A Proposal of Consumer Driven Framework for Enabling Sustainable Production and Consumption

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Abstract. Sustainability becomes the key towards success of manufacturing industries now. Besides increasing efficiency of sustainable industrial processes, sustainable consumption becomes an important complementary strategy for making economies more sustainable gradually. Hence, the research in sustainable production and consumption (SPaC) keeps emerging and the approach of information transition became noticed as the key to promote SPaC. Therefore, there is a notable need for generating proper approach in order to achieve the goal of providing sustainable information of a product for consumers has been discussed.

This paper is looking forward to support the implementation of SPaC by developing a framework aimed at providing sustainable information of a product for consumers. Aspects and attributes have been elicited, and a novel metrics of attributes integrate with life cycle has been developed. Furthermore, a conceptualized framework aimed at evaluating social and environmental performances of a product in its production phase has been developed.

Keywords: Facilitator, SPaC, indicator, framework, consumer driven

1 Introduction

Consumers are key to drive sustainable production and they play a central role in sustainable development [1]. Presently, consumers, even green consumers could not get sufficient information that enable them making greener buying decisions. Facilitator which indicates “Laws, policies and administrative procedures” has been defined in AFI framework, and it used to enable information transition from sustainable production to sustainable consumption[2]. Facilitator is the key element in the whole system and could properly reflect consumers and other stakeholders' attitudes, and it is assured to be function well with the help of infrastructures. From literatures, many kinds of approaches have potential to play the role of facilitator and provide sustainability information for consumers. However, from a systematic review on available approaches, it is showed that in both industrial engineering and marketing science, available approaches or instruments could hardly be directly applied for consumers [3,4]. There is a notable need for generating proper approach or strengthening availa-

ble approaches in order to get the goal of providing sustainable information of a product for consumers[5].

One of the most possible ways of generating facilitator to achieve the goal is to measure sustainability of a product. The instrument could be generated by applying industrial engineering approach and face to stakeholders through appropriate presenting method. Indeed, in last several decades, indices are commonly used approaches for attracting attention and often simplify the problem in order to make the impact of energy consumption and environmental impacts visible in industrial engineering [6]. And they are beneficial for policy making and public communication in sending information of countries' performances about environment, energy, society and economy [7] . Although it is challenging for researchers to cover all topics at the same time, it is still possible to launch by squeezing objective scope to consumers who direct relevant to buying decisions.

This paper will propose a consumer driven framework for enabling sustainable production and consumption by providing sustainability performance information of a product for consumers. This framework is designed to select possible attributes which used to evaluate social and environment performance, from which companies can choose to assess sustainability for their products associated with manufacturing. We used methodology of seven steps of "Sustainability evaluation process" [8] to assess sustainability and employed "Stepwise approach to development of environmental indicators" [9] to select proper indicators. After reviewing on attributes in available sustainability assessments, and considering the objective of this research, a conceptualized framework of facilitator focusing on social and environmental impact in the production phase has been generated.

2 Methodology

2.1 Steps of Sustainability Assessment

Indices for assessing sustainability adopt different constructing steps [8][10][11] . In this research, the methodology adopted is the seven-step "Sustainability evaluation process" [8] (Shown in Table 1). The choice was made based on its property of general applicability of generating single indicator in sustainability assessment.

Table 1. 7 Steps of Sustainability evaluation process (Source: [8])

Step 1. Set sustainability objective	Step 2. Select indicators
Step3. Specify measurement procedures	Step4. Analyze data
Step 5.Report	Step 6. Make managerial decision
Step 7. Evaluate impact	

From previous study[4], the sustainability objective has been fully discussed and well defined as: provide sustainability performance information of a product for consumers in order to make collaborative buying behavior become an incentive for greener manufacturing possible. In Step 2, even though set of indicators are chosen and decided by experts, it is a subjective process since selection of the right set of indicators de-

pends on many factors, such as the type of product, type of processes, final reporting format, budget, approvals required, market, and time availability. Therefore, in this paper, we focused on step 2 "selecting indicators" and the methodology of choosing appropriate indicators will be discussed in the following section.

2.2 Top-Down Approach for Selecting Indicators

A stepwise protocol to develop appropriate sustainable indicators was proposed by Olsthoorn, X., as shown in figure 1 [9]. It is a general protocol for generating environmental indicator that starts from available data collection and then proceeding with normalization, aggregation, together with standardization. An indicator will be presented for its data users at the end.

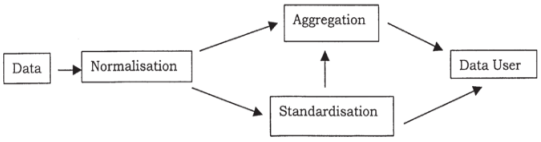

Fig. 1. Stepwise approach to development of environmental indicators (Source: [9])

Compared to above commonly applied stepwise protocol for developing general sustainable indicator, this study focused on providing meaningful, accurate, relevant and cost-effective information for consumers. Therefore, a high emphasis has been put on research on the information needed of consumers.

The selection of key attributes is a crucial task in this study. The very first time the four basic rights which includes safety, information, choice and legal representation of consumer were declared by US President John Kennedy in 1962. Later, the rights to the satisfaction of basic needs, redress, consumer education and a healthy environment were added and adopted by The United Nations in 1985 [12]. Harrison et al. (2005) have proposed some external factors that influence the growth of ethical consumer consumption- a variant of sustainable consumption [13]. And "social and environmental effects of technological advance" was the first dimension of all the perspectives. Therefore, in order to promote sustainable consumption, only sustainability assessment information should be included in this framework, and furthermore, only the information on social and environmental impact of a product should be included.

3 Development of Life Cycle Integrated Metrics

In the field of sustainability assessment, numerous indicators were developed by researchers and practitioners. Past research on reviews of sustainability indicators from the perspective of industrial engineering are common to see [10][14][15]. Various weighting methods of composite indexes have been summarized in [16]. A full list of sub-categories of sustainable performance assessment of a country and involved indicators, plus their related information such as definitions, calculation methods and references were reviewed in the literature [17]. Literatures on achievements and chal-

lenges regarding measuring sustainable development were proposed by Organization for Economic Cooperation and Development [18] .

3.1 Dimension and Aspects Comparison of Indices

From systematic review of available indicators, six publicly available indicators which associate with social and environmental performance assessment have been selected to have a detail study and analysis on [4]. Table 2 shows the list of dimensions of the index. Two main streams of indicator generation could be found in the list of dimensions of indices. One stream is generated in line with the three pillars of sustainability [19]. Impact of social, environmental, and economic performances have been assessed by sub-indicators. Some of them added extra dimensions, such as "well-being" (e.g., CS), or "technical aspects" (e.g., CSPI), or "cost house" (e.g., LInX), to have a complementary list of assessment measures (Reference see Appendix).

Table 2. Comparison of dimensions of index

	CS	CSPI	F-PSI	EPI	G score	E99
Environmental Health	x	x	x	x		
Societal	x	x	x			
Economics	x	x	x			
Organizational Governance		x				
Well-being	x					
Technique		x				
Production Phase			x		x	x
Use Phase			x		x	x
End of life			x		x	x

Another stream of indicators considered life cycle assessment as an important approach when measuring the sustainability of product, so production, using and disposal phases of a product have been regarded as dimensions in this indicator, e.g., E99. In addition, G Score focuses on the production phase of a product, combine with environmental impact. F-PSI has considered both two streams of generation approach and combine sustainability dimensions with life cycle dimensions. This study adapts with definitions of themes and sub-themes in the literature [17].

3.2 Life Cycle Integrated Metrics

In order to carry out the novel metrics integrated life cycle process, a hierarchical diagram is defined using a top-down approach. It includes Dimensions, Aspects and Attributes.

Aspects and attributes are clusted in line with five phases of life cycle of a product. Besides Production, Using and Disposal phases, Transportations between manufacturing and using, and between using and disposal phase should be included. It is suggested that, as a comprehensive framwork for faciliating sustainable consumption, above aspects and attributes should be considered. In the table 3, aspect

of Nature has been listed as a feature which should be assessed through entire life cycle. It is because long term consideration is required in these attributes. In currtent state of research, focus of Consumer Driven Framework was consentrated on aspects and attributes in Production phase and attibutes impact caused in manufacturing phase (as shown in grey area).

Table 3. Metrics of attributes in Consumer Driven Framework with life cycle

	Social Impact	Environmental Impact	
Production	**Human :** Employee Training Employee participation (human right) Child labor Working safety **Company image:** Law suit Local community	**Material:** Reuse/recycling of resource (energy, material, product) Raw Material Extraction Specific Raw material consumption **Energy Using:** Energy Efficiency Renewable Energy Specific energy consumption	**Nature:** Life cycle Air Quality Water Consumption Regional Ozone Urban Particulates Biodiversity and Habitat Average noise level in the periphery of plant dB(A)
Transportation			
Using	Customer health & safety	Fuel Production and Consumption Maintenance Material Production Noise-in-use	
Transportation			
Disposal		Waste Management Energy Process Supplementary Materials Residual value Shredding Dismantling	

4 Development of Consumer Driven Framework

4.1 Goal of Consumer Driven Framework

This framework is designed to integrate all the possible attributes which used to evaluate social and environment performance, from which companies can choose to assess the sustainability for their products associated with manufacturing. Further developed instrument could function well in the mechanism of sustainable consumption as a facilitator. It well connects stakeholders and infrastructure and promotes entire system moving forward.

4.2 Criteria of Developing Consumer Driven Framework

The development of consumer driven framework is decided by following five criteria that suggested for developing a tool for promoting sustainable consumption [5]. First of all, the framework should be capable for meeting consumers' preferences regarding its focusing scope. From the perspective of consumers, the product is the interface they are facing and should make buying decision upon. So it will be much clear if the information is measured and provided based on unit of a product. Beyond considering the content and assessment unit, requirements from consumers are more critical on their presenting format of information. The goal of making information transparency could not be achieved without appropriate format. Therefore, the last three criteria are concerning information transparency ability of the approach. Unless the framework is designed and implemented from consumers' origination, it could hardly be properly applied for consumers. Besides, weather the information is recognizable and weather it has appropriate presenting format are key features. Furthermore, consumers need comparable information regarding their green preferences in order to make greener buying decision.

Therefore, the criteria of consumer driven framework consist of:

(a) Focus on consumers' preferences;

(b) Product based assessment;

(c) Consumers originated;

(d) Degree of recognition by consumers;

(e) Degree of comparability among same type of products.

Additionally, it considered applicability of attributes in the process of developing Consumer Driven Framework.

4.3 Structure of Consumer Driven Framework

The selection of the dimensions of interest to be included in the final model has been based on the literature analysis that led into a preliminary list of associated attributes.

This preliminary consumer driven framework has two dimensions which indicate environmental impact and social impact. Aspects of Nature, Energy Using and Material Using are included in the dimension of environmental impact. Dimension of social impact has aspects of Human and Company Image. Detail attributes are listed in table 4.

Table 4. The proposed list of key aspects and attributes of Consumer Driven Framework

Dimension	Aspect	Attribute
Environmental Impact	Material Using	Reuse/recycling of resource (energy, material, product)
		Raw Material Extraction
		Specific Raw material consumption
	Energy Using	Energy Efficiency
		Renewable Energy
		Specific energy consumption

	Nature	Air	Life cycle global warming
			Greenhouse gas emissions
			Indoor Air pollution
			Regional Ozone
			Nitrogen Loading
			Life cycle Air Quality
		Reducing water stress	Water quality/Drinking Water
			Water Consumption
		Noise level	Average noise level in plant
		Biodiversity	Wilderness Protection (Eco region Protection)
			Timber Harvest Rate
			Agricultural Subsidies
			Overfishing
			Land
Social Impact	Human	Employee	Training
			participation (human right)
			Child labor
			Working safety
		Customer	Satisfaction
			Safety & health
	Company Image	Law suit	
		Local community	

5 Conclusion

This research proposed a framework that aimed at evaluating social and environmental performances of a product in its production phase to help consumers to access the sustainability performance information of a product, and then enhance greener buying decision. The research piece presented in this paper is going to be developed further by introducing detailed formulas for indicators and validating through case studies. Therefore, the proposed framework contributes to the literature in the field development of facilitator in SPaC. The final proposal is a supporting tool for practitioners who can choose to assess sustainability for their products associated with manufacturing based on this framework. A fine-tuned version is thus expected to be released in the near future.

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Reference

1. OECD (2008) Promoting Sustainable Consumption-Good Practices in OECD Countries.
2. Akenji L (2014) Consumer scapegoatism and limits to green consumerism. J Clean Prod 63:13–23. doi: 10.1016/j.jclepro.2013.05.022
3. Taisch M, Shao J (2013) Critical Mapping of Sustainable Index Methodologies. IEEE Int. Conf. Ind. Eng. Eng. Manag.
4. Shao J, Taisch M, Ortega Mier M (2014) Sustainability Assessment Instruments for Consumers. 20th ICE Conf. - IEEE TMC Eur. Conf.
5. Shao J, Taisch M, Ortega M (2014) A Systematic Review on Information Transition Approaches of Sustainable Production and Consumption (SPaC). submitted
6. Bell S, Morse S (2008) Sustainability Indicators-Measuring the immeasurable?, 2nd ed. Earthscan, London • Sterling,VA
7. Amacher GS, Koskela E, Ollikainen M (2004) Environmental quality competition and eco-labeling. J Environ Econ Manage 47:284–306. doi: 10.1016/S0095-0696(03)00078-0
8. Joung CB, Carrell J, Sarkar P, Feng SC (2012) Categorization of indicators for sustainable manufacturing. Ecol Indic 24:148–157. doi: 10.1016/j.ecolind.2012.05.030
9. Olsthoorn X, Tyteca D, Wehrmeyer W, Wagner M (2001) Environmental indicators for business: a review of the literature and standardisation methods. J Clean Prod 9:453–463. doi: 10.1016/S0959-6526(01)00005-1
10. Singh RK, Murty HR, Gupta SK, Dikshit a. K (2009) An overview of sustainability assessment methodologies. Ecol Indic 9:189–212. doi: 10.1016/j.ecolind.2008.05.011
11. Lehni M (1999) Ecoefficiencia World Business Council for Sustainable Development Presentation at WBCSD : Progress toward Sustainability.
12. Ha H, Coghill K, Maharaj EA (2009) Current Measures to Protect E-Consumers ' Privacy in. doi: 10.4018/978-1-60566-012-7.ch006
13. Harrison R, Newholm T, Shaw D, Version E (2005) The Ethical Consumer. SAGE Publication
14. Arena M, Ciceri ND, Terzi S, et al. (2009) A state-of-the-art of industrial sustainability : definitions , tools and metrics. Int. J. Prod. Lifecycle Manag. 4:
15. Dahl AL (2012) Achievements and gaps in indicators for sustainability. Ecol Indic 17:14–19. doi: 10.1016/j.ecolind.2011.04.032
16. Freudenberg M (2003) Composite Indicators of Country Performance: A Critical Assessment. OECD Sci.
17. CSD (2001) Indicators of Sustainable Development: Guidelines and Methodologies.
18. OECD (2009) Policy Brief: Sustainable Manufacturing and Eco-innovation: Towards a Green Economy.
19. Brundtland H (1987) Our common future.

Appendix: List of indicators and references

Compass of Sustainability	CS	Atkisson, B. A., & Hatcher, R. L. "The compass index of sustainability: A five-year review", write for conference "Visualising and Presenting Indicator Systems", Switzerland, 2005.
Composite Sustainability Performance Index	CSPI	Singh, R.K., Murty, H.R., Gupta, S.K., Dikshit, A.K., "Development of composite sustainability performance Index for steel industry", in Ecological Indicators, 7, 565–588, 2007.
Eco-Indicator 99	E99	Pré Consultants, "The Eco-indicator 99 – a damage oriented method for life cycle impact assessment", in Methodology Report. Available at: http://www.pre.nl/, 2001.
Environment Performance Index	EPI	http://epi.yale.edu/
Ford of Europe's Product Sustainability Index	F-PSI	Fleming, J., Ford of Europe's Product Sustainability Index Cost, 2007.
G Score	G	Jung, E., Kim, J., & Rhee, S., "The measurement of corporate environmental performance and its application to the analysis of efficiency in oil industry", in Journal of Cleaner Production, 9(6), 551–563, 2001.