Qfd Based Modelling For E-Business: A Sustainable Approach Using Blended Value Dimensions

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Abstract

Business modelling is not new and has had substantial impacts on the way businesses are planned and operated these days. Although ‘e-business’ and ‘sustainability’ are the two current major global trends but surprisingly none of the e-business modelling ideas covers the sustainability aspects of the business. Researchers are introducing ‘green IT/ICT’ concept lately but none of them clearly explains how those concepts will be used by the e-business modelling ideas. Recently, companies are successfully using QFD as a powerful tool in various fields that addresses strategic and operational decisions in businesses. This research approach, therefore, develops a QFD based e-business model in conjunction with blended value and sustainability aspects. The model explores and determines the optimal design requirements in developing the model. This approach also demonstrates how the sustainability dimensions can be integrated with the value dimensions in developing an e-business model. This approach is unique in the sense that in developing the model sustainability concept is integrated with customer’s value requirements, business’s value requirements, and process’s value requirements instead of only customer’s requirements. QFD, AHP, and Delphi method are used for the analysis of the data. An illustration is provided for the enhanced understanding of the proposed approach.

Keywords: QFD, Business model, Sustainability, E-business, AHP, Blended value.
1 INTRODUCTION

Whilst business models exist for several narrow areas, broad comprehensive e-business models are still very informal and generic. Most of the business modelling ideas consider only economic value aspects of the business and do not concentrate on social or environmental aspects. 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. Researchers are now introducing ‘green IS/IT/ICT’ concept but none of them clearly explains how those concepts will be accommodated inside the e-business models. Therefore, this research approach aims to develop a QFD based e-business model in conjunction with sustainability aspects. The model will be based on ‘blended value’ and will explore and determine the optimal design requirements in developing an e-business model. This research approach will also investigate how the sustainability dimensions can be integrated with the value dimensions in developing the e-business model. This modelling approach is distinct in the sense that in developing the model sustainability concept is integrated with customer’s value requirements, business’s value requirements, and process’s value requirements instead of only customer’s requirements. For the analysis of the data Quality Function Deployment (QFD), Analytic Hierarchy Process (AHP), and Delphi method are used. Besides developing the blended value based e-business model this research approach will also develop a framework for modelling e-business in conjunction with blended value and sustainability which can be implemented by almost any other businesses in consideration with the business contexts. The following section of the article clarifies the rationale of the approach. Definition of terms used in the approach is briefly explained in Section 3. An extensive literature review is covered in Section 4. Section 5 and 6 explicate the research methodology and the research process respectively. Research computation followed by an illustration is provided in Section 7 and Section 8. Finally, Section 9 concludes the article with a discussion and the future research direction.

2 RATIONALE OF THE APPROACH

Research in business modelling is not new and has had significant impact on the way businesses are operated nowadays. Most of the business models research in the information systems field has been concerned with e-business and e-commerce (Al-Debei & Avison, 2010). There exists a number of ideas about e-business models (i.e. Applegate, 2001; Bonaccorsi, Giannangeli, & Rossi, 2006; J. Gordijn & H. Akkermans, 2001; A. Osterwalder, 2004; Rappa, 1999; Tapscott, Lowy, & Ticoll, 2000; Timmers, 1998, etc.) of which most of them provide only conceptual overview and concentrate on economic aspects of the business. None of the e-business modelling ideas exclusively considers the sustainability aspects. Similarly, there is a growing number of literature available about the sustainability of businesses (i.e. Bell & Morse, 2009; Bieker, Dyllick, Gminder, & Hockerts, 2001; Epstein & Wisner, 2001; Labuschagne, Brent, & van Erck, 2005; Lo & Sheu, 2007; Stead & Stead, 2000; Tanzil & Beloff, 2006, etc.) which do not focus on e-business. But the intersection of these two global trends, e-business and sustainability, need to be addressed. Although recently a very few researchers talks about green IT/ICT concept (i.e. Chen, Boudreau, & Watson, 2008; Elliot, 2007, 2009, 2011; Elliot & Binney, 2008; Erek, 2011; Hasna, 2010; L. Hilty & Hercheui, 2010; L. M. Hilty, 2008; Houghton, 2010; Melville, 2010, etc.) but none of them clearly explains how that concept will fit in an e-business model to make it sustainable and at the same time, to protect the interests of the customers. This research approach will develop an e-business model based on ‘blended value’ which will be sustainable and will safeguard the interests of the customers. The ‘blended value’ requirements will identify and select the ‘optimal design requirements’ necessary to be implemented for the sustainability of the businesses. Therefore, the main research questions of the approach are: (i) What are the optimal/appropriate design requirements in developing an e-business model? and (ii) How the sustainability dimensions can be integrated with the value dimensions in developing an e-business model? Based on the research questions this research approach is consists of the following objectives:

– To explore and determine the optimal design requirements of an e-business model.
− To investigate how the concept of blended value dimensions can be used in developing an e-business model.
− To investigate how the sustainability dimensions can be integrated with the value dimensions in developing an e-business model.
− To develop a ‘value-sustainability’ framework for modelling e-business in conjunction with blended value and sustainability concepts.

3 DEFINITION OF TERMS

3.1 Blended value

Blended value is the integration of economic value, social value, and environmental value (Emerson, 2003, 2006; Emerson & Bonini, 2003) for customers, businesses, and value processes. Blended value which is also referred as “shared value can be defined as policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates” (Porter & Kramer, 2011). It is different from CSR value in the sense that CSR value is separate from profit maximization and agenda is determined by external reporting, whereas blended value is integral to profit maximization and agenda is company specific and internally generated.

3.2 Value requirements

Value requirements are the demands for the value by customers (for satisfaction), businesses (for profit), and business processes (for efficient value process). Value requirements instead of customer requirements is important in the sense that “even though customer satisfaction can be obtained efficiently and effectively, an organization still cannot guarantee future corporate profitability if it lacks value creating capabilities” (H.-F. Wang & Hong, 2007). Value can be economic and/or social and/or environmental demanded by customers and/or businesses and/or business processes to fulfil the customer’s requirements and/or to achieve strategic goals and/or to ensure efficient value processes.

3.3 Design requirements

Design requirements also known as HOWs are the requirements required to fulfil the ‘blended value’ requirements in QFD process. The development of the design requirements is at the heart of the QFD process (S. B. Han, Chen, Ebrahimpour, & Sodhi, 2001). Design requirements are developed by the businesses based on the requirements identified in the earlier stages of the QFD process. After needs are revealed the company’s technicians or product development team develop a set of design requirements in measurable and operable technical terms (L.-K. Chan & Wu, 2005) to fulfil the value requirements.

4 BACKGORUND

4.1 Business and e-business modelling

There are number of terms used for business model in the literature. Business model has been referred to as a statement (Stewart & Zhao, 2000), a description (Applegate, 2000; Weil & Vitale, 2001), a representation (Morris et al., 2005; Shafer et al., 2005), an architecture (Dubosson-Torbay et al., 2002; Timmers, 1998), a conceptual tool or model (Osterwalder, 2004; Osterwalder et al., 2005; Teece, 2010), a structural template (Amit & Zott, 2001), a method (Afuah & Tucci, 2001), a framework (Afuah, 2004), a pattern (Brousseau & Penard, 2006), and as a set (Seelos & Mair, 2007) found by Zott et al. (2011). There are different aspects that are used by the scholars for business modelling, such as, product/revenue aspects, business actor/network aspects, and marketing specific aspects, etc. Although a number of researchers tried to include value aspect in their modelling but none of them precisely point out the contents of the value that will be able to make a business
sustainable. The value aspect is included mainly for economic goal purpose, for example, value proposition (Amit & Zott, 2001; Johnson, Christensen, & Kagermann, 2008; Magretta, 2002; A. Osterwalder & Pigneur, 2005; Petrovic, Kittl, & Teksten, 2001), value architecture (Timmers, 1998; Venkatraman & Henderson, 1998), value network (Amit & Zott, 2001; Bouwman, 2002; Jaap Gordijn & Hans Akkermans, 2001), value revenue (Linder & Cantrell, 2001; Rappa, 1999; Teece, 2010), etc.

A study by Zott et al. (2011) found that in a total of 49 conceptual studies in which the business model is clearly defined, almost one fourth of the studies are related to e-business. That means, the majority of research into business models in the IS 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. He provides a taxonomy in which he classifies e-business models according to their degree of innovation and their functional integration. Applegate (2001) introduces the following six e-business models: focused distributors, portals, producers, infrastructure distributors, infrastructure portals, and infrastructure producers. Weill and Vitale (2002) suggest a subdivision into so called atomic e-business models, which are analyzed according to a number of basic components. Rappa (1999) provides taxonomy of e-business models based on the value offerings and mode of generating revenues. Dubosson-Torbay et al. (2001) identify the following principal dimensions for classifying business models: user’s role, interaction pattern, nature of the offering, pricing system, level of customization, and economic control. Tapscott, Ticoll and Lowy (2000) provide a typology of business models that they call b-webs, which are classified according to their degree of value integration and their degree of control of the value creation process. The proposed business model by Gordijn and Akkermans (2001) is based on e-value methodology, which consists of building blocks that can be used to represent an e-business idea and a modelling process to model, analyze, and evaluate such an idea. Sustainability concept is still entirely absent in the e-business modelling area.

4.2 Business, e- business and sustainability

A sustainable business maintains “a balance among economic development, environmental stewardship, and social equity” (Sikdar, 2003). In other words, 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). 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 incorporating economic, social, and environmental perspective 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” (Porter & Kramer, 2011). Moreover, most of the scholars mainly express the needs for blended value and very few of them provide with only hypothetical ideas for maintaining sustainability. A comprehensive business model for sustainability with operational directions is still not present.

E-business is the point where economic value creation and information technology/ICT come together (Akkermans, 2001). ICT can have both positive and negative impact 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). Technology is a source of environmental contamination during product manufacture, operation, and disposal (Brigden, Labunskas, Santillo, & Walters, 2007; Greenpeace, 2009; WWF/Gartner, 2008). 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 consistent with the definition of environmental sustainability of IT (Elliot, 2011), sustainability of e-business can be defined as the activities within the e-business domain to minimize the negative impacts and maximize the positive impacts on the society and the environment through the design, production, application, operation, and disposal of information technology and information technology-enabled products and services throughout their life cycle.

5 METHODOLOGY

Research by adopting a combination of qualitative and quantitative methods, mixed method, has got popularity in current research stream (Bryman, 2006) since it assists in enhancing the quality, accuracy, validity and reliability of data (Babbie, 2004; Creswell, 2003). In this approach, initially ‘a sustainable e-business modelling approach based on blended value’ is proposed after considering the previous literature and the research objectives. This proposed model can be tested with the sample data to justify its capability and validity along with the progress of the research. Any business can be chosen for data collection. Sample data can be collected from field study by conducting semi-structured interviews with the customers and through focus group meetings with the dept-in-charges. Once the model’s capability is proven, large volume of data will be collected from the customers and the organizations by organizing surveys and focus group meetings to test the comprehensive model. Therefore, both qualitative and quantitative methods will be used in this research approach for data collection and analysis.

5.1 Research elements

Apart from QFD this research approach uses ‘blended value requirements’ and ‘sustainability’ as the main elements. According to our approach, blended value is consists of three values: customer value, business value, and process value. Sustainability of business includes economic value, social value, and environmental value. Therefore, 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 strategy to reach their goals? (iii) What process value is required by the businesses to have an efficient and sustainable value processes? Consequently, based on the measurement from three dimensions blended value requirements can be categorised into 9 (nine) groups (Figure 1) which will be used as the main elements of this approach. They are as follows:

5.1.1 Economic value for customer requirements:

This means any of the customer’s value requirements which is somehow economically related directly or indirectly to the product or service that is to be delivered to the customer. In other words, these requirements mean all types of economic benefits that the customers are looking for. For example, price of the product or service, quality, after-sales-service, availability or ease of access, delivery, etc. appear under this category.

5.1.2 Social value for customer requirements:

Social value requirements for the customer include any value delivered by the businesses for the customer’s society. These social value requirements are not the social responsibilities that the business organisations are thinking to perform, rather these are the requirements that the customers are expecting or indirectly demanding for their society from the products or services or from the supplier of the products or services.
5.1.3 Environmental value for customer requirements:

Environmental value requirements stand for 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). This environmental value is demanded or expected by the customers.

5.1.4 Economic value for business requirements:

These requirements are those requirements which add some economic value to the business directly or indirectly if they are fulfilled. These economic requirements are not demanded by the customers instead they are identified by the businesses to be fulfilled to achieve the planned future goals. For example, reducing the cost of production, increase of sales and/or profit, getting cheaper raw materials, minimizing packaging and delivery cost, replacing the employees with more efficient machinery, etc.

5.1.5 Social value for business requirements:

Social value requirements are to add some value to the society from business’s point of view if they are fulfilled. These value requirements reflect what social value the business is planning and willing to deliver to the customers’ society in time regardless of the customers’ demand. For instance, Lever Bros Ltd. uses few principles to focus on social value, such as, emphasising on employees’ personal development, training, health, and safety; improving well-being of the society at large, etc. (Zairi & Peters, 2002).

5.1.6 Environmental value for business requirements:

This value is not required or demanded by the customers instead business itself considers delivering this value for various reasons. 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 (Denton, 1994). By implementing environmental friendly operations businesses may achieve cost reductions, too. For example, reduced contaminations, recycling of materials, improved waste management, 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.

5.1.7 Economic value for process requirements:

These are mainly related to the cost savings within the existing value processes which can be later transferred to the customers. The managers identify these value creating inefficiencies within the existing processes and try to correct them which result in some sort of economic benefits for the organisations. For example, up-to-date technologies, adequate amount of training, using efficient energies, improved supply chain management systems, etc. can increase the efficiency of the value processes that can certainly add some economic value to the organisation.

5.1.8 Social value for process requirements:

To identify these requirements managers look at the whole value process of the organisation and see whether there is any scope to add some value to the society they are operating within the existing value process systems. For instance, educating disadvantaged children, organising skills training for unemployed people, employing disabled people, establishing schools and colleges, sponsoring social events, organising social gathering, organising awareness programs etc. can add value to the society and most of these requirements can be easily fulfilled by the businesses without or with a little investments or efforts.
5.1.9 Environmental value for process requirements:

To fulfil these requirements, the businesses try to find and implement all the necessary steps within the existing value processes that will stop or reduce the chances of negative impacts and facilitate positive impacts on the environment, thus, adding some value to the environment. For example, leakage of water/oil/heat, inefficient disposal and recycling of materials, unplanned pollution (air, water, sound) management, heating and lighting inefficiency, etc. within the existing value processes result damages to the environment. Thus these requirements need to be fulfilled to minimize the impact of current value processes on the environment.

![Figure 1. Research approach.](image)

5.2 Research tools

5.2.1 Quality Function Deployment (QFD):

The product design and development process is supported by QFD. It 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). Therefore, it can be also used to analyse business needs and value process needs. The popular application fields of QFD are product development, quality management and customer needs analysis; however, the utilisation of QFD method has spread out to other manufacturing fields in time (L.-K. Chan & Wu, 2002). Recently, companies are successfully using QFD as a powerful tool that addresses strategic and operational decisions in businesses (Mehrjerdi, 2010). This tool is used in various fields for determining customer needs (Stratton, 1989), developing priorities (C. H. Han, Kim, Choi, & Kim, 1998), formulating annual policies (Philips, Sander, & Govers, 1994), manufacturing strategies (Crowe & Cheng, 1996; Jugulum & Sefik, 1998), and environmental decision making (Berglund, 1993). 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 customer needs, business needs, and process value needs. It will also be used to develop and select optimised design requirements based on organisation’s capability to satisfy the blended value requirements for the sustainability of the businesses. In QFD modelling, ‘customer requirements’ are referred as WHATs and ‘how to fulfil the customer’s requirements’ are referred as HOWs (See Figure 2). The process of using appropriate HOWs to meet the given WHATs is represented as a matrix. Different users build different QFD models involving different elements but the most simple and widely used QFD model contains at least the customer requirements (WHATs) and their relative importance, technical measures or design requirements (HOWs) and their relationships with the WHATs, and the importance ratings of the HOWs. Six sets of input information is required in a basic QFD model: (i) WHATs: attributes of the product as demanded by the customers, (ii) IMPORTANCE: relative
importance of the above attributes as perceived by the customers, (iii) HOWs: design attributes of the product or the technical descriptors,

(iv) Correlation Matrix: interrelationships among the design requirements, (v) Relationship Matrix: relationships between WHATs and HOWs (strong, medium or weak), and (vi) Competitive Assessment: assessment of customer satisfaction with the attributes of the product under consideration against the product produced by its competitor or the best manufacturer in the market (Mukherjee, 2011).

5.2.2 Analytic Hierarchy Process (AHP):

Analytic hierarchy process 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 a powerful and widely-used multi-criteria decision-making technique for prioritizing decision alternatives of interest (Park & Kim, 1998). 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), Bhattacharya et al. (2005), Hanumaiah et al. (2006), Lam and Zhao (1998), Chan and Wu (1998), Han et al. (2001), Xie et al. (1998), Wang et al. (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 blended value requirements before developing design requirements in QFD process.

5.2.3 Delphi Method:

The Delphi method has proven a popular tool in information systems (IS) research (Brancheau, Janz, & Wetherbe, 1996; Hayne & Pollard, 2000; Holsapple & Joshi, 2002; Lai & Chung, 2002; Okoli & Pawlowski, 2004; Paul, 2002) which was originally developed in the 1950s by Dalkey and his associates at the Rand Corporation (Grisham, 2009). This research technique has gained substantial acceptance across disciplines (Czinkota & Ronkainen, 2005). The Delphi can be labelled as an expert method and by nature, it can fall into the category of both quantitative and qualitative study (Laakso, Rubin, & Linturi, 2010). Okoli and Pawlowski (2004) and Grisham (2009) provide with the lists of examples of research areas where Delphi was used as the major tool. This research approach will use
Delphi method in designing and selecting optimised design requirements for the company in QFD process to develop the blended value based e-business model.

6 RESEARCH PROCESS AND STEPS

The necessary data for this approach will be collected from face to face interviews and structured focus group meetings. In the first stage, blended value requirements (economic value, social value, and environmental value for customer’s requirements, business requirements and value process requirements) for particular products will be identified based on the existing value proposition, value process and value delivery. Customer requirements will be identified through open-ended semi-structured questionnaires. Business requirements and value process requirements will be identified through focus group meetings with the dept-in-charges. Required number of questionnaires will be collected from the customers and based on the feedback from the customers necessary data will be collected from structured focus group meetings. Collected data will be analyzed using AHP and QFD. There are few steps that will be used to complete the data analysis. They are as follows:

1) The blended value requirements will be grouped and categorized into classifications based on the type of requirements. Those requirements then will be prioritized using AHP to find out the importance level of each of the requirements.

2) The target level for each of the total requirement will be set depending on the importance level of the each requirement and the organization’s capability and strategy. After prioritizing, total requirements will be benchmarked, if necessary, to set the target levels of the requirements.

3) Based on the target levels of each requirements design requirements will be developed. Design requirements will be developed through Delphi method after structured discussion or focus group meeting with the related dept-in-charges. Design requirements will be benchmarked, if necessary, before setting target values for those requirements. Also, costs will be determined for elevating each design requirement.

4) A relationship matrix between blended value requirements and design requirements will be developed using QFD to get the weights of the each design requirement. Then based on the weights (how much each design requirement contributes to meeting each of the total requirements) certain design requirements will be selected initially.

5) Then trade-offs among the initially selected design requirements will be identified for cost savings since improving one design requirement will have a positive, negative, and/or no effect on other design requirements.

6) Finally, design requirements will be chosen based on the following criteria:
   • initial technical ratings based relationship matrix between total requirements and design requirements;
   • technical priorities depending on organization’s capability, and
   • trade-offs among the design requirements.

7 RESEARCH COMPUTATION

In QFD process the relationship between a blended value requirement (BVR) and a design requirement (DR) is described as Strong, Moderate, Little, or No relationship which are later replaced by weights (e.g. 9, 3, 1, 0) to give the relationship values needed to make the design requirement importance weight calculations. 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:

\[ D_w = \sum_{i=1}^{n} A_i R_{iw} \quad \forall w, \quad w = 1, \ldots, m \quad \ldots \ldots \quad (1) \]

Where,

\[ D_w = \text{importance weight of the } w\text{th design requirement}; \]
Thus, the relative importance of the 1st customer requirements (BVR_{i1}) will be:

\[ R_{i1}^{CR} = \frac{A_{i1}}{\sum_{i=1}^{n} A_i} \quad \text{.......... (3)} \]

Where,
\( R_{i1}^{CR} \) = relative importance of the 1st customer requirement (\( BR_{i1} \));
\( A_{i1}^{CR} \) = absolute importance of the 1st customer requirement (\( BVR_{i1} \));

Similarly, the absolute importance and the relative importance of all other blended value requirements (CRs, BRs, and PRs) can be determined by the Equations (2) and (3). Now, the absolute value for the first design requirements (\( DR_1 \)) will be:

\[
A_{i1} \cdot D_{w1} + A_{i2} \cdot D_{w1} + \ldots + A_{in} \cdot D_{w1}
\]

In the same way, the relative importance of the 1st design requirements can be determined by the following equation:

\[
R_{i1} = \frac{A_{i1}}{\sum_{i=1}^{n} A_{i}}
\] .......................... (4)

Where,
\( R_{i1} \) = relative importance of the 1st design requirement (\( DR_1 \));
\( A_{i1} \) = absolute importance of the 1st design requirement (\( DR_1 \));

If we assume that there are \( n \) total blended value requirements which include \( n_1 \) customer requirements, \( n_2 \) business requirements, and \( n_3 \) process requirements, then,

\[
\begin{align*}
    n_2 &= n - (n_1 + n_3) \\
    n_3 &= n - (n_1 + n_2)
\end{align*}
\]

Again, if we consider \( w_c, w_b, \) and \( w_p \) as the weights of the customer requirements (CRs), business requirements (BRs) and process requirements (PRs) decided by the decision makers respectively, then,

\[
w_c + w_b + w_p = 1
\]

Therefore, the relative importance of blended value requirements can be determined as follows:

\[
\begin{align*}
    R_i^{BVR} &= w_c R_i^{CR} \quad i = 1, 2, \ldots, n_1 \\
    R_i^{BVR} &= w_b R_i^{BR} \quad i = n_1 + 1, n_1 + 2, \ldots, n_2 \\
    R_i^{BVR} &= w_p R_i^{PR} \quad i = n_2 + 1, n_2 + 2, \ldots, n
\end{align*}
\]

Now if we assume that there are \( n \) number of blended 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 requirements (\( CR_q \)) and the \( t^{th} \) design requirements (\( DR_t \)) is acquired from a teamwork (Özgener, 2003; H.-F. 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 \( \delta_{tu} \) denote the correlation between \( DR_t \) and \( DR_u \). So, by adapting Wasserman (1993) a normalised \( R_{qt} \) can be defined as follows:

\[
R_{qu}^{norm} = \frac{\sum_{t=1}^{m} R_{qt} \delta_{tu}}{\sum_{u=1}^{n} \sum_{t=1}^{m} R_{qt} \delta_{tu}}
\] .......................... (5)

where,
\( q = 1 \ldots n \)
\( u = 1 \ldots m \)

Therefore, by integrating \( R_{qu}^{norm} \) with \( R_i^{BVR} \) the overall importance weights of the design requirements can be determined as follows:

\[
A_{u}^{DR} = \sum_{i=1}^{n} R_i^{BVR} R_{qu}^{norm} \] .......................... (6)

where,
\( u = 1 \ldots m \)

\[
R_{u}^{DR} = \frac{A_{u}^{DR}}{\sum_{u=1}^{m} A_{u}^{DR}}
\] .......................... (7)

where,
\( u = 1 \ldots m \)
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 requirements (blended value requirements) weights in Equation (2) and (3), and Equation (5) we can determine the normalised ratings of blended value requirements and design requirements. Then by integrating the normalised ratings of blended value requirements and design requirements and the relative importance weight of the blended 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 trade-offs among the selected design requirements are identified based on whether improving one design requirement have a positive, negative, and/or no effect on other design requirements. Finally, after considering the initial technical ratings found out from the absolute importance and relative importance of the design requirements, the organisation’s capability, and the cost trade-offs optimised design requirements will be selected to develop the blended value based sustainable e-business model.

According to our approach the blended value requirements (BVRs) include customer requirements (CRs), business requirements (BRs), and process requirements (PRs) as mentioned above. Therefore, for the space limitation the analysis for CRs, BRs, and PRs are not shown separately in this section, instead CRs, BRs, and PRs are represented by BVRs in most cases. However, in the following section we have shown CRs, BRs, and PRs separately including their importance weights.

### 8 ILLUSTRATIVE EXAMPLE

In this section, we provide with a simple example with assumed information. We assume that a particular business has satisfactorily reached in step 4 of QFD process (as mentioned in Section 6) and identified a total of 7(seven) blended value requirements: 3 CRs (1 economic: After-sales-service, 1 social: Customers’ safety, and 1 environmental: Reduced emissions), 2 BRs (1 economic: Cheaper raw materials, 1 social: Employees’ health), and 2 PRs (1 economic: Up-to-date machineries, 1 social: Employing disabled people) that do not meet the required target. Let assume the AHP weights of those requirements are as follows (Table 2):

<table>
<thead>
<tr>
<th>Blended Value Requirements</th>
<th>AHP weights</th>
<th>Order of importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After-sales-service (CR1)</td>
<td>0.6412</td>
<td>1</td>
</tr>
<tr>
<td>Customers’ safety(CR2)</td>
<td>0.1326</td>
<td>3</td>
</tr>
<tr>
<td>Reduced emissions (CR3)</td>
<td>0.2262</td>
<td>2</td>
</tr>
<tr>
<td>Business Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheaper raw materials (BR1)</td>
<td>0.8516</td>
<td>1</td>
</tr>
<tr>
<td>Employees’ health (BR2)</td>
<td>0.1484</td>
<td>2</td>
</tr>
<tr>
<td>Process Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up-to-date machineries (PR1)</td>
<td>0.7465</td>
<td>1</td>
</tr>
<tr>
<td>Employing disabled people  (PR2)</td>
<td>0.2535</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2: Assumed AHP weights of the blended value requirements.

Now, let consider that the QFD team has reasonably identified 9 (nine) design requirements (which we are not explaining further here due to the space limitation) to meet the target of the above blended value requirements. By following the Equation (2) and Equation (3) the initial weights of the relationship matrix for each type of requirements (CRs, BRs, PRs) are as follows (Table 3):

<table>
<thead>
<tr>
<th>DR1</th>
<th>DR2</th>
<th>DR3</th>
<th>DR4</th>
<th>DR5</th>
<th>DR6</th>
<th>DR7</th>
<th>DR8</th>
<th>DR9</th>
<th>A.I.</th>
<th>R.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR1</td>
<td>0</td>
<td>1.923</td>
<td>5.771</td>
<td>0</td>
<td>0</td>
<td>0.641</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8.335</td>
</tr>
<tr>
<td>CR2</td>
<td>0.133</td>
<td>0</td>
<td>0.133</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.399</td>
<td>1.193</td>
<td>0.133</td>
<td>1.991</td>
</tr>
<tr>
<td>CR3</td>
<td>0</td>
<td>0</td>
<td>2.036</td>
<td>0.226</td>
<td>0.679</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.941</td>
<td>0.222</td>
</tr>
<tr>
<td>BR1</td>
<td>7.664</td>
<td>0.852</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.852</td>
<td>0</td>
<td>0</td>
<td>9.368</td>
<td>0.798</td>
</tr>
<tr>
<td>BR2</td>
<td>0.445</td>
<td>0.445</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.336</td>
<td>2.374</td>
</tr>
<tr>
<td>PR1</td>
<td>0</td>
<td>0</td>
<td>6.719</td>
<td>2.239</td>
<td>0.746</td>
<td>0</td>
<td>0</td>
<td>0.746</td>
<td>10.45</td>
<td>0.911</td>
</tr>
<tr>
<td>PR2</td>
<td>0</td>
<td>0.254</td>
<td>0.760</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.014</td>
<td>0.885</td>
</tr>
</tbody>
</table>

Note: A.I.= Absolute importance; R.I.= Relative importance; DR= Design requirements.

Table 3: Assumed initial weights of the blended value requirements and design requirements.

Let assume, the organisation is also considering, as a whole, 60% importance to the CRs, 20% importance to the BRs, and 20% importance to the PRs. Therefore, by following the Equation (4),
Equation (5), Equation (6), and Equation (7) the normalised relative importance of the blended value requirements and design requirements will be as follows (Table 4):

<table>
<thead>
<tr>
<th></th>
<th>DR1</th>
<th>DR2</th>
<th>DR3</th>
<th>DR4</th>
<th>DR5</th>
<th>DR6</th>
<th>DR7</th>
<th>DR8</th>
<th>DR9</th>
<th>R.I.</th>
<th>O.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR1</td>
<td>0.231</td>
<td>0.692</td>
<td>0.077</td>
<td>0.200</td>
<td>0.599</td>
<td>0.067</td>
<td>0.377</td>
<td>0.090</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CR2</td>
<td>0.067</td>
<td>0.067</td>
<td>0.231</td>
<td>0.091</td>
<td>0.133</td>
<td>0.018</td>
<td>0.091</td>
<td>0.160</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>CR3</td>
<td>0.818</td>
<td>0.091</td>
<td>0.231</td>
<td>0.063</td>
<td>0.563</td>
<td>0.071</td>
<td>0.071</td>
<td>0.096</td>
<td>0.090</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BR1</td>
<td>0.187</td>
<td>0.643</td>
<td>0.215</td>
<td>0.071</td>
<td>0.041</td>
<td>0.071</td>
<td>0.071</td>
<td>0.096</td>
<td>0.090</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BR2</td>
<td>0.250</td>
<td>0.750</td>
<td>0.024</td>
<td>0.021</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PR1</td>
<td>0.153</td>
<td>0.108</td>
<td>0.200</td>
<td>0.248</td>
<td>0.021</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>PR2</td>
<td>0.024</td>
<td>0.215</td>
<td>0.071</td>
<td>0.071</td>
<td>0.071</td>
<td>0.071</td>
<td>0.071</td>
<td>0.071</td>
<td>0.071</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>R.I.</td>
<td>0.153</td>
<td>0.108</td>
<td>0.200</td>
<td>0.248</td>
<td>0.021</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>0.042</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>O.I.</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: R.I.= Relative importance; E.C.= Estimated cost; DR= Design requirements; O.I.= Order of importance.

Table 4: Normalised weights of the blended value requirements and design requirements.

Based on the above calculation what is established is that among all the blended value requirements CR1 should be considered as the most important requirements among all the blended value requirements. Then PR1, BR1, and CR3 should be looked after respectively followed by other requirements. Similarly, DR4 should be implemented before any other design requirements and then DR3, DR1, DR2 and other DRs should be implemented respectively if the resources supports. The organisational capability is another major factor to be considered when investing. Also, management must look for the cost trade-offs within the design requirements for efficient investment. In most cases, there are savings when multiple DRs are implemented simultaneously.

9 CONCLUSION WITH FURTHER RESEARCH DIRECTION

A number of ideas and proposals about business modelling and e-business modelling are available in the literature but there is no clear proposal or idea about sustainable e-business modelling. Similarly, there are only few thoughts in the literature about ‘blended value’ or shared value; but all of them considered blended value only from customer’s value requirements point of view. In this article, we proposed a new sustainable modelling approach using QFD. In our approach, all of the value requirements (customer, business, and process) are taken into consideration to develop the model. Therefore, this modelling approach is significant for four reasons. Firstly, this modelling approach is unique in the sense that although there are few modelling approaches exist about ‘e-business’ and ‘sustainable business’ separately, there is no approach available about e-business modelling and sustainability. Secondly, in the previous approaches of sustainable business model ‘blended (economic, social, environmental) value’ was considered only from customer’s point of view to develop new design requirements. But in this approach ‘blended value’ is considered not only from customer’s point of view but also from business’s point of view and value process’s point of view since the fulfilment of only customer’s requirements cannot guarantee long run sustainability for the businesses. Thirdly, what was not shown before is how the sustainability dimensions can be integrated with the value dimensions in developing an e-business model. The fourth area to which this modelling approach is likely to contribute is the efficient allocation of resources for the businesses. Importance level of the value requirements for the sustainability can be identified in this approach that will help the businesses to decide about the correct allocation of resources.

In this paper, we have shown how QFD can be used to model e-business. We have also shown how the proposed model needs to be implemented with detailed formulas after providing extensive literature in this field. The necessary tools are identified for this approach and the whole research process is explained step by step. An illustration is also provided for the clearer picture of the proposed approach. Further research will be directed at the implementation of this approach in the real life businesses. There should not be any difficulty in implementing this approach in any real life businesses other than fitting the elements of this approach in different business contexts.
References


