.8428	1.0806	0.8428	1.2018	0.8235
B4	1.0897	1.0983	1.081	0.8138	1.0722	0.9645	**1.3453**	0.9547
B5	1.1783	1.1925	1.0958	0.9093	1.0107	0.9093	**1.3637**	0.8885
B6	1.1704	1.1800	1.1561	1.0268	**1.2099**	0.8761	**1.4387**	1.0155
B7	1.1681	1.1865	1.1524	0.9048	1.0976	0.9048	1.2019	0.8841
B8	0.8431	0.795	0.9046	0.7024	0.7712	0.7024	1.0494	0.6074

Appendix D (C3) The total-relation matrix *T*

	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
B1	0.2520	0.2478	0.2974	0.3676	0.4000	0.2953	**0.4328**	**0.4437**
B2	0.3314	0.2577	0.2512	0.4287	0.4139	0.3562	0.4015	**0.4658**
B3	0.1867	0.1775	0.1704	0.3403	0.3135	0.2419	0.3581	0.2294
B4	0.2581	0.2454	0.1488	0.1720	0.1950	0.1890	0.2350	0.2482
B5	0.2440	0.2320	0.2409	0.2185	0.2321	0.1622	0.3644	0.3761
B6	**0.4509**	0.4287	0.4304	**0.4489**	**0.5195**	0.2609	**0.4792**	**0.4839**
B7	0.3749	0.3564	0.4029	0.4096	**0.4791**	0.2864	0.3346	**0.4813**
B8	0.4122	0.3919	0.3914	0.4086	**0.4726**	0.2900	0.3942	0.3371

Appendix D Overall total-relation matrix *T*

	B1	B2	B3	B4	B5	B6	B7	B8
B1	1.3856	1.5703	1.5502	1.4325	**1.7714**	1.4258	**1.9234**	1.5436
B2	**1.7886**	1.3999	1.6405	1.5671	**1.9544**	1.3874	**2.0317**	1.6567
B3	1.2598	1.3068	1.1040	1.1925	1.5443	1.0980	1.5785	1.1560
B4	1.4991	1.4026	1.2686	1.0158	1.4016	1.3596	1.7329	1.4244
B5	1.5481	1.4546	1.3668	1.1483	1.3214	1.1175	**1.8147**	1.4873
B6	**1.7534**	1.6308	1.6085	1.5046	**1.9716**	1.1721	**1.9513**	**1.7418**
B7	**1.7686**	**1.7498**	1.6212	1.3777	**1.8799**	1.2675	1.6159	1.6211
B8	1.4768	1.2333	1.3328	1.1459	1.4789	1.0568	1.4948	1.0311

Appendix E. List of threshold values

	C1	C2	C3	Overall
Mean	0.1251	1.0307	0.3304	1.4862
Standard Deviation	0.0936	0.1779	0.1001	0.2540
Threshold Value (θ)	**0.2187**	**1.2086**	**0.4305**	**1.7402**

Appendix F Grey Theory

The method of converting fuzzy data into crisp scores (CFCS) is normally employed to deal with problems of decision-making in a grey environment (Zhu et al., 2011). This approach has been deemed to be more effective by researchers for arriving at crisp values (e.g., when compared to the centroid method) (Wu and Lee, 2007). The calculation process is shown as follows:

x denotes a closed and bounded set of real numbers and a grey number $\otimes x$ is defined as an interval with known upper and lower bounds, but unknown distribution information for *x* (Deng, 1989). It is described as:

$$\otimes x = \left[\underline{\otimes} x, \overline{\otimes} x\right] = \left[x' \in x \,\middle|\, \underline{\otimes} x \leq x' \leq \overline{\otimes} x\right] \qquad \text{A0}$$

In A0, $\underline{\otimes} x$ and $\overline{\otimes} x$ represent the lower and upper bounds of $\otimes x$, respectively.

The following relationships (Equations A1 to A4) are basic mathematical operations used in grey number theory:

$$\otimes x_1 + \otimes x_2 = [\underline{x}_1 + \underline{x}_2, \bar{x}_1 + \bar{x}_2] \qquad \text{A1}$$

$$\otimes x_1 - \otimes x_2 = [\underline{x}_1 - \bar{x}_2, \bar{x}_1 - \underline{x}_2] \qquad \text{A2}$$

$$\otimes x_1 \times \otimes x_2 = [\min(\underline{x}_1\underline{x}_2, \underline{x}_1\bar{x}_2, \bar{x}_1\underline{x}_2, \bar{x}_1\bar{x}_2), \max(\underline{x}_1\underline{x}_2, \underline{x}_1\bar{x}_2, \bar{x}_1\underline{x}_2, \bar{x}_1\bar{x}_2)] \qquad \text{A3}$$

$$\otimes x_1 \div \otimes x_2 = [\underline{x}_1, \bar{x}_1] \times [\frac{1}{\underline{x}_2}, \frac{1}{\bar{x}_2}] \qquad \text{A4}$$

$\otimes x_{ij}^{p}$ is defined as the grey number for an evaluator *p* that will evaluate the influence of barrier *I* on barrier *j*. $\otimes x_{ij}^{p} = [\underline{\otimes} x_{ij}^{p}, \overline{\otimes} x_{ij}^{p}]$, where $\underline{\otimes} x_{ij}^{p}$ and $\overline{\otimes} x_{ij}^{p}$ represent the lower and upper bounds of $\otimes x_{ij}^{p}$, respectively.

Three steps of the modified-CFCS method are described as follows:

(1) Normalization

$$\otimes \tilde{x}_{ij}^{p} = (\underline{\otimes} x_{ij}^{p} - \min_j \underline{\otimes} x_{ij}^{p})/\Delta_{min}^{max} \qquad \text{A5}$$

$$\otimes \tilde{x}_{ij}^{p} = (\overline{\otimes} x_{ij}^{p} - \min_j \overline{\otimes} x_{ij}^{p})/\Delta_{min}^{max} \qquad \text{A6}$$

where

$$\Delta_{min}^{max} = \max_{j} \overline{\boxtimes} x_{ij}^{p} - \min_{j} \underline{\boxtimes} x_{ij}^{p} \qquad \text{A7}$$

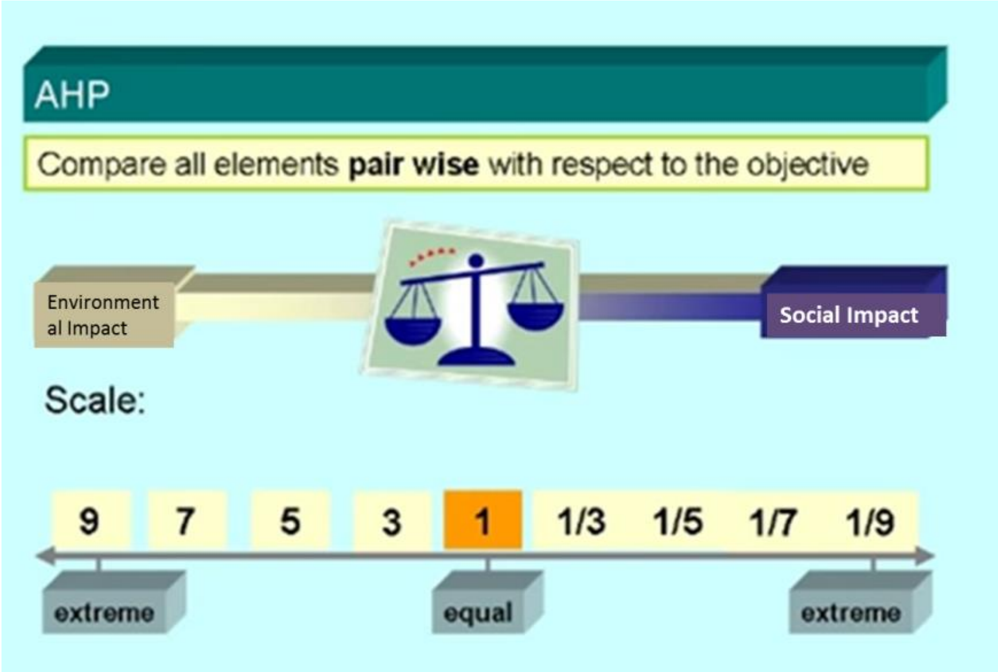
(2) Determination of a total normalized crisp value

$$Y_{ij}^{p} = (\underline{\boxtimes}\tilde{x}_{ij}^{p} \left(1 - \underline{\boxtimes}\tilde{x}_{ij}^{p}\right) + (\overline{\boxtimes}\tilde{x}_{ij}^{p} \times \overline{\boxtimes}\tilde{x}_{ij}^{p}))/(1 - \underline{\boxtimes}\tilde{x}_{ij}^{p} + \overline{\boxtimes}\tilde{x}_{ij}^{p}) \qquad \text{A8}$$

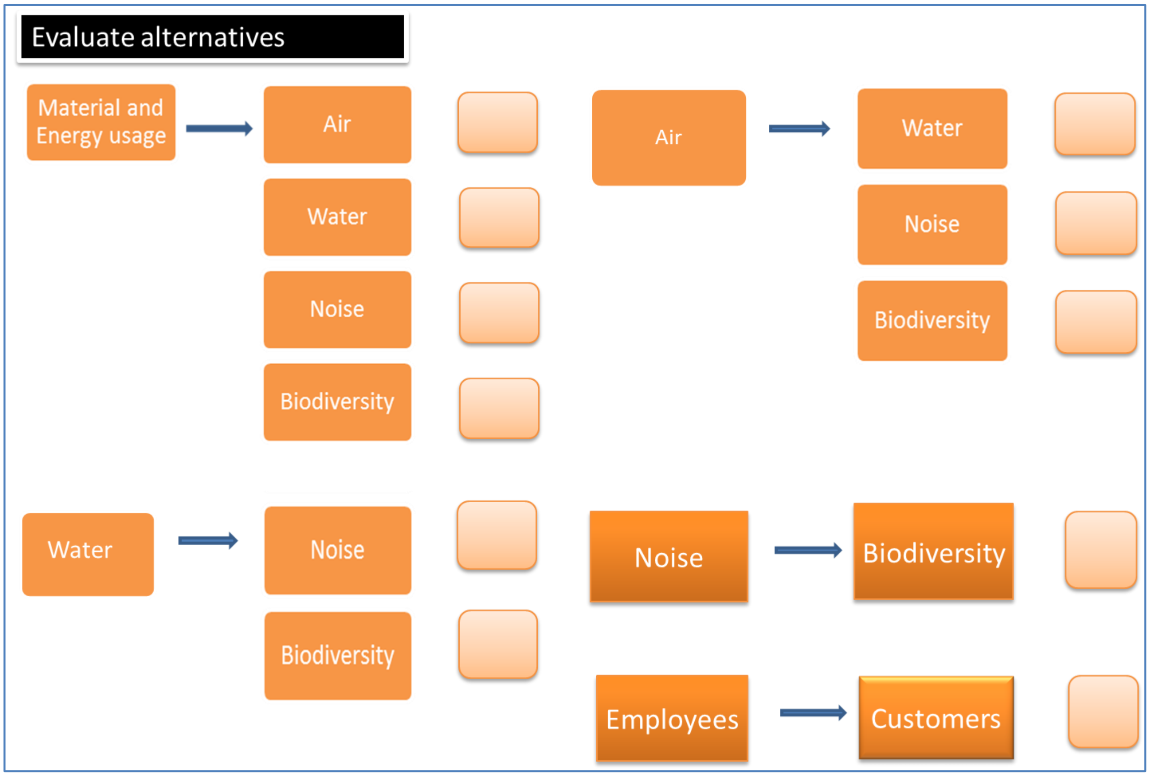
(3) Calculation of the final crisp values

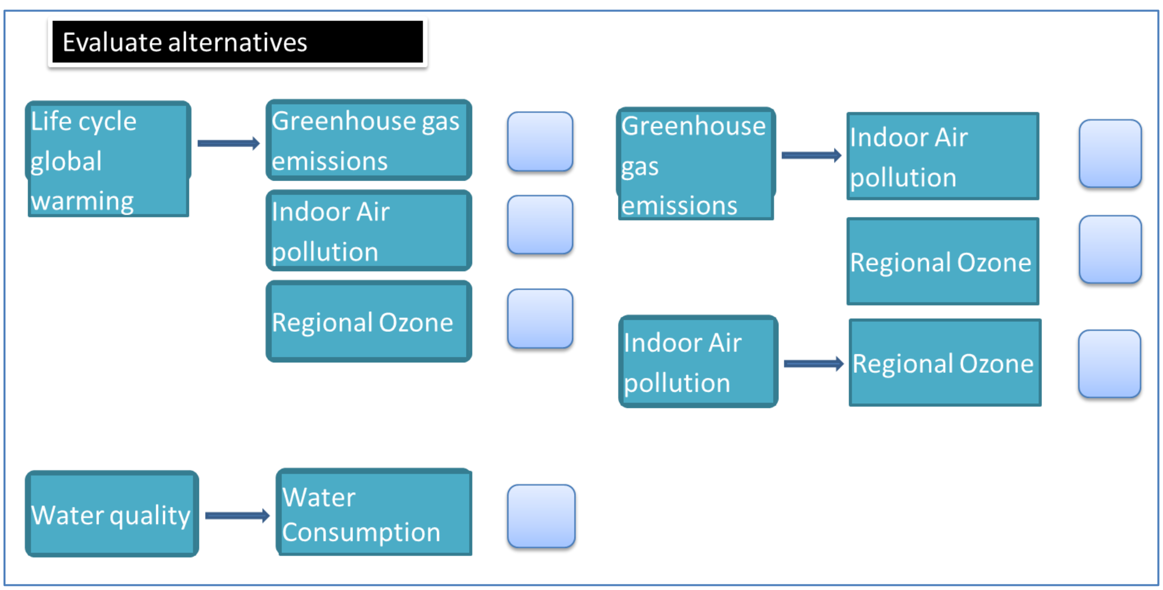
$$z_{ij}^{p} = \min_{j} \underline{\boxtimes} x_{ij}^{p} + Y_{ij}^{p} \Delta_{min}^{max} \qquad \text{A9}$$

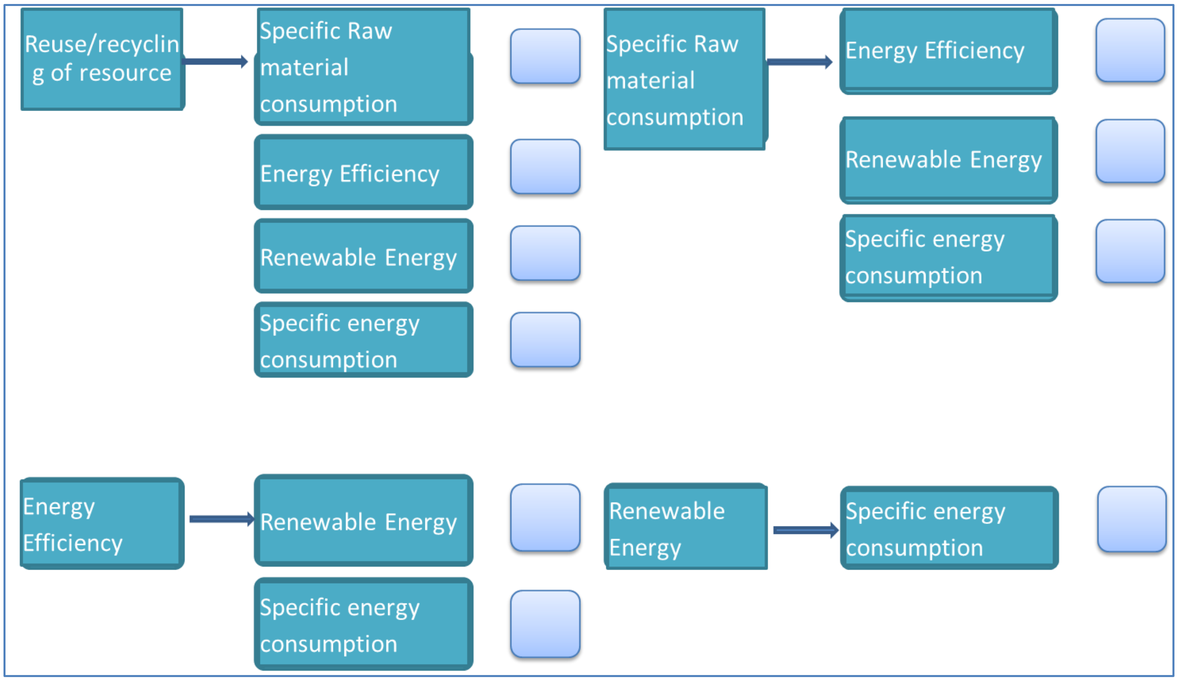
Appendix G. Survey for AHP analysis

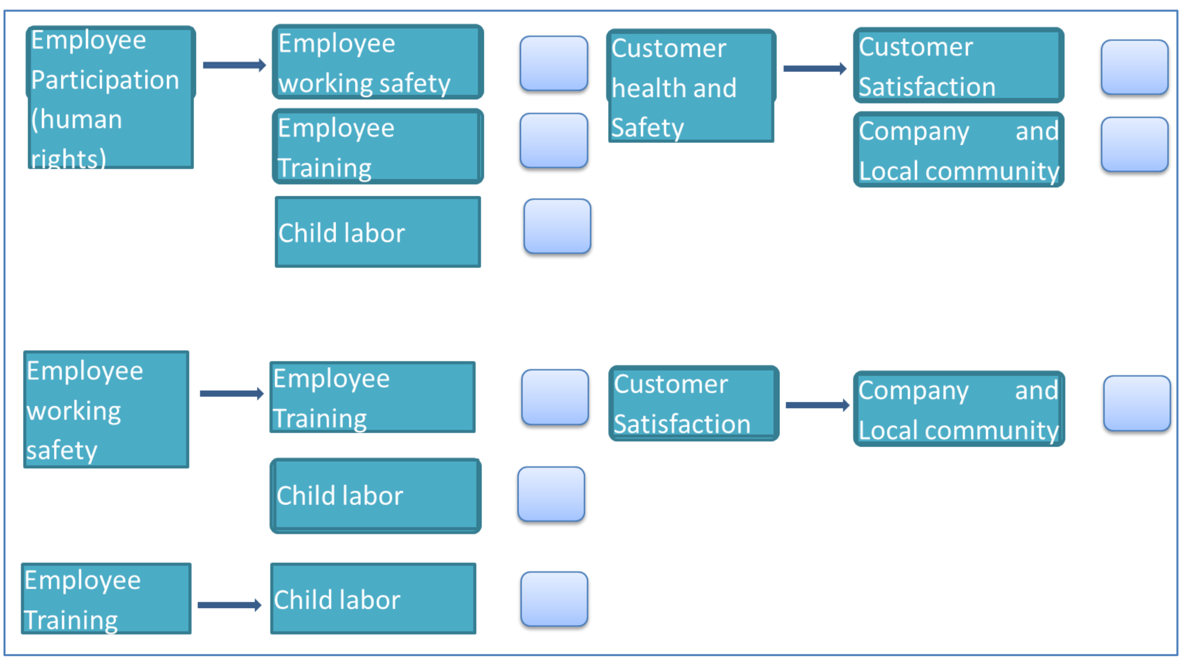


Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Overwhelmingly more important
2,4,6,8	Intermediate value to represent shades of judgment between the five basic assessment


Evaluate alternatives
Material and Energy usage
Air
Water
Noise
Biodiversity
Air
Water
Noise
Biodiversity
Water
Noise
Biodiversity
Noise
Biodiversity
Employees
Customers


Evaluate alternatives
Life cycle global warming
Greenhouse gas emissions
Indoor Air pollution
Regional Ozone
Greenhouse gas emissions
Indoor Air pollution
Regional Ozone
Indoor Air pollution
Regional Ozone
Water quality
Water Consumption


Reuse/recycling of resource
Specific Raw material consumption
Energy Efficiency
Renewable Energy
Specific energy consumption
Specific Raw material consumption
Energy Efficiency
Renewable Energy
Specific energy consumption
Energy Efficiency
Renewable Energy
Specific energy consumption
Renewable Energy
Specific energy consumption


Employee Participation (human rights)
Employee working safety
Employee Training
Child labor
Customer health and Safety
Customer Satisfaction
Company and Local community
Employee working safety
Employee Training
Child labor
Customer Satisfaction
Company and Local community
Employee Training
Child labor

Appendix H. Survey for consumers

Survey for Consumers

General Informaiton

1. What is your gender?

- ◯ Female
- ◯ Male

2. What is your age?

- ◯ 18 to 29
- ◯ 30 to 39
- ◯ 40 to 49
- ◯ 50 to 59
- ◯ 60 to 69
- ◯ more than 70

3. Where are you located now?

Other (please specify)

Next

Survey for Consumers

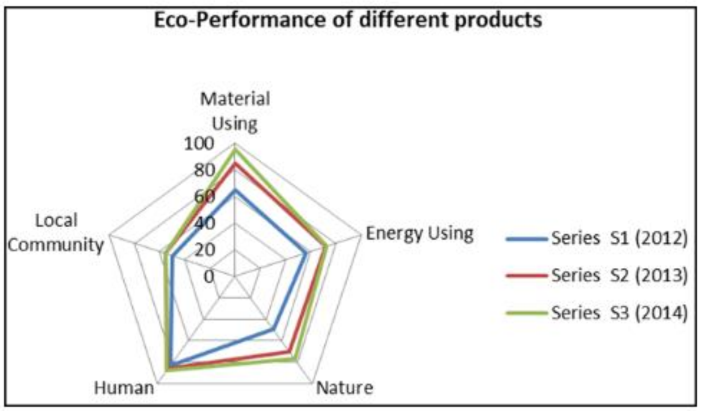
Questions

4. Will you consider sustainability performance of a product when you are purchasing?

- ◯ Extremely likely
- ◯ Very likely
- ◯ Moderately likely
- ◯ Slightly likely
- ◯ Not at all likely

5. From the picture, which product you think is more sustainable? (The higher score means higher performance)

- ◯ Series 1
- ◯ Series 2
- ◯ Series 3



6. How much more you would like to pay for the one you selected in the question above?

- ◯ 0
- ◯ 10%
- ◯ 20%
- ◯ 30%
- ◯ 40%
- ◯ 50%
- ◯ 60%
- ◯ 70%
- ◯ 80%
- ◯ 90%
- ◯ 100%

Prev Next

Survey for Consumers

Questions on importance of attributes

If you were seeking to assess the overall sustainability performance of an automobile, how would you rate the importance of following attributes? Please circle the appropriate number.

1=Very limited importance; 2= Does not matter much; 3 =Moderately important; 4=important; 5=Extremely important

7. In part of environmental impact of a product in its manufacturing phase, how would you rate the importance of following attributes?

	1	2	3	4	5
Reuse/recycling of resource (energy, material, product)	○	○	○	○	○
Specific Raw material consumption	○	○	○	○	○
Energy Efficiency	○	○	○	○	○
Renewable Energy	○	○	○	○	○
Specific energy consumption	○	○	○	○	○

8. Similarly, please select the number of importance of following attributes.

	1	2	3	4	5
Life cycle global warming	○	○	○	○	○
Greenhouse gas emissions	○	○	○	○	○
Indoor Air pollution	○	○	○	○	○
Regional Ozone	○	○	○	○	○
Water quality/Drinking Water influence	○	○	○	○	○
Water Consumption in production	○	○	○	○	○

9. Similarly, please select the number of importance of following attributes.

	1	2	3	4	5
Noise level in production plant	○	○	○	○	○
Wilderness protection	○	○	○	○	○
Overfishing	○	○	○	○	○
Land	○	○	○	○	○

10. In part of social impact of a product in its manufacturing phase, how would you rate the importance of following attributes?

	1	2	3	4	5
Employees'Training	○	○	○	○	○
Employees' Participation	○	○	○	○	○
Employees' Working Safety	○	○	○	○	○
Child Labor	○	○	○	○	○
Customer Health and Safety	○	○	○	○	○
Customer Satisfaction	○	○	○	○	○
Company and Local Community	○	○	○	○	○

11. If there is anything else you would like to tell us, please use the space provided below.

12. If you are also interested to get information about the results of this survey or our further studies in the field of sustainable production and consumption, please do not hesitate to write down your email address so that we can contact you:

Thank you for your kind cooperation in this survey.

Prev Done