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AN AHP-QFD INTEGRATED APPROACH TO MEET THREE DIMENSIONAL ENVIRONMENTAL VALUE REQUIREMENTS IN SUSTAINABLE E-BUSINESS MODELLING

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Abstract

It is surprising that although 'e-business' and 'sustainability' are the two current major global trends but none of the e-business modelling ideas covers the sustainability aspects of the business. Environmental value requirement is one of the three pillars of sustainability concept that must be fulfilled to achieve a fully sustainable e-business model. A little literature is available on 'sustainability of ICT' but none of them clearly explains how environmental value requirements can be identified and efficiently fulfilled to achieve sustainability in e-business. Recently, companies are successfully using Quality Function Deployment (QFD) as a powerful tool in various fields that addresses strategic and operational decisions in businesses. This research approach, therefore, uses an Analytic Hierarchy Process (AHP) integrated QFD approach to show how environmental value requirements can be identified and efficiently fulfilled to achieve sustainability of e-business with a comprehensive case study. This approach is unique in the sense that in developing the model environmental value requirements are considered from three dimensions and environmental value concept is integrated with customer's value requirements, business's value requirements, and process's value requirements. The approach uses the case of a commercial bank in Bangladesh for the demonstration of the approach.

Keywords: Environmental value, QFD, Business model, Sustainability, E-business, AHP.

1 INTRODUCTION

Business modelling is not new and has had substantial impacts on the way businesses are planned and operated these days. The majority of research into business models in the information systems field has been concerned with e-business and e-commerce; and there have been some attempts to develop convenient classification schemas (Al-Debei & Avison, 2010). For example, definitions, components, and classifications into e-business models have been suggested (Afua & Tucci, 2001; Alt & Zimmerman, 2001). Timmers (1998) was the first who defined e-business model in terms of the elements and their interrelationships. Applegate (2001) introduces the six e-business models: focused distributors, portals, producers, infrastructure distributors, infrastructure portals, and infrastructure producers. Daniel et al. (2004) proposed a framework for achieving sustainability of e-marketplaces. More e-business approaches are proposed by Morris et al. (2005), Weill and Vitale (2002), Rappa (1999), Dubosson-Torbay et al. (2001), Tapscott, Ticoll and Lowy (2000), Gordijn and Akkermans (2001) and many more. But surprisingly, sustainability concept is still entirely absent in the e-business modelling area. Sustainable business means a business with dynamic balance among three mutually inter dependent elements: (i) protection of ecosystems and natural resources; (ii) economic efficiency; and (iii) consideration of social wellbeing such as jobs, housing, education, medical care and cultural opportunities” (Bell & Morse, 2009). Importantly, it has been evident that there is a positive correlation between environmental and social sustainability and economic return (Carter & Rogers, 2008). Even though many scholars enlightened their study on sustainability but still “most companies remain stuck in social responsibility mind-set in which societal issues are at the periphery, not the core. The solution lies in the principle of shared (blended) value, which involves creating economic value in a way that also creates value for society by addressing its needs and challenges” (M. E. Porter & Kramer, 2011). But these blended value or shared value definitions in the literature neither directly include the business value nor the process value. Business value is vital in the sense that it safeguards the interest of the organisation and helps to keep in track for achieving goals. Similarly, process value is another vital element as it supports to produce both customer value and business value (Dewan & Quaddus, 2012). Therefore, we define three dimensional environmental value as the environmental value for customer, business, and value process. Moreover, most of the scholars mainly express the needs for blended value and a very few of them provide with only hypothetical ideas for maintaining sustainability. A comprehensive e-business model for sustainability with the directions to meet environmental value requirements of all stakeholders is yet to be developed.

E-business is the point where economic value creation and information technology/ICT come together (Akkermans, 2001). But ICT can have both positive and negative impacts on the society and the environment. Positive impacts can come from dematerialization and online delivery, transport and travel substitution, a host of monitoring and management applications, greater energy efficiency in production and use, and product stewardship and recycling; and negative impacts can come from energy consumption and the materials used in the production and distribution of ICT equipment, energy consumption in use directly and for cooling, short product life cycles and e-waste, and exploitative applications (Houghton, 2010). But it is believed that corporations have the knowledge, resources, and power to bring about enormous positive changes in the earth’s ecosystems” (Shrivastava, 1995). A sustainable society uses ICT for fostering a good life for all human beings of current and future generations by strengthening biological diversity, technological usability, economic wealth for all, political participation of all, and cultural wisdom (Fuchs, 2008). In such a theoretical lacuna regarding sustainability and e-business modelling the aim of this paper is to identify the environmental value requirements for all stakeholders necessary to develop a sustainable e-business model for banking industry. This research approach also directs the strategic and operational settings of the organizations to the fulfilment of those environmental value requirements. This research approach is unique in the sense that in developing the model environmental value concept is integrated with customer’s value requirements, business’s value requirements, and process’s value requirements instead of only customer’s requirements. The value requirements from these three dimensions are considered crucial for sustainable e-business modelling (Dewan & Quaddus, 2012). The case of a commercial bank in Bangladesh is used for the demonstration of the approach. Therefore, we, in this paper use AHP integrated QFD approach to: (i) explore and determine the three

dimensional environmental value requirements in developing e-business model; and (ii) decide design requirements (DRs) to fulfil those requirements. This approach also shows how the design requirements are related to assist the decision makers in deciding strategies by developing House of Environmental Sustainability. The following section of the article covers extensive literature review on blended value based sustainable e-business modelling, three dimensional environmental value requirements, QFD, and AHP. Section 3 explicates the rationale for the three dimensional environmental value requirements in e-business modelling. The detailed research methodology and the case study are covered in Section 4 and Section 5 respectively. Section 6 is consists of an analysis on findings and limitation of the approach; and finally, Section 7 concludes the article with further research direction.

2 LITERATURE REVIEW

2.1 Blended value based e-business modelling

The sustainable e-business modelling approach by Dewan, Chowdhury, and Quaddus (2012b) uses 'organisational value requirements' and 'sustainability' as the main elements. According to the approach, organisational value includes three values: customer value, business value, and process value; and sustainability of business includes economic value, social value, and environmental value. The authors argue that to be competitive in the market the value need to be measured from three dimensions: (i) What total value is demanded by the customers? (ii) What total value is required by the businesses based on their strategies to reach their goals? and (iii) What process value is required by the businesses to have a sustainable value processes? Consequently, based on the measurement from three dimensions blended value requirements are categorised into nine groups (Dewan, Chowdhury, & Quaddus, 2012a) which are used as the main elements of the approach.

2.2 Description of the three dimensional environmental value requirements

2.2.1 Environmental value requirements for customer (EnVR1)

Currently environmental value has become a significant requirement for the customers. Customers, suppliers, and public are increasingly demanding that businesses minimize any negative impact of their products and operations on the natural environment (Klassen & Whybark, 1999). Customers now do not just look at the economic value of the product or service, they also want to know whether that product or service or the supplier of that product or service cause any impact on the environment. They also want to know, if there is any impact, then whether it is positive or negative, and to what extent; because they believe business have major role to play in helping and enhancing the environment and thus, every business should develop sound environmental management policies for processes and products (Demirdogen, 2007). As a whole, the customers want the businesses to act more responsibly by performing an important and positive role in the society through creating additional environmental value for the future generations.

Environmental value requirements include all the environmental factors related directly or indirectly, to the product or service delivered to the customer or they can be somehow related to the operations of supplier of the product or service, such as, emissions (air, water, and soil), waste, radiation, noise, vibration, energy intensity, material intensity, heat, direct intervention on nature and landscape, etc (Figge, Hahn, Schaltegger, & Wagner, 2002). The impacts on the environment may occur directly from the product or service, and/or they may occur internally within the organisation, and/or they may occur along the value chain of the businesses. Bovea and Vidal (2004) suggest how more value can be added to the product for the customer by integrating environmental impact, costs and customer evaluation during the product design process. Munoz and Sheng (1995) present a model which they believe can serve as a framework for decision-making in environmentally-conscious manufacturing. Moreover, it is noticeable now that numerous businesses have already implemented plan to minimise the impact on the environment. For example, Intel and IBM are both devising ways to help utilities harness digital intelligence in order to economize on power usage (M. E. Porter & Kramer, 2011).

2.2.2 *Environmental value requirements for business (EnVR2)*

According to Denton (1994), adding environmental value can be a competitive advantage for the businesses since businesses can differentiate themselves by creating products or processes that offer environmental benefits. To be competitive in the market businesses need to act environmental friendly these days. As mentioned in the section EnVR1 above, there are number of ways how businesses can minimise the impact on the environment. By implementing environmental friendly operations businesses may achieve cost reductions, too. For example, minimum use of environmentally-toxic chemicals, reduced contaminations, recycling of materials, improved waste management and reuse or recycling of waste, using fuel efficient machineries, minimize packaging, using recycled water, etc. reduce the impact on the environment and at same time they may reduce the costs of the businesses. Businesses themselves identify these environmental value requirements based on the environment they are operating and aim to achieve some goals by fulfilling these requirements. In the section EnVR1, we discussed environmental value requirements that are demanded by the customers but these environmental value requirements are identified by the businesses for their different business goals that they aim to achieve in time. For example, one of the principles of Lever Bros Ltd. is to take great care to minimize the environmental impact of all their operations- from raw material procurement, product design, manufacture and distribution- to use and disposal (Zairi & Peters, 2002).

2.2.3 *Environmental value requirements for process (EnVR3)*

To minimize the impact of current value processes on the environment these value requirements need to be fulfilled. To fulfil these requirements the businesses try to find and implement all the necessary steps within the existing processes that will stop or reduce the chances of effecting the environment, thus, adding some value to the environment. These requirements are identified within the current value process system by the managers so that they can be fulfilled and can start adding more value immediately. EnVR1 requirements are demanded by the customers but EnVR2 and EnVR3 are identified by the businesses themselves to increase the value by increasing the efficiencies in the business processes now and in the future respectively. For example, leakage of water/oil/heat, incompetent waste management, inefficient disposal and recycling of materials, unplanned pollution (air, water, sound) management, uncontrolled ecosystem stress, heating and lighting inefficiency, etc. will result in incompetency in the value processes for the businesses. Hence, businesses may get rid of these inefficiencies and add value to the value creation processes by fulfilling these environmental value requirements.

2.3 **Quality Function Deployment (QFD)**

QFD was laid out in the late 1960s to early 1970s in Japan by Akao (1990). QFD is based on collecting and analysing the voice of the customer that help to develop products with higher quality and meeting customer needs (Delice & Güngör, 2010). The product design and development process is supported by QFD. Therefore, it can be also used to analyse business needs and value process needs. Recently, companies are successfully using QFD as a powerful tool that addresses strategic and operational decisions in businesses (Mehrjerdi, 2010). Chan and Wu (2002) and Mehrjerdi (2010) provide a long list of areas where QFD has been applied. QFD, in this approach, will be applied as the main tool to analyse environmental value requirements of customer, business, and process. It will also be used to develop and select design requirements to meet the environmental value requirements for the sustainability of the e-businesses. In QFD modelling, 'environmental value requirements' are referred as WHATs and 'how to fulfil the environmental value requirements' are referred as HOWs.

2.4 **Analytic Hierarchy Process (AHP)**

AHP is an established multi-criteria decision making approach that employs a unique method of hierarchical structuring of a problem and subsequent ranking of alternative solutions by a paired comparison technique. AHP was originally developed by Saaty (1980). The strengths of AHP is lied on its robust and well tested method of solution and its capability of incorporating both quantitative and qualitative elements in evaluating alternatives (Das & Mukherjee, 2008). AHP is frequently used

in QFD process, for instance, Georgiou et al. (2008), Han et al. (2001), Das and Mukherjee (2008) Lu et al. (1994), Armacost et al. (1994), Park and Kim (1998), Mukherjee (2011), Koksal and Egitman (1998), and more. In this research approach, based on customer value requirements, business value requirements, and process value requirements AHP will be used to prioritize the three dimensional environmental value requirements before developing design requirements in QFD process.

3 RATIONALE FOR THE THREE DIMENSIONAL ENVIRONMENTAL VALUE REQUIREMENTS

There was a time when businesses limited their view of business profitability as they were only aware of economic gain and were focused on sound financial systems to maintain that gain. Then slowly the trend for socially and environmentally conscious businesses started and now to compete in the market businesses need to deliver not only the economic value but the sustainable value. Therefore, to satisfy the customers, only economic value is not enough. Instead of economic value in early days, customers now want to know what total value they are going to receive from the businesses (Dewan et al., 2012a). These environmental, social, and economic values cannot be fully achieved only by fulfilling the requirements of businesses or customers. Therefore, to achieve sustainability, value propositions of the businesses must include customer value, business value, and process value to produce and deliver complete sustainable value.

The 'stakeholder theory' is sincerely considered in this research approach while identifying the elements of sustainable e-business modelling as there are multiple stakeholders involved in e-business modelling. Stakeholder theory holds the idea that businesses shall take decision considering the interest and impact of all stakeholders. The task of management is to maintain a balance among the conflicting interests of stakeholders. If a balance cannot be ensured organizational sustainability will be questioned (Freeman, 1984). Hence, it can be summed up that for the sustainability of the business stakeholder theory indicates the development of a business model that recognizes the value requirements of multiple stakeholders. According to the literature, the sustainable value must include values from three areas: (a) Economic value, (b) Social value, and (c) Environmental value. Importantly, businesses must also realise that to be competitive in the market this value need to be measured from three dimensions (Dewan et al., 2012a):

Dimension 1: What environmental value is demanded by the customers?

To sustain, every business must find out the requirements that need to be fulfilled to minimize the gap of what value the customers are receiving and what value they are expecting. Businesses need to see whether the customers are receiving the environmental value that they are expecting, or not. If not, the businesses must identify all the existing discrepancies and try to fulfil those discrepancy requirements to deliver the environmental value to the customers effectively. Generally, voice-of-the-customer (VOC) approach is used to identify these discrepancies.

Dimension 2: What environmental value is required by the businesses based on their strategy to reach their goals?

Conventionally, customer requirements were the only concern for the businesses to compete successfully in the market and still now there is no doubt about the importance of customer requirements in business. But nowadays only fulfilment of customer requirements does not guarantee the long term competency and profitability for the businesses. To compete successfully every business must have their own clear goal defined in their strategy that they want to achieve in time. This dimension includes all the business requirements necessary to reach the organisational targets.

Dimension 3: What environmental value is required by the businesses to have efficient value processes?

Simply producing and delivering the value is not enough to be competitive these days. Rather, value need to be produced effectively by the businesses to compete and to ensure profitability for the long run. To produce value effectively, efficient process is a must. All the inefficiencies of the value

processes must be identified and corrected to produce the environmental value effectively. This dimension of measurement includes all the requirements that are necessary to make all the processes of a business environmentally efficient.

4 RESEARCH METHODOLOGY

Research paradigm can be classified as two types: positivist and interpretivist (Onwuegbuzie & Leech, 2005). In positivist research, reality is independent from the researcher and the research is objective oriented (Johnson & Onwuegbuzie, 2004; Smith, 1983) and data collection, analyses are value-free rather than subjective interpretation (Krauss, 2005). This research approach complies with the framework of positivist paradigm as the research is very much objective oriented with regards to identifying the three dimensional environmental value requirements and corresponding design requirements using AHP integrated QFD. An inquiry to the previous researches affirms that QFD has been used frequently in object oriented research. In a QFD analysis the following steps are followed:

Step 1: Identification of the three dimensional environmental value requirements that are termed as WHATs;

Step 2: Relative importance ratings of WHATs are determined by using AHP method;

Step 3: Design requirements (HOWs) to fulfil the three dimensional environmental value requirements are generated;

Step 4: Correlation between design requirements (HOWs) are determined;

Step 5: Relationships between WHATs and HOWs are determined;

Step 6: Relative importance of HOWs are determined;

Step 7: Based on the rankings of weights of HOWs the design requirements are selected.

Before developing the QFD framework the relative importance ratings of WHATs are determined by using AHP method following the approach of Quaddus and Siddique (2001). In this regard data have been collected from strategic managers, decision makers of IT Division, corporate customers, and retail customers of a particular bank which is top ranked both in implementing ICT and in CSR activities in Bangladesh. The banking industry has been chosen for this approach since financial institutions are critically dependent on information systems activity for daily operations (Broadbent & Weill, 1993; McFarlan, McKenney, & Pyburn, 1983). Moreover, banks are information-intensive and highly dependent on information technology as their core technology (Jarvenpaa & Ives, 1990; M. Porter & Millar, 1985). Face to face semi-structured interview has been conducted for collecting data regarding identification of environmental value requirements (WHATs) and design requirements (HOWs). The primary aim of employing semi-structured interviews is to gain in-depth insight into the perceptions of the individual interviews and to develop a greater understanding of environmental value requirements in Bangladesh rather than to draw generalizations from this study (Soh & Martinov-Bennie, 2011; Turley & Zaman, 2007). The average interview time was around sixty-eighty minutes. The opinion of the decision makers regarding the importance of WHATs has been collected following the scale developed by Saaty (1980) then the scores are averaged for analysis based on AHP. Then the respondents have been asked about corresponding design requirements (HOWs) for QFD analysis. In developing the QFD framework the relationship between environmental value requirements and corresponding design requirement (DR) is described as Strong, Moderate, Little, or No relationship which are later replaced by weights (e.g. 9, 3, 1, 0). These weights are used to represent the degree of importance attributed to the relationship. Thus, as shown in Table 1, the importance weight of each design requirement can be determined by the following equation:

$$D_w = \sum_{i=1}^n A_i R_{iw} \forall_w, \quad w = 1, \dots, m \quad \dots \quad (1)$$

Where, D_w = Importance weight of the w th design requirement;

A_i = Importance weight of the i th environmental value requirement;

R_{iw} = Relationship value between the i th environmental value requirement and w th design requirement;

m = Number of design requirements; and n = Number of environmental value requirement.

In Table 2, customer's environmental value requirements, business's environmental value requirements and process's environmental value requirements are considered as part of the three dimensional environmental value requirements. The importance weights of these environmental value requirements are calculated using AHP by discussion with the same respondents. Then geometric means of those importance weights were used to ignore the biasedness of the data. According to the QFD matrix the absolute importance of the environmental value requirements can be determined by the following equation:

$$AI_i = \sum_{w=1}^n R_i D_w \forall_w, \quad w = 1, \dots, m \quad \dots\dots\dots (2)$$

Where, AI_i = Absolute importance of the i th environmental value requirement (BR_i);

R_i = Importance weight of the i th environmental value requirement;

D_w = Importance weight of the w th design requirement to fulfil the requirements;

Therefore, the absolute importance for the 1st customer's environmental value requirement (BR_{i1}) will be:

$$AI_{i1}^{SC} = R_{i1}D_{w1} + R_{i1}D_{w2} + \dots + R_{i1}D_{wm}$$

Thus, the relative importance of the 1st customer's environmental value requirement (BR_{i1}) will be:

$$RI_{i1}^{SC} = \frac{AI_{i1}}{\sum_{i=1}^n AI_i} \quad \dots\dots\dots (3)$$

Where, RI_{i1}^{SC} = Relative importance of the 1st customer's environmental value requirement (BR_{i1});

AI_{i1}^{SC} = Absolute importance of the 1st customer's environmental value requirement (BR_{i1});

Environmental Value Requirements		DR_1	DR_2	.....	DR_m	A. I.	R. I.
CEVs	VR_{i1}	$R_{i1}D_{w1}$	$R_{i1}D_{w2}$	.....	$R_{i1}D_{wm}$	AI_{i1}	RI_{i1}
	VR_{i2}	$R_{i2}D_{w1}$	$R_{i2}D_{w2}$	.....	$R_{i2}D_{wm}$	AI_{i2}	RI_{i2}
	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots
	VR_{in}	$R_{in}D_{w1}$	$R_{in}D_{w2}$	.....	$R_{in}D_{wm}$	AI_{in}	RI_{in}
BEVs	VR_{j1}	$R_{j1}D_{w1}$	$R_{j1}D_{w2}$	.....	$R_{j1}D_{wm}$	AI_{j1}	RI_{j1}
	VR_{j2}	$R_{j2}D_{w1}$	$R_{j2}D_{w2}$	.....	$R_{j2}D_{wm}$	AI_{j2}	RI_{j2}
	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots
	VR_{jn}	$R_{jn}D_{w1}$	$R_{jn}D_{w2}$	.....	$R_{jn}D_{wm}$	AI_{jn}	RI_{jn}
PEVs	VR_{k1}	$R_{k1}D_{w1}$	$R_{k1}D_{w2}$	.....	$R_{k1}D_{wm}$	AI_{k1}	RI_{k1}
	VR_{k2}	$R_{k2}D_{w1}$	$R_{k2}D_{w2}$	.....	$R_{k2}D_{wm}$	AI_{k2}	RI_{k2}
	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots	\vdots
	VR_{kn}	$R_{kn}D_{w1}$	$R_{kn}D_{w2}$	.....	$R_{kn}D_{wm}$	AI_{kn}	RI_{kn}
A. I.		AI_{d1}	AI_{d2}	....	AI_{dm}		
R. I.		RI_{d1}	RI_{d2}	....	RI_{dm}		

Note: A.I.= Absolute importance; R.I.= Relative importance; DR= Design requirements; CEVs= Customer's Environmental Value Requirements; BSVs= Business's Environmental Value Requirements; PSVs= Process's Environmental Value Requirements.

Table 1: QFD matrix.

Similarly, the absolute importance and the relative importance of all other requirements (CEVs, BEVs, and PEVs) can be determined by following the Equations (2) and (3). Now, the absolute value for the first design requirements (AI_{d1}) will be:

$$AI_{d1} = R_{i1}D_{w1} + R_{i2}D_{w1} + \dots + R_{in}D_{w1}$$

In the same way, the relative importance of the 1st design requirements (RI_{d1}) can be determined by the following equation:

$$RI_{d1} = \frac{AI_{d1}}{\sum_{d=1}^n AI_d} \dots\dots\dots (4)$$

Where, RI_{d1} = relative importance of the 1st design requirement (DR_1);

AI_{d1} = Absolute importance of the 1st designrequirement (DR_1);

If we assume that there are n total environmental value requirements which include n_1 customer's environmental value requirements, n_2 business's environmental value requirements, and n_3 process's environmental value requirements, then,

$$n_2 = n - (n_1 + n_3)$$

$$n_3 = n - (n_1 + n_2)$$

Again, if we consider w_c , w_b , and w_p as the weights of the customer's environmental value requirements (CEVs), business's environmental value requirements (BEVs) and process's environmental value requirements (PEVs) decided by the decision makers respectively, then,

$$w_c + w_b + w_p = 1$$

Therefore, the relative importance of integrated environmental value requirements (IEVRs) can be determined as follows:

$$RI_i^{IEVR} = w_c RI_i^{CEV} \quad i = 1, 2, \dots, n_1$$

$$RI_i^{IEVR} = w_b RI_i^{BEV} \quad i = n_1 + 1, n_1 + 2, \dots, n_2$$

$$RI_i^{IEVR} = w_p RI_i^{PEV} \quad i = n_2 + 1, n_2 + 2, \dots, n$$

Now if we assume that there are n number of environmental value requirements and for them we need m number of design requirements then the rating R_{qt} between each pair of the q^{th} customer's environmental value requirement (CEVs) and the t^{th} design requirements (DR_t) is acquired from a teamwork (Özgener, 2003; Wang & Hong, 2007) with the weighting value of 0-1-3-9 to represent no, weak, moderate, or strong relationship. To allow the possible inter-dependence among the design requirements let assume δ_{tu} denote the correlation between DR_t and DR_u . So, by adapting Wasserman(1993) a normalised R_{qt} can be defined as follows:

$$R_{qu}^{norm} = \frac{\sum_{t=1}^m R_{qt} \delta_{tu}}{\sum_{u=1}^m \sum_{t=1}^m R_{qt} \delta_{tu}} \dots\dots\dots (5)$$

where, $q = 1 \dots \dots n$ and $u = 1 \dots \dots m$

Therefore, by integrating R_{qu}^{norm} with RI_i^{IEVR} the overall importance weights of the design requirements can be determined as follows:

$$AI_u^{DR} = \sum_{i=1}^n RI_i^{IEVR} R_{qu}^{norm} \dots\dots\dots (6)$$

where, $u = 1 \dots \dots m$

$$RI_u^{DR} = \frac{AI_u^{DR}}{\sum_{u=1}^m AI_u^{DR}} \dots\dots\dots (7)$$

where, $u = 1 \dots \dots m$

The initial absolute importance and the relative importance of all other design requirements can be determined by following the Equation (1) and (4). Based on the example of customer's environmental value requirement weights in Equation (2), Equation (3), and Equation (5) we can determine the normalised ratings of integrated environmental value requirements and design requirements. Then by integrating the normalised ratings of environmental value requirements and design requirements and the relative importance weight of the environmental value requirements we can define final absolute importance weight and relative importance weight of the design requirements as shown in Equation (6) and (7). The physical relationships among the design requirements are specified on an array

known as the “roof matrix”. In the roof matrix four types of relations have been shown namely strong, medium, weak, and no relation which are represented by the following symbols: \surd = Very strong relation; Δ = strong relation; \square = weak relation; \diamond = no relation.

5 CASE STUDY

Developed countries are already enjoying the benefits of e-banking. Apart from the developed countries, the developing countries are also experiencing sturdy growth in e-banking including India, Thailand, Malaysia, Philippines and more (Mia, Rahman, & Uddin, 2007). Bangladesh is also experiencing the similar growth in e-banking. Bangladesh ranked 115th in the Global Network Readiness Index in 2010-2011 up from 130th in 2008-2009 (Dutta & Bilbao-Osorio, 2012) showing an significant upward trend in the ICT sector. Among all other businesses in Bangladesh the banking sector is ahead in implementing e-businesses, which is also termed as e-banking. Currently a number of private commercial banks and foreign commercial banks in the country are offering limited services of telebanking, internet banking, and online banking facilities. As a part of the stepping forward to e-banking, the foreign commercial banks played the pioneering role with adoption of modern technology in retail banking during the late 1990s whereas the state owned commercial banks and private commercial banks came forward with such services recently (Hasan, Baten, Kamil, & Parveen, 2010). On 28 February 2011, the Central Bank of Bangladesh inaugurated the EFT (Electronic Funds Transfer) payment systems which is now being used by the 40 banks out of a total of 47 banks (30 private, 9 foreign, 4 state-owned, 4 specialized).

As the reach of ICT expands into the developing world, so does its impact on the society and environment, both positive and negative (Ansari, Ashraf, Malik, & Grunfeld, 2010). Although almost all the banks are implementing ICT to sustain in the competition the sustainability of ICT is still not considered as the business driver in Bangladesh. Most of the banks have started realising the importance of the sustainability concept in e-business but still do not know how to achieve it through the fulfilment of environmental and social requirements. Few of the banks are trying to contribute for the environmental development but contributing fields are chosen in a standalone fashion without any analysis of the environmental value requirements by customer, business, or process. The prevalence of this circumstance has motivated the researchers to conduct the study particularly on banking industry of Bangladesh. The name of the case company is Dutch-Bangla Bank Limited (DBBL). The company is operating with its 125 online branches and about 2500 ATM booths around the country. The bank also provides Internet banking facilities. The following sections enumerate the case study analysis and discussion by applying an AHP-integrated QFD approach. Following the research steps in methodology section the QFD process in this case study starts with identification of environmental value requirements (WHATs) and their weights. Consequently, identification of design requirements (HOWs) corresponding to the environmental value requirements are discussed and so on.

5.1 Identification of environmental value requirements (WHATs)

As per the opinion of the respondents of the case company the following environmental value requirements have been identified:

5.1.1 *Environmental value requirements for customer*

The identified important environmental value requirements for customers are as follows: (i) Energy resources (CEV1); (ii) Air resources (CEV2); (iii) Usage of materials (CEV3); (iv) Commitment for future generations (CEV4); (v) Environmental policy and management (CEV5); (vi) Environmental legislation compliance (CEV6); and (vii) Land resources (CEV7) (see Figure 1 and Table 2).

5.1.2 *Environmental value requirements for business*

The following are the identified important environmental value requirements for business: (i) Fuel and power consumption (BEV1); (ii) Environmental legislation compliance (BEV2); (iii) Internal

environmental policy and management (BEV3); (iv) Usage of materials (BEV4); (v) Commitment for future generations (BEV5); (vi) Air pollution (BEV6); and (vii) Land resources (BEV7) (see Figure 2 and Table 2).

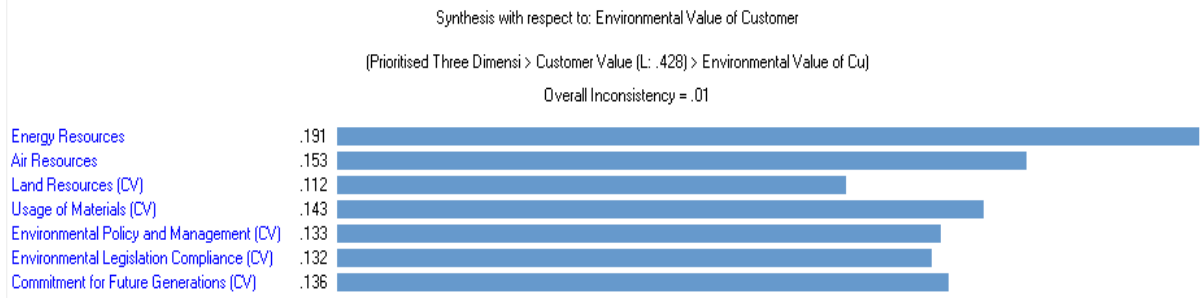


Figure 1: Weights of the environmental value requirements for customer.

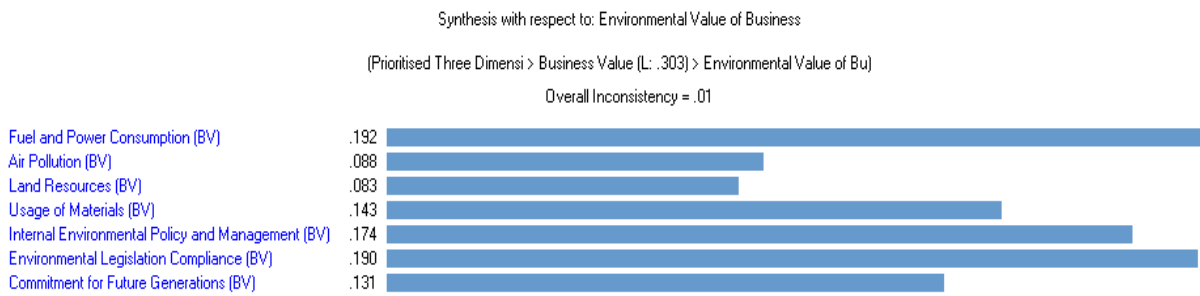


Figure 2: Weights of the environmental value requirements for business.

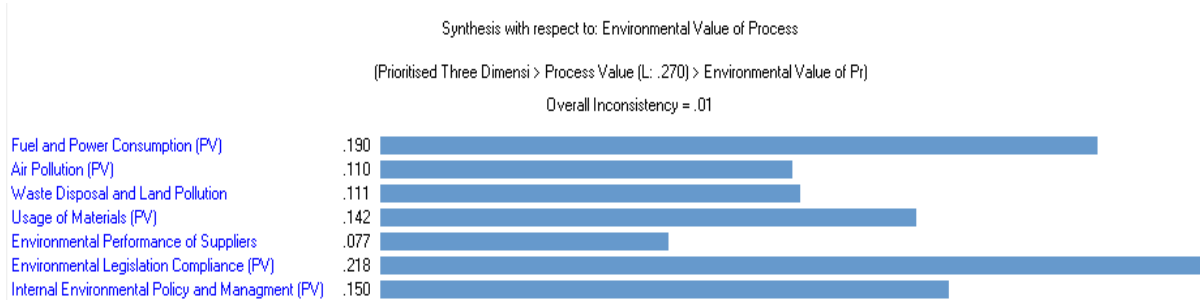


Figure 3: Weights of the environmental value requirements for process.

5.1.3 Environmental value requirements for process

The identified important environmental value requirements for process are: (i) Environmental legislation compliance (PEV1); (ii) Fuel and power consumption (PEV2); (iii) Internal environmental policy and management (PEV3); (iv) Usage of materials (PEV4); (v) Waste disposal and land pollution (PEV5); (vi) Air pollution (PEV6); and (vii) Environmental performance of suppliers (PEV7) (see Figure 3 and Table 2).



Figure 4: Weights of the three dimensional environmental value.

Overall Inconsistency = .01

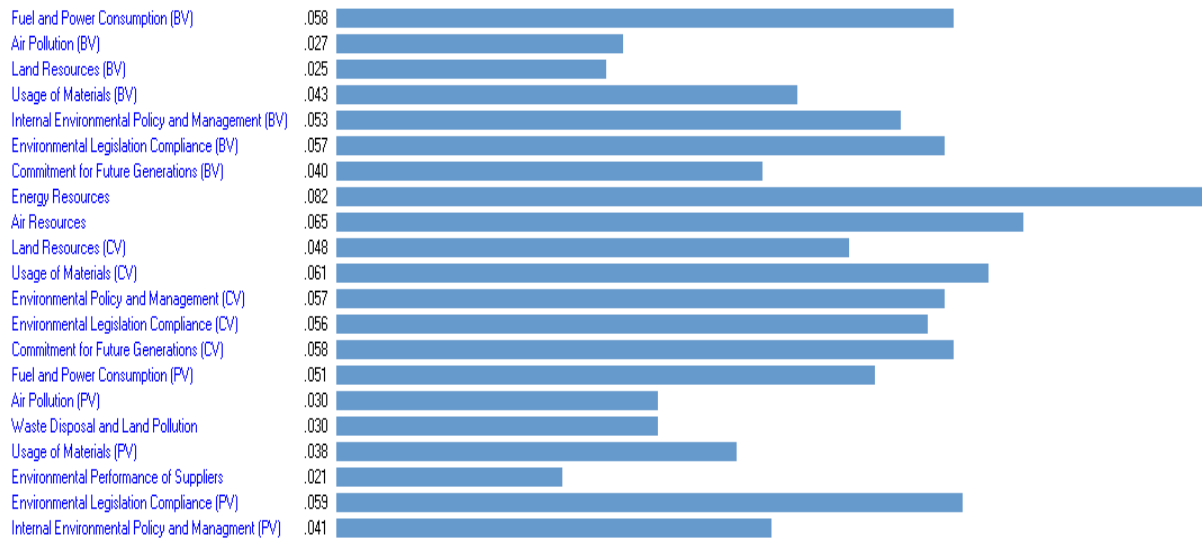


Figure 5: Integrated weights of the three dimensional environmental value requirements.

Environmental value requirements for customer:	AHP weight	Order of importance	Integrated weight	Integrated order of importance
Energy resources (CEV1)	0.191	1	0.082	1
Air resources (CEV2)	0.153	2	0.065	2
Usage of materials (CEV3)	0.143	3	0.061	3
Commitment for future generations (CEV4)	0.136	4	0.058	5
Environmental policy and management (CEV5);	0.133	5	0.057	6
Environmental legislation compliance (CEV6)	0.132	6	0.056	7
Land resources (CEV7)	0.112	7	0.048	9
Environmental value requirements for business:				
Fuel and power consumption (BEV1)	0.192	1	0.058	5
Environmental legislation compliance (BEV2)	0.190	2	0.057	6
Internal environmental policy and management (BEV3)	0.174	3	0.053	8
Usage of materials (BEV4)	0.143	4	0.043	10
Commitment for future generations (BEV5)	0.131	5	0.040	12
Air pollution (BEV6)	0.088	6	0.027	15
Land resources (BEV7)	0.083	7	0.025	16
Environmental value requirements for process:				
Environmental legislation compliance (PEV1)	0.218	1	0.059	4
Fuel and power consumption (PEV2)	0.190	2	0.051	8
Internal environmental policy and management (PEV3)	0.150	3	0.041	11
Usage of materials (PEV4)	0.142	4	0.038	13
Waste disposal and land pollution (PEV5)	0.111	5	0.030	14
Air pollution (PEV6)	0.110	6	0.030	14
Environmental performance of suppliers (PEV7)	0.077	7	0.021	17

Table 2: AHP weights of the environmental value requirements: segmented and integrated.

5.2 Identification of design requirements (HOWs)

After identification of the three dimensional environmental value requirements the design requirements have been explored from the interview with the decision makers of the bank. It has been found from the AHP calculations that some of the environmental value requirements have same importance weights. Therefore, the integrated order of importance ranks from 1 to 17 although the total number of item in three categories is 21. The design requirements that are identified by the decision makers to meet the environmental value requirements are: (i) Create sustainability oriented organizational culture by establishing green banking unit for awareness and monitoring of energy usage (DR1); (ii) Reduce the impact on air through responsible use of resources (AC, generator, mass transport) (DR2); (iii) Create the culture of environmentally responsible usage of materials (e.g., maximise recycling) (DR3); (iv) Improve vigilance to illegal actions through developing vigilance team (DR4); (v) Ensure environmentally responsible action by creating awareness about returning some value to the society (DR5) (vi) Ensure environmentally responsible consumption by creating awareness about efficient fuel and power consumption (DR6); (vii) Implement green energy where possible (DR7); and (viii) Strictly follow green banking rules imposed by the central bank (DR8) (see Figure 6).

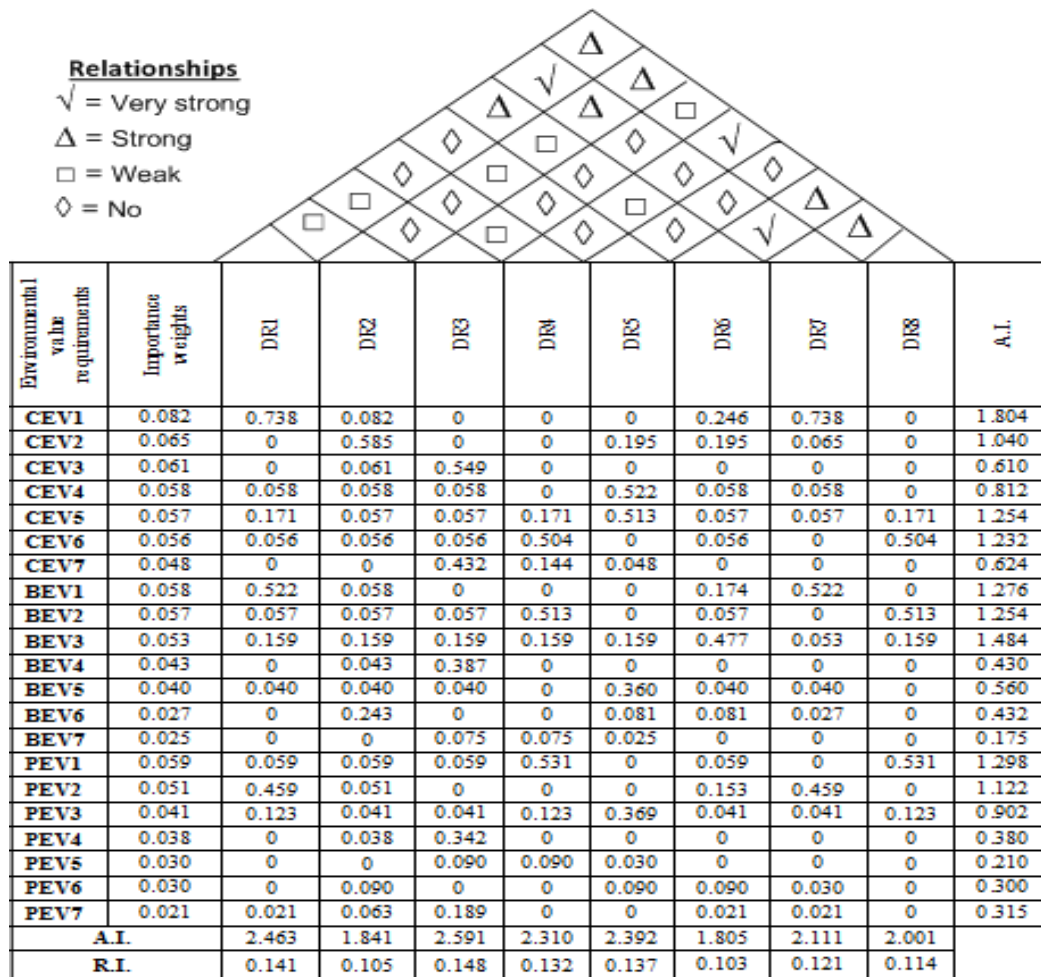


Figure 6: House of Environmental Sustainability.

6 DISCUSSION AND LIMITATIONS

From the interview of the six decision makers of the company and six customers (corporate and retail) a total of twenty one environmental value requirements have been identified from three categories. After identification of all the environmental value requirements, respondents have been asked to

compare among the environmental value requirements within each category. Then they were asked to compare among customer value, business value, and process value (see Figure 4). Based on the weights of the customer value, business value, and process value the integrated weights of all environmental value requirements were calculated using AHP. Among the identified environmental value requirements it has been found from the AHP calculations that some of the requirements have same importance weights as explained in Section 5.2. The AHP weights of each category of environmental value requirements are shown in Figure 1, Figure 2, and Figure 3; and the integrated AHP weights are shown in Figure 5. From the QFD analysis it can be enumerated that among all the environmental value requirements the most important requirement is 'Energy resources' (0.082) and corresponding to this environmental value requirement the most important design requirements are 'Create sustainability oriented organizational culture by establishing green banking unit for awareness and monitoring of energy usage' (DR1) and 'Implement green energy where possible' (DR7). Corresponding to the second important environmental value requirement 'Air resources' (0.065), the most important design requirement is 'Reduce the impact on air through responsible use of resources' (DR2). Regarding the third important environmental value requirement 'Usage of materials' (0.061), the important design requirement is 'Create the culture of environmentally responsible usage of materials' (DR3). Similarly, for the fourth important environmental value requirement 'Environmental legislation compliance' (0.059), the important design requirements are 'Improve vigilance to illegal actions through developing vigilance team' (DR4) and 'Strictly follow green banking rules imposed by the central bank' (DR8); and so on (see Figure 6).

From the House of Environmental Sustainability (Figure 6) it is found that DR3 (Create the culture of environmentally responsible usage of materials) has the highest relative importance (0.148) since it is contributing significantly to CEV3, CEV7, BEV3, BEV4, and PEV4. Similarly, DR1 holds the second highest relative importance (0.141) as it is considerably contributing to CEV1, CEV5, BEV1, BEV3, PEV2, and PSV3; and DR5 holds the third highest relative importance (0.137). Moreover, the roof matrix of the House of Environmental Sustainability shows that there is a very strong relationship between 'Create sustainability oriented organizational culture by establishing green banking unit for awareness and monitoring of energy usage' (DR1) and 'Implement green energy where possible' (DR7). It is also notable that the relationship between 'Improve vigilance to illegal actions through developing vigilance team' (DR4) and 'Strictly follow green banking rules imposed by the central bank' (DR8) and the relationship between 'Ensure environmentally responsible consumption by creating awareness about efficient fuel and power consumption (DR6) and 'Implement green energy where possible' (DR7) are strong, too. Therefore, implementation of DR1 and DR7 together will save some costs since they are highly correlated. Similarly, DR4 and DR8 together, and DR6 and DR7 together will also save costs, too. Now, based on this QFD analysis the company knows which environmental value requirements are most important and which design requirements to go for first based on its capability.

One insignificant limitation of this research approach is that it doesn't consider the capabilities (financial and readiness) of the organisation when deciding about the design requirements as it is assumed that every company knows its capability. Besides, this research approach gives the flexibility to choose the design requirements from the relative importance list based on the weights and individual company's capability.

7 CONCLUSION

This research study has various implications. Firstly, the approach efficiently identifies the important environmental value requirements using AHP. Secondly, it suggests the corresponding design requirements to efficiently fulfil those environmental value requirements. Thirdly, it uses correlation matrix and roof-matrix to identify the most important design requirements for the strategic implementations by the management. Finally, this approach is unique in the sense that in developing House of Environmental Sustainability environmental value requirements are considered from three dimensions instead of one dimension. Which was not shown before is that how environmental value concept can be integrated with customer's value requirements, business's value requirements, and process's value requirements. Based on the opinion of respondents a comprehensive case study has

been demonstrated. Our further research will include QFD analysis along with the cost-benefit analysis to identify the optimised design requirements for the environmental sustainability of the e-business. Next step of our research will also include conducting survey based research to see how the identified design requirements for environmental value requirements really contribute to the environmental sustainability of e-business.

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