A framework for design and assessment of products in developing countries

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Abstract

In an attempt to increase opportunity and quality of life for people in poverty, governments and non-government organisations (NGOs) sell and donate products to developing countries. Typically these are essential household items such as cookstoves, water filters, and solar lighting. However, to date there has been limited research into the uptake and long term effectiveness of these products. To overcome this problem and provide guidance to future and existing designers and NGOs an assessment framework has been created consisting of eight critical indicators for product success. These indicators have been identified from a literature review, the analysis of 63 products and 18 interviews with product designers and NGOs. The results have been presented in an easy to use assessment web which can assist designers in the design process and ensure that products designed for these markets are long-lasting and effective.

Keywords

Developing Countries, Industrial Design, Product Design, Product Assessment, Product Development

Introduction

It is estimated that 1.2 billion people live on less than $1 a day; 80% of the world's population live on less than $10 a day (World Bank, 2011); and approximately 25,000 people die every day due to a lack of food (World Food Programme, 2012). In an attempt to combat this global problem, governments and Non-Government Organisations (NGO) throughout the world work to alleviate poverty. This assistance is primarily provided in the form of debt relief, loans and the donation of medical goods or essential products. The essential products commonly distributed and investigated within this study include water filters, cookstoves and solar lighting.

In recent years the design industry has become actively involved with international development, increasing number of products being created for these markets and the number of discussions and publications regarding new product development for low-income and marginalised individuals is steadily increasing. This is, in part, due to the rise of design thinking, user centred design and the rapid growth of many countries which has enabled designers to become involved within this area (Nussbaum, 2010). When combined with attractive business opportunities presented within 'Base of the Pyramid' economics (Prahalad, 2006), it is unsurprising that many business leaders are actively engaged in looking for solutions to simultaneously alleviate poverty while making a profit (Diehl & Christiaans, 2007).

To date, little is known about the success or failure of these initiatives, firstly this is a new area for design and there have been few opportunities for long term studies. Secondly, there are a limited number of methods available for evaluating the effectiveness and appropriateness of these products. This lack of knowledge and documentation is a hindrance to designers, businesses and NGOs who want to create long-lasting products for these communities. To overcome this problem, this paper presents research for a framework of assessment to analyse the effectiveness of products designed for developing countries. The framework is the result of 63 product analyses, a detailed literature review and 18 interviews with experts from design organisations and NGOs. The framework presented is in the form of an assessment web for use within the design process enabling product comparison, product re-design and as an aid for concept selection.

The assessment web has been documented in two parts, the first outlines the initial method and how it was created, the second uses case studies to focus on factors which are critical to the success of products. Evidence suggests that if a designer and NGO apply this form of assessment, it will help create longer-lasting, robust product designs.

History of Design for Development

The roots of Design for Development (DfD) stem from a US Marshal Plan in 1955 to investigate the craft-based activities within developing countries (USAID, 2012). At this time it was recognised that design could have a powerful influence on an economy and it was hoped that design methods could be developed and embedded into government policies (Coward & Fathers, 2005). However, this did little to expand the reach of industrial design and it was not until the 1970s that the concept of DfD re-emerged (Er, 1993). Initially, this came in the form of Papanek's publication of 'Design for the real world' which challenged designers to be more responsible for their designs and design for needs instead of artificially created wants (Papanek, 1972). Bonsiepe (1977), held a similar belief and argued that the introduction of industrial design could have a positive effect within developing economies but this could only be achieved by embedding industrial design into government policy and not being purely hardware/artefact driven (Bonsiepe, 1977). These discussions culminated in the Ahmedabad declaration in 1979 where the first commitment to DfD was made in a joint conference between the International Council of Societies of Industrial Design (ICSID) and the United Nations (UN). It declared "design [to be] a powerful force for the improvement of the quality of life in the developing world" (ICSID and UNIDO, 1979). The aim of this conference was to increase the reach and spread of industrial design within the developing world (Coward & Fathers, 2005), although little happened in the preceding years (Margolin, 1989). It was not until the 1990s and early 2000s that there was an increase in DfD research and publications from Er (1997), Donaldson (2002) and Coward and Fathers (2005) dominated the literature. These studies primarily focused on the role of design in developing countries and the priorities of products.

Focus shifted slightly with the publication of "Bottom of the Pyramid" (BoP) in which Prahalad (2002) claimed that there was an untapped market within developing countries with and increasing purchasing power. He estimated that there were four billion people living in the survival market (less than $2 a day) that had a combined purchasing power close to $5 trillion (Prahalad, 2006). The challenge, he argued, was to stop thinking of the poor as victims of poverty but instead think of them as customers and consumers. This shifted the perspective of many organisations that typically donated products for zero cost and provided an incentive for many businesses, especially companies struggling with existing mature markets (Prahalad, 2006). Consequently, BoP continued to grow in popularity over the years with a number of businesses, designers and educators actively promoting it (Delft, 2009). In 2009 Delft Technical University hosted a conference to

discuss design for BoP which addressed how to define, measure and ensure value creation within BoP ventures (Delft, 2009). Some of these approaches have been recognised as valid methods within the literature (Austin-Breneman & Yang, 2013).

During the development of BoP economics, the concept of 'design thinking' was also increasing in popularity. Design thinking uses a systems thinking approach to solve design problems (Kandachar, Jongh, & Diehl, 2009) and brings the designer from the detailed development position to a point where they are involved in formulating business models and ethnographic research (Brown, 2009). According to Kandachar (2012), design thinking enables designers to imagine the world from a different perspective and have greater empathy with users. This empathy allowed designers to solve complex problems in the developing world more successfully (Brown, 2009). Brown, an advocate of design thinking and CEO of IDEO, published a number of case studies where design thinking has been used to develop products and services for BoP customers in developing countries. Often these projects are the result of a co-creation method and employ a user-centred design approach.

One example of this can be seen in work carried out by the charity International Development Enterprise (iDE). iDE believe in the importance of a user-centred design approach within the development of their products (Polak, 2008). Polak, the CEO, claims to interview at least 100 people prior to deciding the most appropriate product for the market (Polak, 2008). To publicise this approach IDEO published the Human Centred Design (HCD) toolkit which aids designers and NGOs through a user-centred design process (IDEO, 2011). The toolkit gives examples of setting up focus groups, understanding users and promotes co-creation/co-design (IDEO, 2011). Since publication, it has been commonly understood that concentrating on the user is fundamental when designing products for different contexts, despite first being identified by Papanek (1972), Bonsiepe (1977) and Donaldson (2002).

Despite the known benefits of designing with users, many companies design remotely with designers relying on second-hand information and a limited number of field visits (Murcott, 2007)(Donaldson, 2008). This approach is a hindrance to product success and is in part due to the limited amount of funding and resources available. In an attempt to overcome this, a number of approaches are available which tailor the design process to a specific use. According to Holt and Barnes (2010) these are known as Design For X (DFX) and commonly found in the engineering design literature. Recently designing for BoP has become a subset of the DFX methodology and can be used to help create products which sustainably improve the livelihood of people living in poverty (Donaldson, 2009) (Austin-Breneman & Yang, 2013). Other similar methods include; Design for Micro-Enterprise (DfME) (Austin-Breneman & Yang, 2013), Design for Extreme affordability (MIT, 2013) and Designing for the base of the pyramid (Diehl & Christiaans, 2007) (Castillo, Diehl, & Brezet, 2012).

Each of these approaches provide a useful starting point but does little to help designers with the core design process and the ability to accurately assess products and concepts. Having identified this significant shortcoming, this research set out to address this with the following research questions:

- What are the current products used and distributed by NGOs and other organisations?

- What factors are required to create long lasting, effective products for developing countries?

Research Method

The research adopted a flexible, qualitative approach to answer the questions proposed. This consisted of a literature review to understand the historical background and provide insight into current thinking, 63 product analysis which highlighted strengths and weaknesses of product design and 18 interviews with experts to validate and expand on initial findings. This method was adopted as it enabled a triangulation of data, providing results which could be trusted.

Firstly, a literature review was carried out within industrial and engineering design literature. The focus of this was the history of DfD up to the present day and the examination of product case studies and examples of product distribution.

Secondly, 63 products designed for developing countries were collated and analysed, these came from a range of backgrounds and divided into categories dependent on the product type; Water & Sanitation, Health, Agriculture, Education, Communication and Energy. Information about each product was documented; this data was collected from published papers, newspaper reports and manufacturers websites. These products were common household items such as water filters, cookstove, lighting, and basic medical equipment. Once product information had been collected it was observed that the products could be further categorised depending on the design type. These categories were;

- Products designed for less industrialised economies
- Products designed with less industrialised economies
- Products designed by less industrialised economies

The difference in design approach is evident when analysed and can contribute to product success.

The combination of literature review and product analysis was used to answer the first research question and helped highlight some of the factors needed for successful product design. To explore this further, a series of semi-structured interviews were conducted with 18 design and NGO experts about their experience of designing and distributing products in developing countries. Participants were selected for having background knowledge in the design or distribution of products for developing countries. Designers were invited to participate if they had relevant experience, while charities were contacted using the BOND directory of charities in international development (BOND, 2013). The response rate was good with a high level of senior staff willing to participate. Each interview was conducted via Skype using a semi-structured approach; this was split into two parts. The first part discussed the strengths and weaknesses of products previously designed and distributed. While the second part of the interview addressed method of assessment and potential factors deemed critical for long lasting, effective products. Each interview lasted between 30-45 minutes - recording and transcriptions were taken with full consent.

Data Analysis

Data analysis was conducted using Thematic Analysis with an open coding approach (Robson, 2011). This commonly consists of identifying codes and grouping them together into themes, the themes then form the basis for interpretation (Gibbs, 2008). The nature of the research meant that the codes were created entirely from the data in an exploratory fashion (Tesch, 1990). Figure 1 shows how the participants' codes formed the indicators critical to product success.
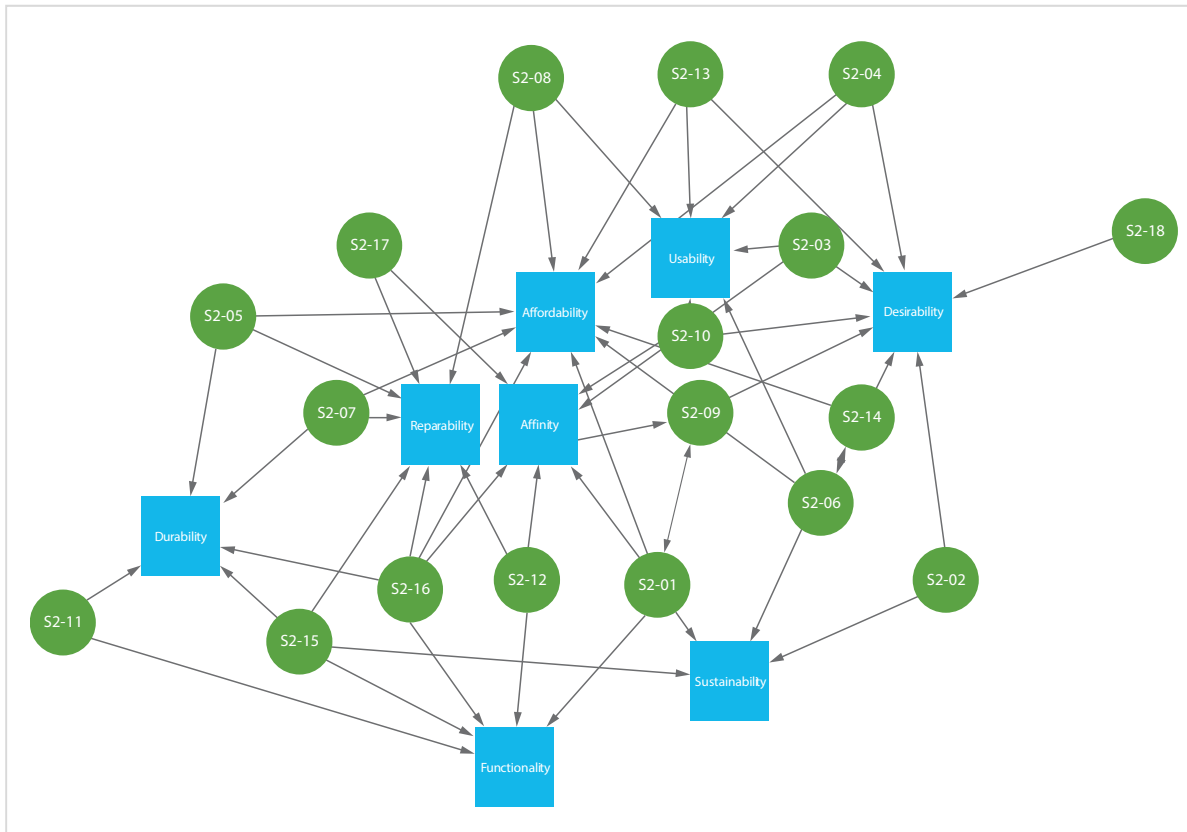
Figure 1 –Coding data showing how codes were used to create indicators

Results

The analysis revealed that eight indicators were critical to the success of products designed for developing countries. These are, in no particular order:

1. Affinity

2. Desirability

3. Reparability

4. Durability

5. Functionality

6. Affordability

7. Usability

8. Sustainability

Products that had considered and taken into account these factors had a higher level of product uptake and sustained use. These eight indicators are described in detail below with case study examples of products.

1. Affinity

Affinity is the connection that users have to a product, primarily on an emotional level. Interviews with NGOs highlight that purely functional products resulted in lower uptake and a lack of consistent use, compared with products which provided an emotional attachment. The affinity indicator comprises elements such as; cultural appropriateness, being proud to own the product and a financial investment in the product. An example demonstrating the importance of affinity is Hyrodlogic's Tunsai water filter. Hydrologic is a for profit company linked to iDE based in Cambodia (Hydrologic, 2011b). The filter was sold to customers for $12 (Hydrologic, 2011a). However, interview data revealed that the Tunsai had a relatively low uptake; one of the main reasons for this was that it was not considered to be an aspirational product. To overcome this, PATH, an American technology development NGO carried out user research with Hydrologic. They discovered that users liked the simplicity of the system but ultimately were not proud to own it. To overcome this and take into account users aspirational needs, the Tunsai was re-designed to become more stylish and look more like a water filter. The re-design increased the cost of the product from $13.50 to $23.50 (Ashden Award, 2012), but outsold the existing product 3/1 and increased user uptake by 42%. This highlighted the need for aspiration design and creating affinity with users.

2. Desirability

Designers who were interviewed stated that as well as being aspirational products needed to be aesthetically desirable. The nature of a global economy means that users in developing countries are equally exposed to the styles, fashion and types of products seen in the developed world. Consequently, if goods and services are designed to a lower quality it will be noticed and can affect the uptake and long term use of products. One Laptop per Child (OLPC) which provide laptops to poor children as an education tool (Fox Buchele & Owusu-Aning, 2007) and launched from Massachusetts Institute of Technology (MIT) Media Lab in 2005 over came this problem by paying attention to styling and detailed design equivalent to that of a product found in a developed country. Consequently, the design won a number of international design awards which created a demand for the product in developed countries as well as in developing countries.

3. Reparability

Products purchased by BoP consumers represent a significant investment. It is therefore important that when failures occur, products can be repaired or returned. Two approaches to this have been found within interviews with NGOs and designers; either products are designed to be repaired by local craft or tradesmen, or alternately, they can be supplied with a warranty to receive a replacement. The nature of BoP consumers means that they can be some of the most demanding in the world because the financial investment they make is high (Nussbaum, 2010). Interview data suggests that many ask about how to repair the product or how to return if it is faulty before purchasing. An example of a successful product is D-light who produce low cost, high quality and durable solar-rechargeable LED lanterns for BoP customers (Ashden, 2009). It was designed and tested with users using a user–centred approach (Tozun, 2011), but one of the unique features of the light is the business model which provides a two year warranty for the product, enabling users to return the product if faulty.

4. Durability

The hostile nature of developing countries typically means that wear rates are higher and products need to be designed and built with a higher level of durability and robustness compared with similar products in the developed world. The Q Drum demonstrates how durability can be incorporated into the design providing a robust and long lasting product. The drum is a rolling container designed to transport fifty litres of water (Q Drum, 2012). It was designed by Piet Hendrikse, to aid rural people when collecting and transporting

water, it has been used in a number of African countries (Kopernik, 2010). The Q Drum is a donut-shaped plastic container with a rope tied though the centre, allowing the drum to be pulled along uneven ground, instead of users carrying or lifting containers on their head. The design incorporates a longitudinal central shaft providing vertical support to improve strength (Webb, 2011). The attention to durability means each drum can withstand forces of up to 3.7 tonnes before failure (Design for the other 90%, 2012). Due to these design decisions the Q Drum should last for years of daily use in harsh conditions.

5. Functionality

Functionality is an important factor to consider according to interview data and product analysis. Typically users neglect products which fail to provide their functional expectations. BoP customers are highly demanding and consequently products need to be designed to provide the maximum level of functionality (D-Rev, 2013). The re-Motion knee, designed by D-Rev is an example of optimum functionality. There are an estimated 30 million amputees in the world with 95% lacking access to prosthetics (Hamner, Narayan, & Donaldson, 2013). In conjunction with JaipurFoot, a manufacturer of low cost prosthetics, re-Motion was designed to be purely functional while providing the same level of quality seen in developed countries (Hamner et al., 2013). The knee is an affordable prosthetic joint which has similar performance with that of knee designs in developed countries. To date 4200 amputees have been fitted with the knee and it has proved to be successful (D-Rev, 2013).

6. Affordability

Many people in developing countries have limited income, typically, below $2 per day; consequently they are restricted by their purchasing power (Polak, 2008). Interview data highlighted that the price of a product is crucial, not only to the users but also the NGO. The literature review suggested that there is a trend for NGOs to move away from donating products and instead providing micro-finance, micro-credit and loans which enable users to buy their own products. Although still in the early stages this can affect the design approach and it is important to establish who the consumer is at the start of a project. Some products can be affordable by providing incentives for users and increasing their income. The Treadle pump is a well-known example of a low-cost irrigation pump originally designed in 1984 by George Klassen (Polak, 2000). The pump costs between $20 and $100 depending on the location and is used to irrigate agricultural fields (iDE, 2013). Interview data reveals that typically the pumps increase the farmer's crop yield which can be used to repay the initial investment in one calendar year. Farmers are typically supplied these pumps by Farm Business Advisors (FBAs) who work on a commission basis and act as an intermediary between the NGO and the users.

7. Usability

The nature of designing for developing countries requires that products need to be easy to understand and useable across different cultures and languages. Product analysis revealed that many products come with picture diagrams showing how they work and how to use them. This is effective, but it is important to embed usability into the core design of the product. Designers interviewed stated that by including the user in the initial design phase enabled enhanced input into product usability. The lifeline radio is an example of a product which has been designed with users to ensure it is easy to use and understand in different cultures. Radio is the primary means of communication across Africa and in rural areas electricity is scarce and batteries are unaffordable (Chick, 1997). The lifeline radio was designed to provide education programs across three frequencies and is powered either by a dynamo generator or solar panel (Freeplay Energy, 2011). The design of the radio was inspired by user input and has been designed to be simple to use even by people with limited or no prior knowledge of how a radio works. One interview participant

stated that you cannot make a product simple enough when designing for these environments and educating the local population was really important.

8. Sustainability

Sustainability has been split into two parts; firstly, it is important to consider environmental sustainability in terms of material choice, end of product life and overall environmental costs. Secondly, the product distribution needs to be sustainable within the existing economic market. Evidence from interviews suggests that if products are distributed for free in the same markets where locals sell similar items this skews the markets and reduces the demand for sold products. Locals will often wait for the free product, even if this has a negative effect on their health or livelihood. Fitting in with the wide environment is important, ensuring that products distributed do not cause an unsustainable change in culture or the way people live. The Chulha Stove designed by Philips is an example of a sustainable stove design which caters for some of the 1.6 million people who die annually due to smoke inhalation (Philips, 2011). The stove is a re-design of an existing model created in 1986. Philips' design is 20-35% more efficient that the original model making it environmentally sustainable, but Philips has also considered market sustainability enabling locals to make and sell the product from plans provided by the company (Kulkarni, Mareguddi, Rocchi, & Griffoen, 2009). It is this overall sustainability that is important and not just creating environmental friendly products.

Development of framework

The indicators presented enabled designers and NGOs to understand the key factors required to create long-lasting and effective products for developing countries. It was therefore important to present these indicators in a useable and flexible format, enabling designers and NGOs to quickly and effectively assess products and concepts. To achieve this, the indicators were arranged in a web format (Figure 2). This enables designers to quickly and easily assess products during the design phase. Each product is given a score from zero to five across each of the indicators, with five being the highest. This method provides instant visual feedback to the designer about the potential success of the product being evaluated and enables them to see where changes should be made. An example is shown in Figure 2.
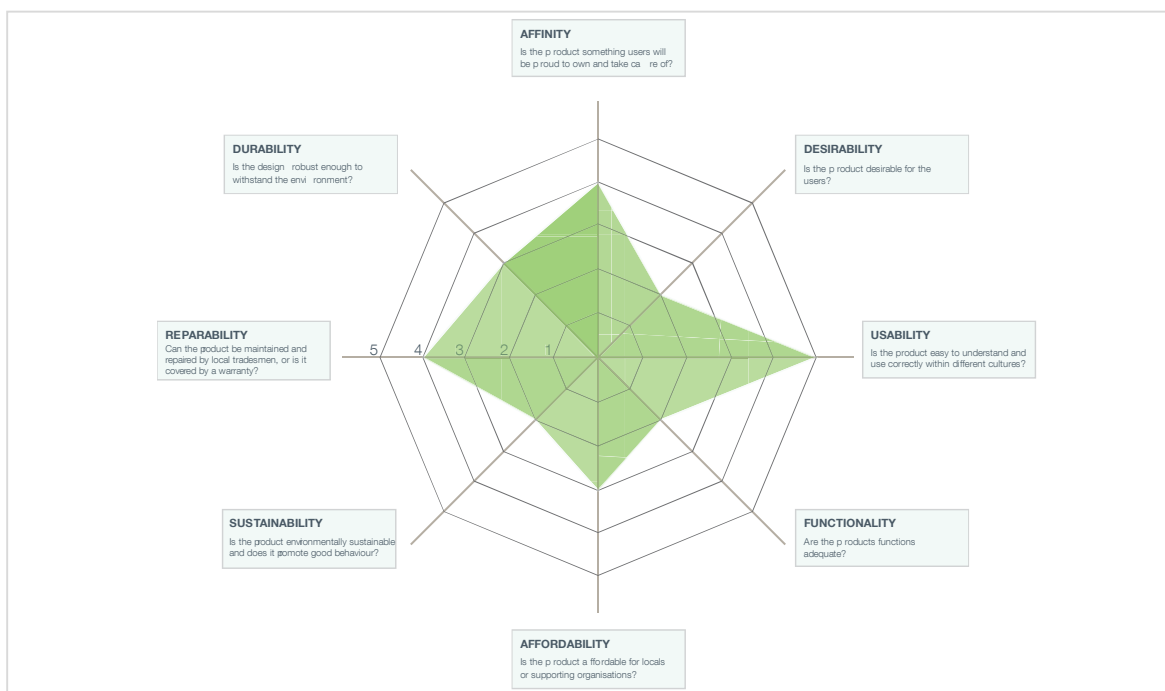

Figure 2: Product assessment web, an example of ranking a product against each of the indicators

Examples of use

Three scenarios of use have been documented which demonstrate how the framework can be used to improve the design and long-term effectiveness of products.

Concept generation – The web can be used while developing concepts, it quickly and easily provides a matrix to evaluate products against. The designer is given immediate feedback regarding which concept is better and ensures that nothing has been forgotten in the initial stages of the design process.

Product evaluation – Interview data reveals that it can be challenging for NGOs to know which product is suitable for a new environment, especially when entering new markets or countries. The assessment-web can be used to assist this process by highlighting the strengths and weaknesses of possible products, making it easy to rank products and enable NGOs to make more informed decisions on the most appropriate product. An example can be seen in Figure 3, products A, B and C have been ranked and compared against each other. In this case A is the most suitable as it scores the highest against the majority of the indicators.
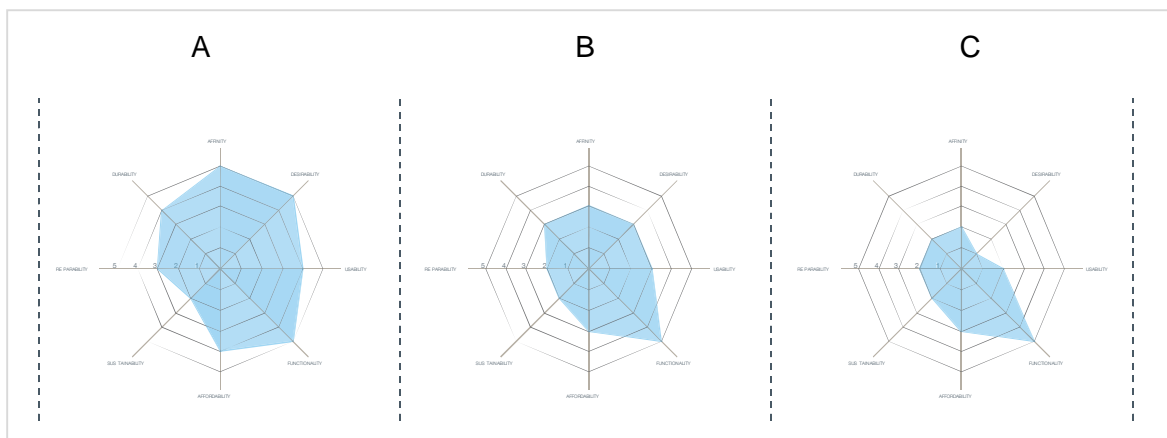

Figure 3: The comparison of three products, A,B and C used by NGOs

Design improvement – The assessment-web can also be effective in highlighting areas of weakness in existing products. Products can be assessed and scored against each indicator which can be fed back to the designer. This information can be utilised by the designer when improving on the product design, and enables the designer to concentrate first on the weakest areas. Figure 4 demonstrates how this can be used to improve product rating and ultimately long term effectiveness.
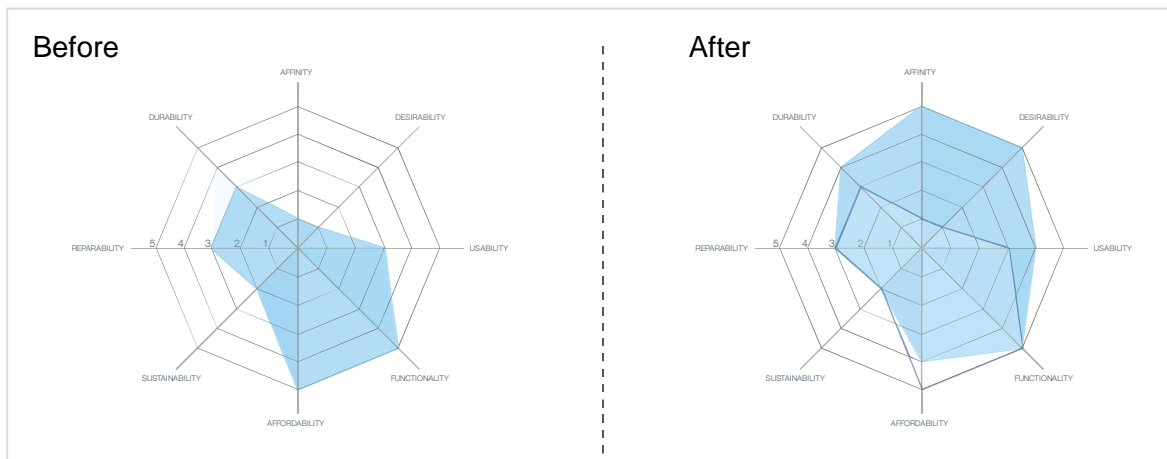

Figure 4: Design improvement

The assessment web was exposed to each of the interview participants and was highly rated. Participants described it as easy to use, intuitive and useful, finding it quick and easy to compare products. They also stated that it helped create an awareness of important factors that can be used to help in a re-design process of products.

Discussion

Eight assessment indicators have been created from literature review, interview data and product analysis. These have enabled the development of a framework for designers and NGOs while designing products for developing countries. By considering each of the indicators in the design process it is expected that products will have increased users uptake and be longer-lasting. The assessment framework has been presented in the form of a web which allows it to be used by designers and NGOs in the analysis of new and existing products.

Conclusion

This paper presents a method for product evaluation and assessment for use with both product designers and NGOs. The assessment web is a tool which helps designers identify areas to consider while designing a product. The tool can also be used by NGOs to evaluate existing and future products. Literature review, product analysis and interviews with 18 experts helped to identify these critical factors which have been presented in an assessment web for use within the design process. The next stage in this research is to test and validate the tool within a live project to ensure it can help create long-lasting, effective products for the developing world and avoid the high level of product wastage seen today.

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