Design for the BOP and the TOP: Requirements handling behaviour of designers

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Published in:
[Host publication title missing]

2015

Design for the BOP and the TOP: Requirements Handling Behaviour of Designers

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Abstract The base (BOP) and the top (TOP) of the world income pyramid represent the people living in poverty and the people from developed countries, respectively. In the approach of business development combined with poverty alleviation, the design of products for the BOP plays an important role. There is an urgent need to develop an understanding of the process of designing products for the BOP. Requirements handling is an important ingredient of a design process. This research, using a protocol study, examined the differences between the requirements handling behaviour of designers when they design a product for the BOP and TOP markets. We found differences between their requirements handling behaviour in terms of their attention to different topics of requirements, and their handling of solution-specific and solution-neutral requirements.

Keywords Base of the pyramid · Product design · Requirements · Protocol analysis

1 Introduction

The world income pyramid can be divided into three segments—top, middle, and bottom. The top segments (i.e., 'Top of the Pyramid'—TOP), includes people from developed countries. The middle segment consists of the rising middle class from

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A. Chakrabarti (ed.), *ICoRD'15 – Research into Design Across Boundaries Volume 2*,
Smart Innovation, Systems and Technologies 35, DOI 10.1007/978-81-322-2229-3_17

developing countries. The bottom segment, generally called the 'Base of the Pyramid' (BOP), consists of the poor people. About two-fifths of the world population can be categorized as poor [1].

1.1 Design for BOP Markets

In recent years, a poverty reduction approach that combines business development with poverty alleviation has received attention [2]. In this approach, the poor at the BOP are considered as producers and consumers of products. Design of products is an important ingredient of this market-based approach. Furthermore, some universities have begun to offer courses and/or design projects in the area of the design for the BOP.

Design research is important in understanding and improving design practice and education [3]. However, design researchers have given little attention to the field of the design for the BOP. Most of the design research has been carried out in the context of developed countries and relatively affluent markets [4, 5]. There has been little empirical examination of the design for the BOP. This limits our ability to develop tools and methods for improving current practice and education of design for the BOP.

In our previous research [5], using a protocol study, we explored the differences between the design processes for the BOP and TOP markets. Specifically, we investigated the strategies (i.e., problem driven, solution driven strategy) used by the designers. In this paper, based on the data from the protocol study, we examine how designers handle requirements in designing products for the BOP and TOP markets. We have discussed the implications of the findings for design practice.

1.2 Requirements Handling in Design

Chakrabarti et al. [6] found that the main ingredients of the design process are: requirements (i.e., problems), solutions, information, and strategy (i.e., plan of action to progress through the design process). In the design process, requirements and solutions co-evolve [7].

Based on the analysis of designers' activities, Nidamarthi [8] found that the designers use tentative solutions to enhance the understanding of the initial requirements. He also observed that these solution-generated requirements (i.e., solution-specific requirements) played an important role in the problem solving process. Restrepo and Christiaans [9], based on their empirical studies of designers, have characterised requirements depending on their specificity—'solution-specific' and 'solution-neutral'.

In his experiments with designers, Nidamarthi [8] found that requirements do not get fulfilled if they are ignored. In the experiments, the designers were asked to

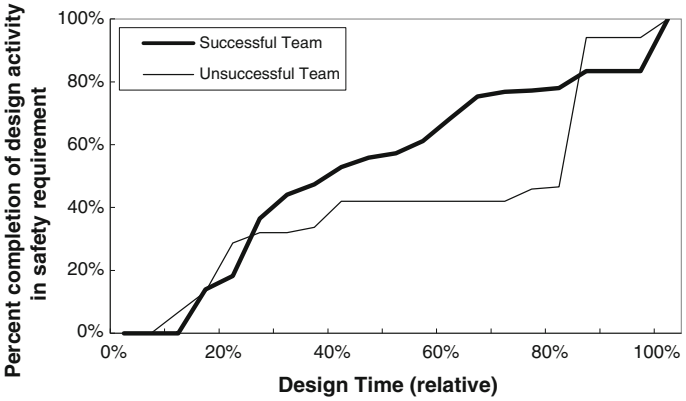

Fig. 1 Distribution of activity related to the requirement regarding 'safety' by two teams—adopted from [8]

consider some safety aspects (see Fig. 1). In this Fig. 1, any horizontal segment indicates inactivity by the design team in the related requirement for that duration. The design team, which provided enough attention to the requirements regarding safety aspects, was successful in satisfying safety-related requirements.

2 The Protocol Study

The details of the protocol study are presented in our previous research [5]. However, for easy reference, we briefly present the protocol study in this paper. In total, eight designers individually participated in the study. These designers were divided into two groups, namely BOP and TOP groups/sessions. In a laboratory setting, four designers (BOP designers) solved a design problem for the BOP, and four other designers (TOP designers) solved the same problem for the TOP. These eight designers were Masters students in 'Industrial Design' or 'Product Design'. Before this protocol study, we ensured that the BOP and TOP designers had prior experience of working on university-based design projects for the BOP and the TOP, respectively. We believe that excepting this difference in experience of working on university-based design projects, the designers in the BOP and TOP sessions are fairly similar. It is therefore likely that the differences in the design processes for the BOP and TOP markets are mainly due to the differences in these markets. There can be some differences in these design processes due to the difference in the BOP and TOP designers' degree of familiarity with the respective contexts. We have discussed these issues later in Sect. 4. Our experimental arrangement was pragmatic, and the findings gained through this research are useful in terms of their implications for design practice. These implications are discussed in Sect. 4.

The formulated design problem needs to be applicable for the BOP and TOP markets. We created the design problem as follows.

> A highly contagious and deadly disease called 'anthrax-d5' is spreading across (…). This disease is transmitted only through contaminated food and water. A person infected with this disease needs to be hospitalized in order to save his/her life. The spread of this disease is such that the existing healthcare infrastructure (i.e., available number of hospitals) is inadequate to hospitalize and treat the large number of infected people. There is an urgent need to erect a number of temporary shelters that can be used as hospitals. For (xxx), where the 'anthrax-d5' is spreading at an enormous rate, design such a temporary shelter that can be used to hospitalize 5 infected people (per shelter). Each shelter also needs to accommodate basic healthcare facilities and healthcare staff consisting of 1 nurse. The time to install this shelter must be less than 2 h. The shelter also needs to withstand different types of weather conditions.

In the above problem, in the case of the BOP sessions, (…) was replaced by 'a cluster of BOP communities in a developing country' and (xxx) by 'the cluster of BOP communities'. In the TOP sessions, (…) was replaced by 'a city in a developed country' and (xxx) by 'the city in the developed country'.

The audio recordings were transcribed. The transcripts were divided into segments, with each segment corresponding to a single thought, expression, or idea. The coding scheme consisted of four major categories, borrowed from the coding scheme successfully implemented and developed by Chakrabarti et al. [6]. The four major categories are: 'requirement', 'solution', 'information', and 'strategy' (see Table 1).

As shown in Table 1, for the segments that were classified under the 'requirement' category, we coded the type of requirement (i.e., solution-specific or

Table 1 Coding scheme

Category	Description (example)
Requirement	Designer deals with a requirement ("That needs to include…", "I am assuming this should be…")
Req. type	
Solution-specific (*SR*)	A requirement that is specific to any of the designer' solutions (The designer, in relation to a specific solution, dealt with the following requirement, "The outside of it should be of leak-proof material to protect from rain.")
Solution-neutral (*NR*)	A requirement that is not specific to any of the designer's solutions ("The solution needs to be as cost-efficient as possible.")
Req. topic	Categorization of a requirement based on its topic (e.g., materials, geometry, aesthetics, ergonomics, etc.)
Solution	Designer deals with a solution ("Let's put cloth on inside…", "So, this is efficient to…")
Information	Designer deals with information ("Developed countries have…", "This is actually not accurate information of…")
Strategy	A plan of action for proceeding through the design process ("I will start by just taking some notes about what this task is.")

solution-neutral), and the topics of requirement (e.g., materials, geometry, etc.). Some topics of requirements were borrowed from Pahl and Beitz [10] and Dwarakanath and Blessing [11], and some topics evolved during the coding process.

We measured the reliability of the coding process by calculating the percentage agreement between two coders. Due to resource limitations, two out of the eight protocols (i.e., two transcripts) were coded by the researcher and one coder. The average inter-coder reliability was above 85 %.

3 Results

3.1 Specificity of Requirements

Figure 2 shows the average percentage of segments according to the requirements-specificity in the BOP and TOP sessions. In the BOP and TOP sessions, there are differences between the occurrence percentages of these two types of requirements. The average percentage of segments associated with the solution-specific requirements (SRs) is higher in the TOP sessions as compared to that in the BOP sessions (48.0 and 32.2 %). In contrary, the average percentage of segments associated with the solution-neutral requirements (NRs) is higher in the BOP sessions as compared to that in the TOP sessions (67.8 and 53.1 %).

Figure 2 also shows that, in the BOP sessions, there is a substantial difference between the average percentage of segments classified into SRs and NRs. The designers in the BOP sessions dealt more with the NRs than with the SRs (67.8 and 32.2 %). While the designers in the TOP sessions dealt more with the NRs than

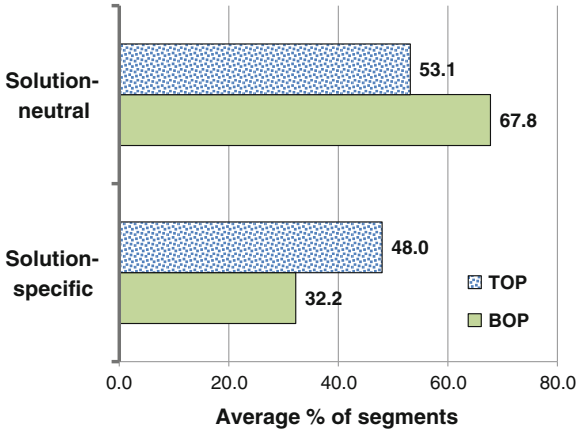

Fig. 2 Solution-specific and solution-neutral requirements

with the SRs (53.1 and 48.0 %), the difference between the average percentage of segments under these two types of requirements is small in the TOP sessions (53.1 and 48.0 %) as compared to that in the BOP sessions (67.8 and 32.2 %).

3.2 Topics of Requirements

The BOP and TOP designers mainly dealt with requirements related to geometry and installation (see Fig. 3). As compared to the TOP designers, the BOP designers dealt more with requirements from the topics-materials (12.5 and 6.7 %), users (13.3 and 6.5 %), energy/power (6.3 and 4.3 %), and costs (3.6 and 1.7 %). As compared to the TOP designers, the BOP designers paid little attention to the requirements related to aesthetics (0.4 and 5.6 %), ergonomics (4 and 10.5 %), information provision (0.4 and 2.6 %), supply chain/logistics (2 and 7.3 %), healthcare (8.6 and 13.8 %), and hygiene (5.4 and 12.4 %). The designers from both BOP and TOP sessions have not considered maintenance requirements. While the TOP designers have considered the requirements about forces and production, the BOP designers have not considered requirements from these topics.

The above differences between the BOP and TOP designers can be due to the differences between the TOP and BOP markets (e.g., the poor physical infrastructure in the BOP markets, low income of the BOP people, etc.). Furthermore, the differences in the occurrence percentages of requirements from different topics indicate the degree of importance the designers have placed on these topics. For example, the findings suggest that, as compared to the TOP designers, the BOP designers have placed more importance on the requirements regarding materials, energy/power, costs, etc. and less importance on the requirements regarding aesthetics, ergonomics, information provision, hygiene, etc.

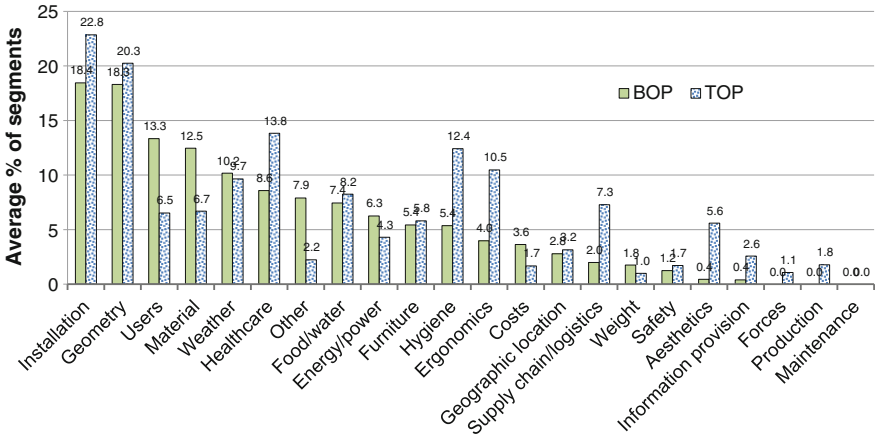

Fig. 3 Topics of requirements

		Q1	Q2	Q3	Q4
SR	BOP	1.9	10.5	11.9	8.0
	TOP	7.2	9.7	21.1	10.0
NR	BOP	39.2	19.9	6.6	2.0
	TOP	35.2	16.4	0.7	0.9

Fig. 4 Distribution of SRs and NRs (average % of segments)

3.3 Distribution of Solution-Specific and Solution-Neutral Requirements

For each designer, the timeline of the design process was divided into four equal quarters, namely Q1, Q2, Q3, and Q4. We counted the number of segments corresponding to solution-specific requirements (SRs) and solution-neutral requirements (NRs) in each of these quarters. Figure 4 shows the average percentage of segments for SRs and NRs in each of the quarters in the case of the BOP and TOP sessions. The coloured bars in this figure are drawn by using the conditional formatting facility of the Microsoft Excel.

From Fig. 4, the following observations can be made. Throughout the process, the occurrence percentage of SRs is higher in the TOP sessions than in the BOP sessions, except for Q2. In Q2, the occurrence percentage of SRs is slightly higher in the BOP sessions than in the TOP sessions (10.5 and 9.7 %). In Q1, the occurrence percentage of SRs is considerably higher in the TOP session than in the BOP session (7.2 and 1.9 %). This indicates that the TOP designers engaged in activities associated with solutions from the beginning of the process (i.e., in Q1).

Figure 4 also shows that, in the TOP and BOP sessions, from Q1 to Q4, there is a gradual decrease in the occurrence percentage of segments associated with NRs. However, there are some differences between these two sessions regarding the occurrence percentages of these NRs along the timeline. The designers in the TOP sessions considered the NRs mainly in the early phases of the process (i.e., in quarters Q1 and Q2). On the contrary, the designers in the BOP sessions dealt with these requirements throughout the process as can be seen from the average percentage of segments in Q3 (6.6 %) and Q4 (2 %).

4 Discussion, Conclusions, and Limitations

In this research, we used a protocol study to compare requirements handling behaviour of BOP and TOP designers. In comparison to the TOP designers, the BOP designers predominantly handled NRs than SRs. The BOP designers handled NRs throughout the process with an emphasis in the early phases. NRs are not specific to a solution, and the higher handling of NRs suggests that a designer is

engaged more in the clarification of the design objectives that the final design solution needs to meet. These findings indicate that the BOP designers engaged more in the clarification of the objectives than the TOP designers. A reason can be greater unfamiliarity with the design task in the BOP sessions. The BOP designers had experience of working on university-based design projects for the BOP. However, they come from the middle to upper middle class strata of the society, and therefore it is likely that they did not experience the context of the poverty/BOP. Consequently, they had less direct knowledge of the BOP. The TOP designers' familiarity with the TOP was relatively higher as they come from middle to upper middle class strata of the society.

There are differences between the BOP and TOP sessions in terms of different types of requirements considered by the BOP and TOP designers. The BOP designers have placed more importance on the requirements related to materials, energy/power, costs, etc. and less importance on the requirements regarding aesthetics, ergonomics, information provision, hygiene, etc. These differences can be attributed to the obvious differences between the BOP and TOP markets (e.g., the physical infrastructure, the income of the BOP people is meagre, etc.).

The TOP designers have paid attention to the requirements regarding aesthetics, ergonomics, information provisions, hygiene, and supply chain/logistics. The BOP designers have not paid enough attention to these requirements despite the importance of these requirements in the BOP. For example, the BOP people, in general, are semiliterate or illiterate, and therefore the requirements regarding information provision are important in the BOP. Also, the BOP people can have preferences regarding aesthetic qualities of products. Furthermore, the requirements regarding supply chain/logistics are important in the BOP.

We propose the following reasons for the BOP designers' less attention to the requirements regarding aesthetics, ergonomics, and information provision. The BOP designers placed more importance on some requirements (e.g., materials, energy/power, costs, etc.); and they thus perceived other requirements as less important. Another reason can be that there was higher degree of unfamiliarity with the design task in the BOP sessions. Furthermore, the designers might tend to think that the BOP people mainly have basic survival needs, and they might tend to give little attention to their other needs (e.g., their aesthetic preference). However, the BOP people can have other needs besides the basic survival needs. Van Kempen's [12] experiments in Bolivia revealed that the poor people can consume status products before satisfying their physiological needs.

The BOP designers paid less attention to the requirements regarding aesthetics, ergonomics, etc. The requirements, which are given less attention, do not get fulfilled [8]. There are examples of 'real life' BOP design projects where the requirements regarding aesthetics and ergonomics were not taken into account, and that caused in the unacceptance of the products by the BOP people. These 'real life' projects are from different sectors such as healthcare and access to clean drinking water [13, 14]. Consider for example a product, namely 'LifeStraw', which is specifically designed for providing clean drinking water to the BOP people. LifeStraw is a water filter in the form of a tube, and can be used by one person (see

Fig. 5 Lifestraw (*Source*—https://www.wikipedia.org/; "LifeStraw use" by Edyta Materka from London, United Kingdom)

Fig. 5). Water passes through a filter when a person sucks it up. According to Starr [14], requirements regarding ergonomics and symbolic meaning of a product were not considered in the design of the LifeStraw, and therefore the BOP people may not like using product. He states, "People don't really like squatting over dirty water and sucking it up in a straw… it's a lot of work to suck it up through a filter." Another example of a product that is not widely used by the BOP people is 'PlayPump' [14]. The PlayPump uses the energy of children at play to operate a water pump. However, in the design of this product, the requirements regarding ergonomics were not taken into account. It can be difficult to operate the PlayPump [15].

Lockwood [13] has explained why condoms are not widely used in the DR Congo. HIV is a serious problem in the DR Congo, and aid agencies have distributed low-priced condoms in the country. However, a few people are using them. According to Lockwood [13], a reason behind this is that the requirements regarding the symbolic meaning of a product were not considered and implemented in the design of condom-packaging. The packaging of condoms, distributed by the aid agencies, shows pictures such as a wife and a husband, and a 'red ribbon' that reminds people about HIV. This type of packaging-design does not motivate people to use condoms.

These examples of 'real life' BOP design projects and the findings of our research suggest that there appears to be a tendency not to pay enough attention to the requirements regarding aesthetics and ergonomics in the design of products for the BOP despite the importance of these requirements in the acceptability of products by the BOP people. A potential implication of these findings is that designers need to overcome the above tendency, and that they ought to consider such requirements in the design of products for the BOP.

There are some limitations to this research. The results are based on the design task that is not a genuine 'real life' design task. The designers worked individually in contrast to genuine design projects that are, in general, carried out by a team. The

process of thinking aloud while solving a design problem may affect the design process. While the sample size in our study is small, the experiment provided sufficient data to observe overall trends and observations. We believe that it is important to validate the results of this research in studies of real design projects using ethnographic methodologies. It would also be interesting to study the differences between the design processes for the BOP and TOP when designers are given the same set of product specifications. For example, designers can be given the same product specifications and then can be asked to design and develop solutions to meet those specification for the BOP and TOP markets.

Acknowledgments This work was partly financed by VINNOVA within the Product Innovation Engineering program (PIEp). We are grateful to the participating designers. This paper is an enriched version of some part of the paper—Jagtap et al. [5].

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