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RESEARCH

Sarah Praceus

Consumer Innovation at the Base of the Pyramid

Emerging Patterns of User Innovation in a Resource-Scarce Setting

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Foreword

Today, an extremely large proportion of the world population is still living in poverty. These people living at the lower end of the global wealth pyramid are the so-called “Base of the Pyramid” (BoP). As the poor are not in a position to buy currently available products and services, they represent a vast and largely untapped market from an industrial perspective.

According to C. K. Prahalad the so-called BoP market offers market entry and growth opportunities particularly to companies aiming to contribute to poverty alleviation. For this purpose products and innovations that are specifically targeted at the BoP market are indispensable. The development of these innovations requires solid, deep and detailed knowledge concerning the living conditions at the BoP and the needs of its consumers. Hence, high hopes are placed on the involvement of the BoP itself as well as their ideas and innovations into the new product development process to ensure market and need knowledge and to achieve overall product success. However, up to now there has been very little research on consumer innovation at the BoP and general knowledge on needs and solutions for subsistence markets is scarce.

The present dissertation by Mrs Praceus employs a quantitative approach to analyze the characteristics of a large sample of innovations generated at the Indian BoP. The research reveals similarities as well as differences compared to consumer innovations generated in the resource-rich world. To furthermore identify innovative consumers and drivers of consumer innovation in subsistence markets, she investigates by means of two separate yet interrelated studies the effect of innovation-relevant resources and contextual factors on the attractiveness of consumer innovations at the BoP.

The results of her work show that wealthier and poor consumers share certain stable demographic predispositions and preferences towards consumer innovation while adapting at the same time to their respective living conditions e.g. through mainly satisfaction of basic needs at the BoP versus hobby-related necessities in the wealthier world. At the BoP resources such as an innovator’s technical experience and education have a positive impact on the technical quality of a solution while technical experience and cooperation exert a positive influence on its creative quality. Repeated innovation activities, however, appear detrimental to creativity. Furthermore creative solutions achieve higher success or acceptance among other BoP consumers while an innovation’s technical elaboration does not relate to its market success.

I believe that the findings gained from Mrs Praceus‘ research are relevant and enriching for both research as well as business practice leading to differentiated and new insights into innovation at and for the BoP.

Taken altogether, I consider the present dissertation by Mrs Praceus as a successful and very readable contribution to the current state of research.

Hamburg, December 2013

Univ. Prof. Dr. Cornelius Herstatt

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This book is based on my dissertation that I have conducted at the Institute for Technology and Innovation Management at Hamburg University of Technology during the period 2010 to 2013. The successful completion of this thesis has only been made possible thanks to the support of my supervisor, colleagues, friends and family.

First, I want to express my gratitude to my doctoral supervisor Prof. Dr. Herstatt for giving me the opportunity to carry out my research under great working conditions at the TU Hamburg-Harburg right from the start. His openness to different methodological approaches and his open-minded leadership style allows his doctoral candidates to fully indulge in their individual research.

I would also like to thank my fellow research colleagues. The many thoughtful discussions and critical questions were always valuable and helped me gain new insights. Among those I want to specifically mention and thank three colleagues who have also become true friends: First Niclas who was the best office mate I could have imagined, second Tim for his incredibly knowledgeable and valuable advice all along the dissertation project and finally Jan who I have shared the entire dissertation journey with from taking the educational leave to returning to the consulting work at McKinsey & Company.

Finally I want to thank my parents and my brother Julian for always being there for me and reminding me of the importance of other things than work and research. Each of them supported me in their own, special ways during this research project.

Above all, my greatest thanks go to my husband Richard for his unconditional support in every situation of life and for always encouraging me to take advantage of the eduational leave of absence from my job to write this thesis.

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List of Abbreviations

General and content-related abbreviations

BoP	Bottom of the Pyramid or Base of the Pyramid
cf.	Compare
CSR	Corporate Social Responsibility
ECG	Electrocardiogram
et al.	Et alia
etc.	Et cetera
e.g.	Exempli gratia
GDP	Gross domestic product
GE	General Electric
ISIC	International Standard Industrial Classification
IFC	International Finance Corporations
ITC	Indian Tobacco Company
MNC	Multinational corporation
NIF	National Innovation Foundation
NPD	New product development
OECD	Organization for Economic Co-operation and Development
SMS	Short Message Service
UNDP	United Nations Development Programme
UK	United Kingdom
USA	United States of America
vs.	Versus
WRI	World Resources Institute

Mathematical abbreviations and units of measure

α	Intercept
B	Regression coefficient
β	Standardized regression coefficient
bn.	Billion
CAT	Consensual Assessment Technique
Cum prob.	Cumulative probabilities
EUR	Euro
F	F-value
km	Kilometers
ln	Natural logarithm
Logit	Logarithm of odds

N	Sample size
ns	Not significant
OR	Odds ratio
p	p-value and probability
r	Correlation coefficient
R^2	Coefficient of determination
SE	Standard error
Sig.	Significance
t	t-value
USD	United States Dollar
VIF	Variance inflation factors
Wald	Wald statistic
Δ	Delta
$	Dollar
%	Percent

1 Introduction

The introduction sets the scene for this dissertation. It identifies guiding research questions and objectives before providing a short overview of employed research approaches and a summary of the chapters.

1.1 Research problem and relevance

Approximately one-third of the world's population lives in poverty and survives on a daily income of $2 per capita (cf. World Bank 2012). This heterogeneous group of people forms the global base of the income pyramid (BoP) across various developing and underdeveloped countries. By extending this definition to the poor in the world who share similar needs and deprivations, the BoP commands an enormous purchasing power of roughly 5 trillion dollars (Hammond et al. 2007). This large and so far mainly untapped market increasingly attracts firms from all over the world (Prahalad 2012). Emerging markets show much brighter growth prospects than developed countries. BoP consumers already account for more than half of the shares of purchasing power (cf. Hammond et al. 2007) and hundreds of millions of them are expected to enter the middle class in the near future (cf. The Economist 2010c). Beyond growth opportunities, serving the BoP is a well suited corporate social responsibility effort. Business at the BoP can contribute to eradicating poverty through affordable products that address unsatisfied basic needs to improve living conditions, integration of the poor into the formal economy and creation of entrepreneurial drives.

However, "[t]he BOP constitutes the largest remaining global market frontier for businesses" (Nakata, Weidner 2012, p. 21) and contains difficult obstacles to be surmounted. The various market-related challenges consist of a general lack of knowledge on this isolated and remote market, ineffective regulatory environments, deficient infrastructure of every kind, the poor's insufficient knowledge and skills as well as access to financial resources (cf. United Nations Development Programme 2008). Firms are still hesitant to tackle these challenges and do business at the BoP. Their lack of experience with subsistence markets (Olsen, Boxenbaum 2009), huge distances and the absence of knowledge regarding the lives, needs and preferences of the poor (Ansari et al. 2012) hinders them from doing so. Above all, firms do not know how to develop appropriate products, services and business models for subsistence markets. Cheap and no-frills versions of existing products from the developed world do not match the dramatically different circumstances at the BoP (Nakata, Weidner 2012). The harsh economic life of the poor, severe market constraints and extremely demanding product requirements can only be overcome

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with the help of innovation to create or adapt products and services (cf. Dos Santos et al. 2009). The new product development for the BoP calls for a different BoP specific innovation focus, sources, capabilities and approaches (cf. Viswanathan, Sridharan 2012; Prahalad 2012).

Thus far research provides only a very limited knowledge and practical guidance on how to innovate for the BoP (Nakata 2012). However, given companies' inability to access the essential BoP market and need information, they require local embeddedness and external support helping them to understand and relate to the BoP (cf. Viswanathan, Sridharan 2012). Innovations have to be co-created with the poor because "[o]nly through a process of co-creation can a BoP venture truly hear and respond to the voices at the BoP" (London 2008, p. 3). Only recently a perception shift from classifying BoP consumers as mere passive recipients toward recognizing the poor as consumers (Prahalad 2010), producers (Karnani 2009; London et al. 2010; Hahn 2009) and most recently as source of innovations (Gupta 2006) has occurred. The integration of BoP users into the innovation process via collaborations, co-inventions and user innovation allows firms to become truly embedded, to incorporate deep market knowledge, insights on solution spaces and instant user feedback into the development process (cf. London, Hart 2004). Although research stresses the importance of user involvement und co-creation as key success factors of innovation for the BoP (cf. Viswanathan, Sridharan 2012), there is scarcely any research or knowledge regarding indigenous or consumer innovation at the BoP (Nakata 2012).

According to user innovation research, the conditions at the BoP suggest a high relevance of consumer innovations for subsistence markets. The specificity and "stickiness" (von Hippel 1994) of garnering necessary information as well as the imperfect market conditions with insufficient or absent supplies of necessary products and services suggest a pronounced tendency toward a locus of innovation at the consumers' site (cf. Hienerth et al. 2011; von Hippel 1998; Ogawa 1998). High hopes for successful new product development are placed in the identification of innovating BoP consumers to increase general market and need knowledge, build on existent consumer innovation and leverage the creative potential of the poor (cf. Viswanathan, Sridharan 2012; Prügl, Schreier 2006).

However, general research on consumer innovation at the BoP "…is in a state of infancy…" (George et al. 2012, p. 662). The concepts of user and consumer innovation originate from developed markets and build on wealthier, resource-rich consumers under completely different living conditions. This research deficit combined with strongly deviating contexts of resource-scarce, subsistence markets call for an investigation of innovating BoP consumers and approaches to identify them (cf. Viswanathan, Sridharan 2012).

1.2 Research objectives and approach

Research objectives

User innovation research suggests that users apply their local knowledge and resources to detect unsatisfied needs and find appropriate solutions (cf. Lüthje 2004; Shane 2000). Consumer innovators from developed countries spend significant amounts of money and time on innovation activities (von Hippel et al. 2011). Moreover, new technologies allowing for Internet-based communication, access to information and digitalized designs facilitate and fuel user innovations (Baldwin, von Hippel 2011). Resource-scarce living conditions under various constraints represent a considerably different context for consumer innovations at the BoP. Low education levels and isolation from the wealthier and developed world restrict the locally available resources of the poor. They rarely benefit from new technology and access to information sharing and providing infrastructure such as the Internet, libraries and community memberships. The unsatisfied needs of the poor are manifold and apply even to the most basic requirements, such as the need for drinking water (cf. Banerjee, Duflo 2007; United Nations Development Programme 2008). Hence, it raises doubts as to whether consumer innovations and innovators at the BoP exhibit the same traits and characteristics than they do in developed countries.

Therefore, the first high level question guiding the research objective of this thesis is: What characterizes the phenomenon of consumer innovation at the BoP? The focus lies on generating insights on consumer innovations at the BoP as well as differences and commonalities compared to consumers in the developed world.

An important prerequisite for the integration of BoP consumers is the identification of promising candidates and factors that influence innovative activities in subsistence markets. The BoP as a huge, intransparent, unfamiliar and poorly connected mass market does not qualify for the lead user approach (von Hippel 1986) that is typically applied in identifying promising users (cf. Faullant et al. 2012). Instead the literature suggests finding promising innovators via their descriptive, definitional traits and focusing on antecedents that can be applied to systematically screen a consumer population (cf. Faullant et al. 2012). While the current research lacks knowledge on general antecedents of attractive consumer innovations, this applies all the more to BoP contexts (cf. Schreier, Prügl 2008; Viswanathan, Sridharan 2012). Hence, the second focus of this thesis is: What factors influence the development of attractive innovations by BoP consumers?

Research approach

To address the overall research objectives, the author has extended the mature and well-explored concept of user innovation to the new and different context of BoP

markets. As recommended for this kind of research, a quantitative approach has been chosen and applied to the analysis (cf. Edmondson, McManus 2007). The analysis is based on a sample of innovations generated by consumers living at the Indian BoP. The National Innovation Foundation (NIF) in collaboration with the Honey Bee Network possesses extensive and unique data on BoP consumer innovations in India. The publicly available profiles on consumer innovators and their solutions (cf. National Innovation Foundation) have served to build up an extensive sample for further analysis. In order to evaluate the consumer innovations a method from social psychological creativity research has been applied, i.e., the Consensual Assessment Technique (CAT) developed by Amabile (Amabile 1982). Thereby expert raters individually evaluate the degree of creativity and technical elaboration of technical BoP innovations.

Studies 1 and 2 focus on the research objectives regarding the discovery of patterns of consumer innovation and compares them with findings on innovating consumers from the developed world. For this purpose a descriptive analysis of the sample was performed. Next a comparative analysis with a consumer innovation sample from the UK (von Hippel et al. 2010) was conducted.

Studies 3 and 4 investigate the second research objective of this dissertation and focus on antecedents of attractive consumer innovations. To provide structural guidance for the analysis, a framework that draws on the social cognitive theory (Bandura 1986) was developed and the componential concept of creativity by Amabile (1983) was used. The assumed relationships between variables of the framework lead to the deduction of research hypotheses on antecedents of BoP consumer innovation. Both studies concentrate on technical BoP consumer innovations because of the required CAT evaluations. The hypotheses were tested by means of two multiple linear and one ordinal regression in the course of the two studies respectively.

1.3 Structure of the document

This dissertation is divided into eight chapters, which address the guiding two research questions. Chapter 1 sets the scene for the research project and identifies guiding research questions and objectives. A short overview of employed research approaches and methodology is followed by a summary of each chapter.

Chapter 2 defines the Base of the Pyramid and describes the research context of this thesis. General benefits and concerns associated with conducting business at the BoP are discussed. Economic living conditions of the poor are portrayed and typical obstacles in serving subsistence markets are depicted. Finally the importance of innovation is highlighted and specifies that innovation for and at the BoP requires

participation of the poor themselves.

Chapter 3 provides an overview of the concept of user innovation and the evolution of consumer innovation research. Particular focus is given to characteristics and motivations of innovating users as well as to approaches to identifying and leverage promising user innovators.

Chapter 4 presents the overarching research focus of this thesis. The two previously discussed research fields, BoP and user innovation, are brought together to introduce the topic of consumer innovation at the BoP. After identification of the research gap, five detailed research questions are formulated. In the second part of this chapter, existing theories are drawn on to introduce the research framework and derive the research hypotheses.

Chapter 5 explains the choice of descriptive and causal analysis to answer the previously raised research questions and to test the hypotheses. Furthermore, this chapter provides an overview of the data source, the collection of data as well as its operationalization from raw data into variables.

Chapter 6 explores and discusses the characteristics of BoP consumer innovators and their innovations before secondly comparing these with sample consumer innovations from developed countries.

Chapter 7 investigates antecedents of attractive consumer innovations at the BoP by means of two separate yet interrelated studies. The chapter explains the choice of applied statistical methods to test the previously raised hypotheses. Study 3 comprises two separate multiple linear regressions to analyze the influence of innovation-relevant resources on creativity and technical elaboration of BoP consumer innovations respectively. Study 4 employs an ordinal logistical regression to investigate the effects of innovation quality (creativity and technical elaboration) and contextual factors on market recognition of BoP consumer innovations. For both studies an assessment of the validity of underlying statistical assumptions will be conducted before finally discussing the findings.

Chapter 8 concludes with a summary of the major findings. Theoretical and managerial implications are derived before discussing the limitations of the findings. This is followed by suggestions for future research.

2 Phenomenological background for the BoP

The concepts of user and consumer innovation originate from developed markets and build on wealthier, resource-rich consumers. To investigate the concepts in a completely different context at the so-called Base of the Pyramid (BoP), phenomenological foundations of the BoP shall in the following lay the groundwork and define the research context for the present dissertation. This section starts with fundamental definitions of the term that refer to a population group and a business concept at the same time. General benefits and concerns associated with doing business with the poor are discussed before portraying the economic living conditions of the poor and depicting the challenges associated with doing business in a BoP environment. Finally I highlight the importance of innovation to successfully serve subsistence markets and introduce approaches guiding BoP innovation efforts before concluding that innovation for and at the BoP requires participation of the poor themselves.

2.1 Definition and background of the Base of the Pyramid

2.1.1 Population group

From a demographic point of view the BoP describes a population group living in various, mainly underdeveloped or developing countries in the world. Their common denominator responsible for the nomenclature consists in their low income levels. If one sorts the world's population by their yearly or daily disposable income as well as by their quantity, one will obtain a roughly pyramid-like shaped distribution with very few wealthy people at the top and a huge base of poor people at the bottom. These poorest people of the poor represent the lowest level of the global income pyramid and are, therefore, referred to as the bottom of the pyramid (Prahalad, Hart 2002; Prahalad 2010). Given the negative connotations of the word "bottom," several additional terms such as "low income market," "subsistence markets" and "low-income segments" are used alternatively (Nakata, Weidner 2012; Hammond et al. 2007). In order to stay close to the original notion of "bottom of the pyramid" introduced by Prahalad and Hart (2002) but to avoid negative connotations, I will use the term "Base of the Pyramid," which is consistent with, for example, Simanis et al. (2008).

At different points in time authors and institutions have proposed diverse income thresholds to define the BoP and estimate diverging BoP population sizes and

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purchasing power.[1] I focus hereinafter on defining thresholds[2] and BoP population size estimates by the World Bank (World Bank 2012). Accordingly, in 2008 there were roughly 1,3 billion people (19% of the world population) living at $1,25 or less per day per capita and 2,4 billion people (36% of the world population) living at $2 or less per day per capita (see Figure 1).

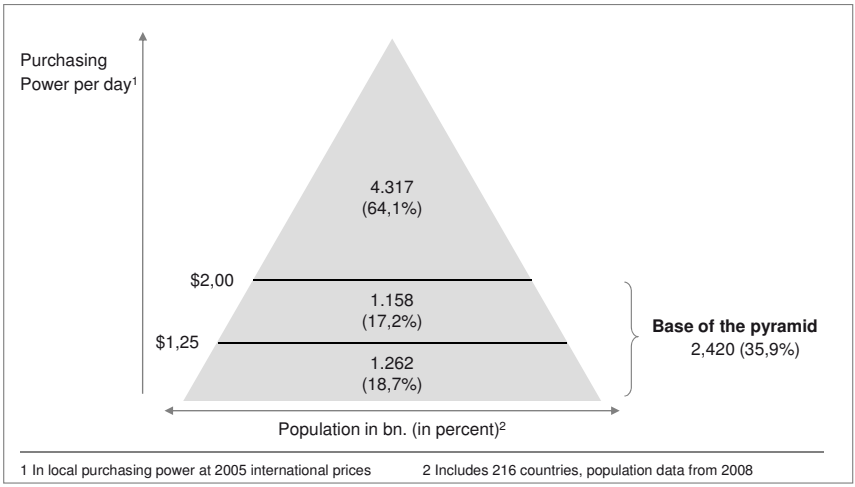

Figure 1: The global income pyramid (cf. World Bank 2012)

While income is the most commonly used indicator to identify the BoP as well as its eponym, it bears certain weaknesses. There is no consensus on where to draw the exact poverty line and minor alterations of thresholds have major impact on the size of the population group. Purchasing power exchange rates are criticized for their missing actuality and inaccuracy as the poor may face manifold price differences, e.g. between rural and urban areas. Consumption is considered as a better indicator for poverty but the extend of vital consumption is relative and depends on factors such as geographic and climate conditions. Finally, income and consumption patterns account only to a limited extend for the effects of household size, integration

[1] Prahalad and Hart (2002) suggest more than a billion people live at less than $1 income per day per capita in local purchasing power and define the BoP at the same time as 4 billion people with an annual income per capita of less than $1.500. Prahalad and Hammond (2002) estimate 4 billion people at the BoP but with an income threshold of $2.000 annual income per capita. Banerjee and Duflo (2007) adopt a poverty line of $1,08 per day per capita whereas Karnani (2006a) defines a threshold of $2 per day per capita.

[2] All following income thresholds correspond to the dollar amount in local purchasing power.

and embeddedness into the community (cf. Karnani 2006b; Banerjee, Duflo 2007; Gradl, Knobloch 2009).

The shared problems of the people at the BoP are a better means of describing poverty (Gradl, Knobloch 2009). Sen (2001) put forward a holistic and widely accepted concept also known as “the theory of poverty” that characterizes poverty as deprivations in capabilities. Sen’s capability perspective does not deny but enhances the income driven identification of poverty given that “… low income is clearly one of the major causes of poverty, since lack of income can be a principal reason for a person’s capability deprivation” (Sen 2001, p. 87). Poverty represents a person’s economic, knowledge, physical, and psychosocial deprivations in capabilities that ultimately result in deprivations in chances and choices in life. These deprivations include basic needs such as food, education, and physical health as well as social isolation, psychological stress and chances for self-realization. For example, better basic education and health can improve one’s quality in life and ability to earn money and offers more job options to choose from (Evans 2002; Sen 2001; Nakata, Weidner 2012).

The BoP from a development and economic perspective, therefore, focuses on shared unmet needs and deprivations. It targets a population group that exceeds the population share defined by BoP income thresholds only (Gradl, Knobloch 2009). The International Finance Corporations (IFC) and World Resources Institute (WRI) (Hammond et al. 2007) recommend considering a larger segment of the poor population for a market-oriented approach. According to this recommendation, roughly 4 billion people at the BoP with a yearly per capita income below $3.000 dispose of a combined purchasing power of $5 trillion (see Figure 2). Their daily per capita income corresponds to $3.35 in Brazil, $2.11 in China, and $1.56 in India in USD (2005). In their report the International Finance Corporations and World Resources Institute find that these 4 billion people share the following three major characteristics: 1) significant and unsatisfied needs for food, access to water, electricity, and health care, 2) their dependence on subsistence markets without access to formal labor markets and opportunities to sell their crops and crafts at fair and controlled conditions, and finally 3) being exposed to poverty penalties, which means that the poor have to pay even higher prices for basic goods, such as water and energy than wealthier people in the formal economy (Hammond et al. 2007).

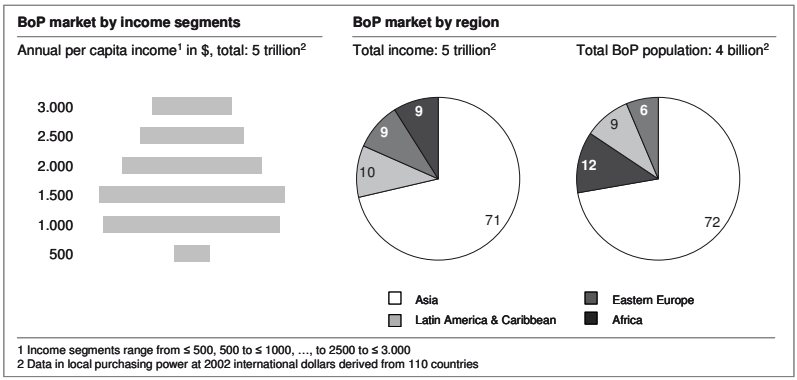

Figure 2: BoP market size (cf. Hammond et al. 2007)

However, the BoP is not a homogenous group. There are a lot of sub-segments at the BoP that differ with regard to their income level and consumption patterns within the defined threshold (Guesalaga, Marshall 2008). People living on $500 to $2.000 annually per capita provide most of total BoP purchasing power, whereas the least is provided by the poorest of the BoP living on less than $500 annually per capita (see Figure 2). Over 70% of the BoP population lives in Asia followed by Africa (12%), Latin America and the Caribbean (9%), and finally Eastern Europe (6%) (Hammond et al. 2007). These people experience different geographic, cultural, political and religious conditions, which consequently cause divergent problems, needs, and preferences (cf. Guesalaga, Marshall 2008; Banerjee, Duflo 2007).

2.1.2 Business concept

C. K. Prahalad and S. L. Hart (2002) who introduced the concept in 1998 in a working paper version of their later paper, “The Fortune at the Bottom of the Pyramid”, first used the term BoP with reference to the underlying business concept. The idea was predominantly popularized by C. K. Prahalad’s book of the same title (Prahalad 2010) that enjoyed great attention throughout the world (e.g. London et al. 2010; Viswanathan, Sridharan 2012; Davidson 2009). The BoP concept emphasizes an economic view on the population group and understands it as a large and so far mainly untapped market that offers profitable business opportunities to companies whose realization contributes at the same time to the development of the poor (Prahalad 2010). Thus companies are “…serving an unserved market and alleviating the level of global poverty while still earning a profit” (Pitta et al. 2008, p. 393).

2.1.2.1 Benefits to the private sector

Over the last years companies have shifted their focus increasingly to emerging markets as sources for economic growth (Arnold, Quelch 1998; The Economist 2010e). According to a special report on emerging markets by *The Economist* "…Western multinationals are investing ever bigger hopes in emerging markets. They regard them as sources of economic growth and high-quality brainpower…" (The Economist 2010e, p. 1). While the developed countries experience sluggish and stagnant growth still struggling with the current crisis, the developing world enjoys high growth rates and bright prospects (see Figure 3) with its huge emerging consumer base that no multinational corporation (MNC) can ignore (Prahalad, Lieberthal 1998). The IMF (International Monetary Fund 2011) estimated a worldwide real GDP growth rate of 5,0% for 2010, while the emerging countries contribute an overall 7,3% GDP increase (e.g. Asia grew by 9,5%, Latin America by 6,1% and Sub-Saharan Africa by 5,0%). These growth rates contrast with a relatively low overall GDP increase of 3,0% across the advanced economies (e.g. 2,8% in the USA and 1,7% in the Euro area).

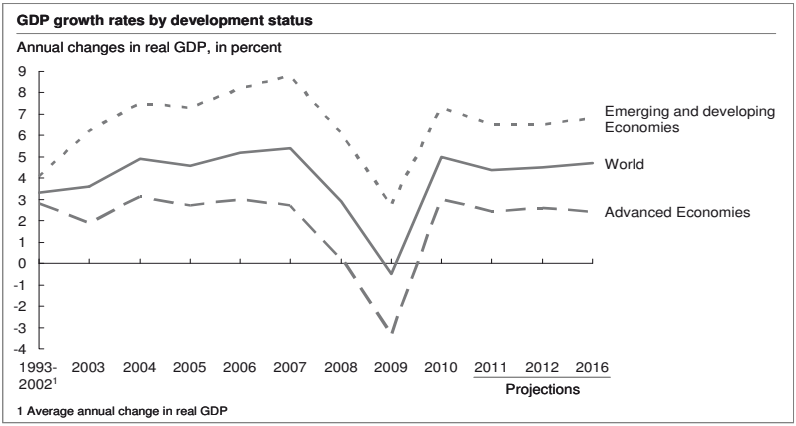

Figure 3: GDP growth rates (cf. International Monetary Fund 2011)

The emerging markets not only represent "…the major growth opportunity in the evolving world economic order" (Arnold, Quelch 1998, p. 7) but also its immense and further growing population paired with the expected economic development promises that several hundreds of millions of consumers will enter the middle class in the near future (The Economist 2010e). In this context companies intending to operate in emerging countries can hardly ignore the 4 billion people living at the BoP. According

to Guesalaga and Marshall (2008), people living at the BoP control more than half of the total purchasing power in developing countries (see Figure 4). To companies the BoP represents a huge market with a purchasing power of approximately $5 trillion (see Figure 2), which roughly corresponds to the combined GDP of Germany and Italy[3] (World Bank 2012) playing a central role in the growing and attractive emerging markets. Additionally, doing business at the BoP offers companies a competitive advantage by tapping into a huge market with very limited competition, as it has so far largely been ignored by the private sector (Hammond, Prahalad 2004). An early entry into the BoP market allows benefiting from first-mover advantages and optimizing market presence and positioning for the BoP's anticipated move toward the middle class and appearance of local and global competitors (Prahalad 2012; The Economist 2010c).

Companies challenging the "largest remaining global market frontier for businesses" (Nakata, Weidner 2012, p. 21) have the opportunity to tap into this $5 trillion market and to enjoy profits despite the individual consumer's poverty. High volume products and services at minimal profit margins enabled SKS Microfinance to generate considerable overall profit through lending approximately $725 million in microloans to more than 2 million Indians living at the BoP over a period of ten years (Akula 2008). Among multiple other examples Prahalad (2010) refers to Aravind Eye Care System in India who performs around 200.000 cataract surgeries per year at a very low prices compared to the developed world (prices are between 25% and 50% of comparable surgery costs in the USA). Even though the poorest 60% of its patients receive free surgery, Aravind nevertheless operates very profitably.

[3] GDP at local Purchasing Power Parity in 2010.

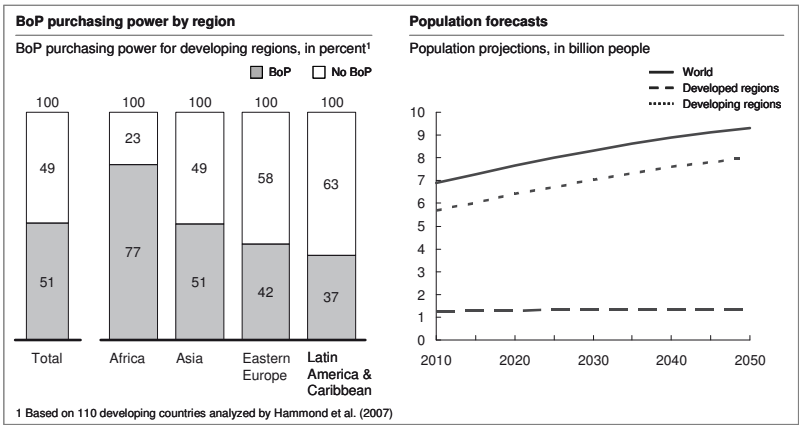

Figure 4: BoP purchasing power and global population forecasts (cf. Guesalaga, Marshall 2008; United Nations Population Division 2010; Hammond et al. 2007)

Furthermore, doing business at the BoP can benefit companies in regard to their corporate social responsibility (CSR) activities. Nowadays companies experience more and more pressure to behave as a "good citizen" and to responsibly address the environmental and social consequences of their business (cf. London, Hart 2004; Porter, Kramer 2006). According to a recent study by the MIT Sloan Management Review and The Boston Consulting Group (MIT Sloan Management Review, The Boston Consulting Group 2012) nearly 70% of 3.000 responding executives from 113 different countries confirm that sustainability, more specifically environmental, economic and societal sustainability, figures permanently on their companies' management agendas. Of the 250 largest MNCs in the world, 64% published separate CSR reports in 2005 (Porter, Kramer 2006). The engagement into BoP business is recognized as an important CSR activity (Hart, Milstein 2003). This fits well Porter's and Kramer's (2006) three major social issue categories for CSR strategies: 1) the generic social issue that is poverty and depending on the respective company's activities it can furthermore involve 2) value chain social impacts whenever the firm's business operations affect emerging markets and the BoP, and finally 3) social dimensions of competitive context if a competitive advantage can be derived e.g. through an early presence in the developing BoP market. CSR is not just charity or business constraints, but it can be "a source of opportunity, innovation, and competitive advantage" (Porter, Kramer 2006, p. 80). Eccles et al. (2011) find that highly sustainable companies adopting a large number of CSR strategies and policies outperform their less sustainably operating peers and achieve higher rates of return. Publication of a company's BoP activities allows a boost to the company's

reputation and contributes to an improved image and its general publicity. To various stakeholders, from suppliers to the broad public and to the end consumer, the firm appears more appealing and trustworthy to conduct business morally. The involvement into CSR and BoP operations can play an important role with regard to employee recruitment, retention and motivation, since employees value social commitment and their identification with the firm increases (Gradl, Knobloch 2009; Porter, Kramer 2006).

2.1.2.2 Benefits to the people living at the BoP

In 2000 for the first time the United Nations formulated clear targets to abate deprivation suffered at the BoP by means of the Millennium Development Goals (United Nations 2005) destined to help people in extreme poverty. The eight overarching goals cover the following targets to be achieved by 2015: 1) reducing the number of people in severe poverty, 2) achieving primary education for boys and girls, 3) promoting gender equality, 4) decreasing child mortality, 5) ameliorating maternal health, 6) fighting diseases, 7) developing environmental sustainability, and 8) establishing a global community for development. The latest progress report published in 2010 (United Nations 2010) shows clear signs of overall improvement with only 27% of the population in developing countries living on less than $1,25 per day per capita in 2005 compared to 46% in 1990.[4] This trend has been mainly driven by strong growth in Eastern Asia. Nevertheless, "the poorest groups, those without education or living in more remote areas, have been neglected and not provided the conditions to improve their lives" (United Nations 2010, p. 4).

Traditional approaches to poverty alleviation are based on the underlying assumption that people at the BoP are helpless, unable to improve their situation by themselves and without opportunities to make their own decisions. Accordingly, BoP people are considered as passive recipients of development aid and charity (Hammond et al. 2007). However, over the last years traditional methods alone have not proven to be successful and no further long-lasting and sustainable effects can be expected from charity and pure development aid actions (Hahn 2009). Ignored by the traditional assumptions, the BoP is in reality engaged in market processes and regular trades, e.g. money and manpower in their informal market environment. The concept of BoP recognizes this and aims to turn them into more comprehensive and competitive, inclusive and fair market processes (Hammond et al. 2007). The BoP concept shifts the view from helpless and passive development aid recipients to resourceful and

[4] This corresponds to 1,8 billion people in 1990 and 1,4 billion people in 2005 (United Nations 2010).

active consumers, producers and even entrepreneurs "… who possess valuable knowledge, resources, and capabilities" (Dos Santos et al. 2009, p. 80). The involvement of the private sector enables traditional approaches to join forces with commercial activities. The private sector can apply their unique resources to fight poverty. Firms have access to considerable scale opportunities, specific know-how and skills as well as substantial financial, managerial and technological resources that can be employed to offer affordable products and services to the BoP (Prahalad, Hart 2002). By addressing the significant and unmet needs of the poor and providing solutions to daily life challenges such as access to clean water, food and health care, the quality of life of the BoP can be considerably improved (Altman, Rego 2009). The private sector's competitive and formal product offerings can entail elimination of poverty penalties, i.e., higher prices for even basic products compared to the more developed world, which consequently allows the BoP to either have more disposable income remaining or to buy a more satisfactory amount of these necessities (Hammond et al. 2007).

Isolation and dependence of subsistence markets hinders the BoP to develop because "…if the poor can't participate in global markets, they can't benefit from them either" (Hammond, Prahalad 2004, p. 35). The connection with the private sector creates opportunities to bring new technology and break-through findings to the poor. The establishment of telemedicine networks in India between rural villages with hospitals based on satellite technology (Altman, Rego 2009) and a broad range of banking services provided through the use of simple mobile phones in Kenya are examples showing how new technology can benefit the poor and how in some cases the BoP can even leapfrog the developed world (cf. The Economist 2010d). BoP business not only allows for a better satisfying of unmet basic needs at affordable prices, but also offers an inclusive "…opportunity to participate in economically productive activities" (Altman, Rego 2009, p. 47).

Access to information, financial resources, production resources and the formal selling markets can be turned into higher productivity and consequently increase purchasing power (Gradl, Knobloch 2009; London et al. 2010). The E-choupal network in India illustrates the above mentioned positive effects that business can bring to the BoP. Traditionally BoP farmers sell their agricultural goods to local markets where buyers dictate prices and corruption is widespread. Given that isolated BoP farmers do not have any information on current commodity prices, buyers used to take advantage of their vulnerability, paying farmers significantly less than they deserved. However, when the Indian Tobacco Company (ITC) established their network of electronic procurement kiosks called e-choupals based on modern satellite technology and solar power, they directly connected BoP farmers with the soy market. The e-choupals provide important information on current prices, demand

forecasts, weather forecasts, agricultural advice to improve soy quality and potential buyers. Thereby the ITC enjoyed sourcing higher quality soy and better supply chain control and security. The BoP farmers' bargaining power, however, increased and helps to yield better prices and subsequently generate higher incomes. Agricultural advice as well as longer planning horizons help to further improve productivity. Additionally, the network offers opportunities for further economic activities and job creation. Every e-choupal is run by a well-chosen micro-entrepreneur and the kiosks can be used as a platform for other businesses and purposes (Hart, London 2005; Prahalad 2010).

Transactional security and trust such as mentioned in the example of the e-choupal enable the BoP to alter their behavior from day-to-day living to more long-term planning and investments that can further increase productivity and quality of life (London et al. 2010). Inclusive business at the BoP creates new entrepreneurial opportunities and entrepreneurial drive for the poor to actively lift themselves out of poverty (Prahalad, Hart 2002; Hammond, Prahalad 2004).

Beyond satisfaction of basic needs and promotion of inclusive economic activities, business at the BoP increases attention to the once ignored billions of poor people that can serve as basis for further poverty alleviation actions (Hammond et al. 2007). Moreover, processes that treat the BoP in a fair and respectful way contribute to higher levels of self-assurance, confidence and dignity for the BoP (Gradl, Knobloch 2009; Hammond, Prahalad 2004). In terms of Sen's theory of poverty (Sen 2001), the array of new opportunities and choices generated by the private sector eases the deprivations defining poverty.

2.1.2.3 Concerns and concept development

Despite all of the discussed advantages and the potential of the BoP concept for both companies and people living in poverty, it also draws criticism and advice for caution. One important discussion topic centers on the one hand, on the tension between offering choices and opportunities for self-determination to the poor and, on the other hand, protecting the BoP. Karnani (2009) and Davidson (2009) describe the BoP as a very sensitive environment with vulnerable consumers. Their lack of education and experience in evaluating product offerings, promotions and marketing campaigns makes them prone to mispurchases and spending money on goods that do not deliver as expected. Whereas this would annoy wealthier consumers, it would be seriously grave for the BoP who cannot afford to buy another product. Children have, for example, been accepted as being a vulnerable market that is protected accordingly but it remains unclear how to handle the BoP market (Davidson 2009). Uncertainty remains with regard to the product categories sold to the BoP. Should

companies promote and sell problematic products such as alcohol, tobacco or skin-whitening at the BoP (Karnani 2009)? According to Banerjee and Duflo (2007) the poor are already spending a high proportion of their incomes, e.g. 6% in Indonesia, on alcohol and tobacco. Companies may create unnecessary wants and needs on which the BoP could waste its already scarce income rather than buying something "good". However, then the following questions arise: Who decides what is "good" and why should the poor not have the freedom to choose by themselves on which products they choose to spend their money (Davidson 2009)?

Product pricing represents another problematic point of the BoP concept: How high should the profit margin be, and what are appropriate prices at the BoP? The private sector has to compromise between maximizing profits and minimizing prices for BoP products. Profit generation in combination with helping the poor are the two indispensable and coexisting prerequisites for the BoP business concept to work, and companies have to restrain from any action that could even potentially seem to take advantage of the BoP's weaknesses or exploit the poor. In the end the BoP customer is no ordinary costumer, and companies need to balance their economic as well as ethical and social responsibilities carefully (Davidson 2009).

Authors such as Karnani (2006a) warn that the BoP concept as presented by Prahalad (2010) and Hammond et al. (2007) is too optimistic. He argues that BoP market size in terms of purchasing power as well as population size is considerably less and estimates the market at 2,7 billion people with a purchasing power of $1,3 trillion still referring to his estimates as being exaggerated. Furthermore, he warns that especially due to the BoP market's heterogeneity, geographic dispersion and fragmentation the costs of serving the BoP are very high and could eat up all of the profits. Pitta et al. believe profits at the BoP "…will come later rather than sooner" (Pitta et al. 2008, p. 400) and recommend companies to adopt a long-term perspective and investment strategy. According to Karnani (2006a) companies that are failing to serve the BoP overestimated purchasing power numbers and several of the successful BoP business examples described by Prahalad are in reality serving only poor people above the $2 per day per person threshold. With regard to global resource scarcity and environmental burdens, Hahn (2009) highlights the impossibility of applying the wasteful development path of the wealthy, developed world to the BoP with its billions of potential new customers. Companies will experience an enormous challenge in carrying out BoP business more sustainably and finding appropriate solutions.

Nevertheless, the BoP concept is still a relatively new and evolving concept that requires further thorough and long-term analysis of successful and unsuccessful cases to evaluate its benefits and risks, especially with regard to aforesaid concerns and criticism. Critics (Karnani 2006a) as well as optimistic BoP supporters (Prahalad

2010), however, endorse the fundamental idea and recommend that companies should pursue or initiate BoP efforts sensibly while allowing for trial-and-error and adaptations. In recent years the BoP concept has developed from the initial underlying idea to understand the BoP as a market focusing primarily on the BoP as consumers (Prahalad 2010) to a more holistic, integrated and inclusive concept (Christensen et al. 2010). The second generation of BoP strategy (Simanis et al. 2008) broadened its scope from the BoP as consumers to producers (Karnani 2006a), a source of innovations (Gupta 2006) as well as entrepreneurs (Christensen et al. 2010) and partners (London 2009).

2.2 Business conditions at the BoP

The economic life at the BoP predominantly takes place in subsistence markets. These markets are mainly found in developing countries and consist of resource-poor communities characterized by weak or non-existent infrastructure with regard related to major human needs such as water, sewerage, electricity, communication, or medical care (Nakata, Viswanathan 2012; Viswanathan, Sridharan 2012). Hence, subsistence people typically experience severe deprivations such as economic, knowledge, physical, and psychosocial deprivations (Nakata, Weidner 2012). They suffer from lack of formal market access and are integrated in informal economies and strong social networks instead (Weidner et al. 2010). The lack of market access implies that in order to sell their products, crops and manpower as well as to buy goods and services, the BoP depends on local employers and intermediaries who take advantage of their dependence (Hammond et al. 2007). In fact, as London and Hart state, “Most entrepreneurs and customers in base-of-the-pyramid markets are poorly served by low-quality vendors or are actively exploited…” (London, Hart 2004, p. 352). Thus, the poor at the BoP do not only content themselves with lower quality goods, but they also very often have to pay higher prices than wealthier consumers (Hammond et al. 2007). This phenomenon is referred to as the “poverty penalties,” as previously mentioned. Subsistence consumers in Bangladesh pay approximately 1,60 EUR for one kilowatt hour energy, which is ten times more than the energy price paid by German consumers. Drinking water is 5 to 10 times more expensive in the slums of Jakarta, Nairobi and Manila than in the wealthier city districts and similar poverty penalties exist for other goods and services such as health care and simple consumer goods (Gradl, Knobloch 2009). The following sections will explore in more detail how the poor earn and spend their scarce income. It will also depict the challenges of conducting business at the BoP.

2.2.1 The economic life of the poor

Banerjee and Duflo (2007) have compiled and analyzed extensive surveys conducted among extremely poor households in 13 different countries across Asia, Africa and Latin America[5] to shed light on the economic life at the BoP. The study reveals that people at the BoP tend to be entrepreneurs carrying out several occupations at the same time with limited specialization. The poor are entrepreneurs in the literal way in that they are self-employed, raise the capital for their activities, run their business and are the residual claimants of earnings (Karnani 2009). Most of the poor, especially in rural areas, operate agricultural businesses. However, non-agricultural businesses such as street kitchens are also very common (Banerjee, Duflo 2007). As positive as connotations of the term "entrepreneur" may be, "[m]ost poor people are not self-employed by choice and would gladly take a factory job at reasonable wages if possible" (Karnani 2009, p. 8). In fact, Banerjee and Duflo (2007) argue that it is easier for the people at the BoP without relevant skills and capital to be self-employed than it is to find employers offering jobs. Their businesses are typically too small to be efficient.

Given that the BoP has very few assets and scarce investment options, there is almost no scope left to turn their activities into viable full-time occupations with higher returns. For example, if the poor could afford to irrigate their small piece of land, they could cultivate it for a longer period of time per year. Due to the small scale of their entrepreneurial business and for risk diversification reasons many people at the BoP carry out multiple occupations. They tend to mitigate exposure to default risks of self-employed activities and their job as employee by pursuing both occupations. Almost all people at the rural BoP own and cultivate a small piece of land as entrepreneurial activity and take on jobs, e.g. as daily laborers. One of the household studies analyzed by Banerjee and Duflo (2007) conducted in Udaipur, India, showed that 98% of the rural household members work as daily laborers, which represents their main source of income. This phenomenon of multiple occupations at the BoP applies to most of the analyzed countries, e.g. in Indonesia 50% and in Guatemala 84% of the rural poor households carry out multiple occupations. This pattern is less pronounced in urban areas as represented by Cote d'Ivoire where 47% of the urban households versus 72% of the rural households pursue multiple occupations.

In order to find their non-entrepreneurial jobs, people at the rural BoP tend to migrate on a temporary basis (Banerjee, Duflo 2007). According to the Udaipur study 60% of

[5] These 13 countries are: Cote d'Ivoire, Guatemala, India, Indonesia, Mexico, Nicaragua, Pakistan, Panama, Papua New Guinea, Peru, South Africa, Tanzania, and East Timor.

the poorest families declare that at least one family member has migrated for work in a given year. However, these people do not travel far and they also do not stay away from home for long. The pursuit of multiple occupations as well as these short-term migrations tend to hinder people at the BoP from learning their jobs better and specializing according to their skills and talents, which consequently prevents them from being promoted and earning higher incomes (cf. Banerjee, Duflo 2007).

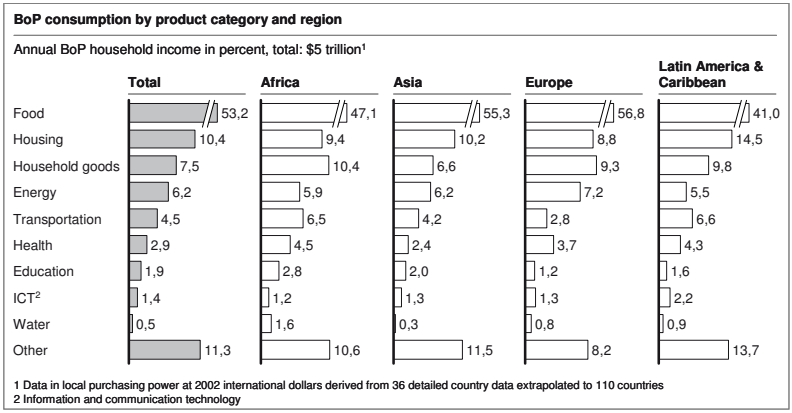

Figure 5: BoP consumption by product category and region (cf. Hammond et al. 2007; Guesalaga, Marshall 2008)

The IFC-WRI report (Hammond et al. 2007) provides detailed information on how the BoP spends its scarce money, which has been further analyzed by Guesalaga and Marshall (2008). The analysis in Figure 5 shows that the poor spend the largest share of their money to satisfy basic and essential needs such as the provision of food. Despite some minor regional differences, food, housing and household goods are among the three highest product categories by relative expenditure in all four regions. These findings largely support arguments expressed by Karnani (2006b) and Viswanathan and Sridharan (2012) that BoP consumers primarily strive to meet their unsatisfied basic needs.

Further studies, however, reveal that the poor also spend money on non-basic needs even if basic ones are not yet satisfied (cf. Prahalad, Hammond 2002). Banerjee and Duflo (2007) find that the poor spend money on entertainment, tobacco and alcohol although they do not have enough to eat. According to their Udaipur study, 57% of the surveyed households declare they do not have enough to eat but the median household spends 10% of its budget per year on festivals such as weddings and funerals. A typical BoP household could, therefore, spend 30% more on food just

considering what it spends on festivals, alcohol and tobacco. Even the very poor in Pakistan choose to send their children to private schools and to pay for it. Furthermore the BoP is willing to afford higher prices for branded products (Barki, Parente 2010) and higher quality items (Nakata, Weidner 2012). Subrahmanyan and Gomez-Arias (2008) grouped various products and service examples from the BoP literature into need categories according to the hierarchical Maslow pyramid. The analysis shows that the BoP does not follow the Maslow framework by first satisfying lower order needs before addressing higher order needs. People at the BoP actually consume non-essential items such as information and communication technologies appealing to higher order needs. Among possible reasons explaining this behavior are the BoP's strong social needs, cultural reasons, compensation for deficiencies in other areas of life (Subrahmanyan, Gomez-Arias 2008), trust in brands as they cannot afford any mispurchases (Barki, Parente 2010), and the desire for status products to keep up with the direct neighborhood (Banerjee, Duflo 2007).

Despite the considerable consumption of alcohol, tobacco and entertainment it is almost impossible for the poor to save money (cf. Banerjee, Duflo 2007). Most BoP consumers have no formal access to a savings account or credit and it seems to be difficult to save at home partly because of the lack of a safe place to keep the money, various temptations, or the risk of inflation. Furthermore, the poor usually have only limited ability to protect themselves against risks and their only insurance means cutting meals, taking children out of school and the integration into a strong social network. Living conditions at the BoP in combination with the lack of savings and insurance explain why the poor are often weak and sick, having problems performing their daily living activities. Also, the lack of saved money prevents the BoP to invest in more profitable, future-oriented technologies, such as fertilizers or seeds (Banerjee, Duflo 2007).

Social networks are very important at the BoP and the main reason why the poor do not migrate for longer (Banerjee, Duflo 2007). Communities can be considered as social capital and insurance that improve the BoP's ability to confront poverty (Subrahmanyan, Gomez-Arias 2008). In their isolated, disadvantaged environments the often illiterate poor rely heavily on their social sources of information as consumers and as entrepreneurs (Viswanathan et al. 2010). Small business owners in a BoP consumer's social environment can act as informal money lenders, ensuring the ability to make essential purchases (Weidner et al. 2010). Finally the importance of social relationships, group recognition and community may even supersede the need to satisfy basic physiological needs (Subrahmanyan, Gomez-Arias 2008).

2.2.2 Market constraints at the BoP

Despite its enormous market potential and the BoP consumers' aspirations for quality products and services, companies and entrepreneurs need to overcome various challenges and offer specific BoP compatible solutions in order to be successful at the BoP (The Economist 2010e; Prahalad, Hart 2010). The United Nations Development Programme (UNDP) (2008) identified and summarized the following five major market constraints that make business at the BoP so difficult, risky and costly: 1) limited market information, 2) ineffective regulatory environments, 3) inadequate physical infrastructure, 4) lack of knowledge and skills and 5) restricted access to financial products and services. The following sections will examine each of these limitations.

1) Limited market information

In order to successfully start a business a large amount of market information is required. For example unmet needs are necessary to detect business opportunities; tastes and preferences guide the development of appropriate solutions. Additionally, the market environment with its competitors and potential suppliers and partners as well as information on demand and willingness to pay are key to calculating a business case (Viswanathan, Sridharan 2012; United Nations Development Programme 2008). Access to relevant information on the BoP seems even more crucial as BoP markets are unlike conventional, wealthier markets in that the companies usually operate without applicable experience (Nakata, Weidner 2012). The needs, tastes and preferences of the BoP do not only differ significantly from the developed world but also within the BoP market itself, caused through the various e.g. geographic, cultural, and religious zones covered by the BoP (Hammond, Prahalad 2004). Rivera-Santos and Rufin (2010) propose that BoP business network structures are different on many levels from business networks in wealthier markets by being more unstable und unpredictable in formal aspects. However, information on the BoP, which is needed to start a business and to determine its viability, is lacking and extremely difficult to access (Prahalad, Hart 2002; United Nations Development Programme 2008). This not only holds true for global enterprises operating in and hailing from wealthy, developed economies, it is also the case among local BoP entrepreneurs who do not know their customers' expectations or quality requirements (London et al. 2010).

2) Ineffective regulatory environments

BoP markets typically lack effective regulatory environments allowing businesses to operate. Existing regulations in developing countries tend to be excessively complicated and nontransparent targeted at large corporations; complying with them

takes a lot of time and takes a substantial investment. A lot of businesses in developing countries in general and at the BoP therefore choose informality over complying with excessive and inadequate regulations (United Nations Development Programme 2008). For companies targeting the BoP, it is extremely difficult to cooperate and set up business links with informal enterprises (United Nations Development Programme 2008) given that there are no binding contracts and only little reliance on agreements (Rivera-Santos, Rufín 2010). Worse than these inadequate regulations is that laws are broken (United Nations Development Programme 2008) and a lack of legal enforcement of rights and regulations (Rivera-Santos, Rufín 2010) hinders provision of protection and market security (London et al. 2010). Companies can thus become subject to crime, corruption and pirating or find themselves in the middle of tribal, racial, religious or political conflicts without any legal protection (Hammond, Prahalad 2004).

3) Inadequate physical infrastructure

The poor at the BoP are largely isolated from other markets and only poorly connected. The road networks are insufficient, there is lack of affordable transportation and data transfer networks are weak due to low mobile phone and Internet penetration despite high growth rates (Vachani, Smith 2008). This is especially true for the large share of the BoP population living in remote rural areas. Seventy percent of the BoP in India (Prahalad 2012) are frequently described as being “media dark” due to missing audio and television signals (Prahalad 2010). Often at extreme geographic locations, these poor or nonexistent distribution and communication networks (Rivera-Santos, Rufín 2010) pose distinct challenges to product delivery, sourcing, information provision and advertisement (Vachani, Smith 2008). Furthermore, the lack of appropriate infrastructure also applies to other important services and supplies such as irrigation, water, sewerage, electricity, waste collection, schools and health facilities (United Nations Development Programme 2008; Banerjee, Duflo 2007). Due to the inadequate physical infrastructure business at the BoP is subject to significant additional transaction costs.

4) Lack of knowledge and skills

The necessary knowledge and skills required to form part of the market as consumer, employee or entrepreneur are very often missing at the BoP due to low education levels and limited access to information (United Nations Development Programme 2008). Even if they receive an education, the quality can be so poor that pupils do not even learn to perform subtraction, division or to read properly (Banerjee, Duflo 2007). Absence of information and experiences makes it difficult for the poor to come to the right decision when buying or selling goods. Producers may not know what kind of

products in which quantity to sell and what are appropriate prices for their goods (Vachani, Smith 2008). BoP consumers, however, are sometimes not able to recognize their needs and the benefits they could derive from using a certain product (United Nations Development Programme 2008). For many products the creation of a so far nonexistent market is necessary and BoP consumers need to be educated with regard to a specific need and the corresponding product (Anderson, Markides 2007). Moreover, BoP employees and entrepreneurs are lacking the knowledge and skills to increase their productivity and to ensure sufficient quality of goods and services (Vachani, Smith 2008). In turn companies willing to do business at the BoP are facing a lack of appropriate suppliers, distributors and partners (Rivera-Santos, Rufín 2010) who are able to deliver their goods reliably at agreed quality levels, set costs and deliver the goods on time (United Nations Development Programme 2008).

5) Restricted access to financial products and services

As previously mentioned, people at the BoP have only very limited access to financial services and products such as savings accounts, credit, insurance and other formal banking services (United Nations Development Programme 2008). However, the lack of credit and savings hinders BoP entrepreneurs from seizing opportunities and managing their resources effectively. Access to working capital and insurance is needed in order to finance production input, larger purchases as well as important long-term investments into, e.g., machinery and seeds to increase productivity (London et al. 2010). Insurance and credit provide stability and decrease risks of BoP entrepreneurs and households who are potential suppliers, partners, consumers and employees of bigger companies targeting the BoP. Without insurance they are vulnerable and cannot protect their belongings against predicaments such as death and illness, and risks such as flooding and theft. Transactions at the BoP are also very costly if formal banking services are not available (United Nations Development Programme 2008).

2.2.3 Organizational challenges

Various market constraints pose significant challenges to conducting business at the BoP, but there are further challenges such as organizational barriers at the company level as well as choosing appropriate business models to offer suitable products and services. Olsen and Boxenbaum (2009) analyzed the factors that prevent a for-profit organization from using BoP strategies. Firstly mindset conflicts arise because employees either emphasize shareholder value maximization, rejecting all sustainability activities or support sustainability activities while disapproving the combination of business and sustainability. Furthermore, adopting a BoP strategy implies radical changes to existing business operations and routines. Organizations

were reluctant to face the implied changes and struggled with the approach of the BoP project because they felt that they did not have sufficient information and experience and perceived the BoP project as “uncomfortably ambiguous and highly intangible” (Olsen, Boxenbaum 2009, p. 112). MNCs with BoP experience affirm the occurrence of organizational problems to understand local BoP environments and the need for new mindsets, approaches and capabilities (London, Hart 2004). Common project evaluation criteria and incentive structures favoring new market opportunities with minimum risk, low degrees of complexity, early break-even and immediate returns tend not to be applicable to BoP projects (Olsen, Boxenbaum 2009).

Finally one of biggest challenges consists in developing and offering appropriate products and services as well as business models that are compatible with the BoP (The Economist 2010e). Business at the BoP is radically shaped by restrictions and constraints (Viswanathan, Sridharan 2012), and addressing the BoP does not mean offering cheap and no-frills version of existing products from the wealthier world but tailoring solutions to their dramatically different circumstances (Nakata, Weidner 2012). A few frameworks aim at outlining major requirements and limitations for successful BoP solutions (see Figure 6).

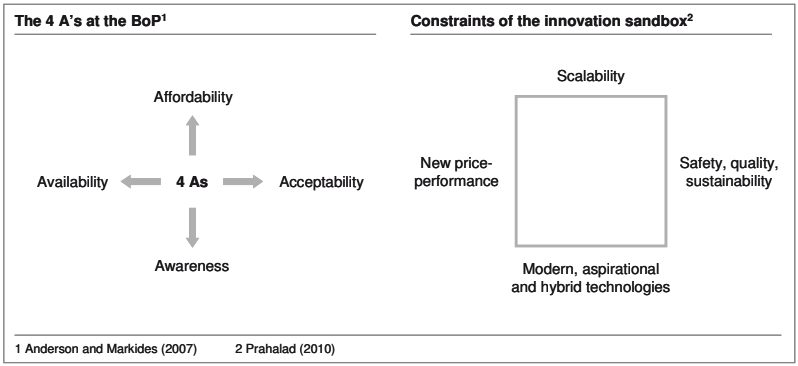

Figure 6: Requirements for product offerings at the BoP (cf. Anderson, Markides 2007; Prahalad 2010)

According to Anderson and Billou (2007) BoP approaches have to deliver the four A’s, more specifically, availability, affordability, acceptability and awareness, in order to be successful. Products and services have to be made available at the BoP by overcoming distribution hurdles and being ready to use in a BoP environment. BoP offerings need to be offered at a price point and at payment schemes that are affordable. Furthermore, products have to correspond to the unique needs of the

BoP, fit into the usage situations and adhere to specific, regional, social or cultural habits in order to be accepted by the poor. Finally despite “media darkness” and language diversity, people at the BoP have to aware that a given product or service exists.

Prahalad (2010) formulated constraints bordering the solution space for the development of BoP products and service offerings. As a result BoP solutions must be scalable (scalability) in order to benefit a noteworthy number of poor people and to be profitable as it tends to be a low margin and high volume business. An affordable price must be the starting point with cost structure and profit margin complying with the set price limits (new price-performance) (Prahalad 2012). Furthermore, the harsh BoP market constraints and cost pressure require in most cases that the application of modern technology and latest scientific knowledge be mixed with the existing BoP infrastructures (modern, aspirational and hybrid technologies) meeting global safety, quality and sustainability standards (safety, quality and sustainability) (Prahalad 2010).

2.3 Innovation for and at the BoP

The following section focuses on why innovation is a fundamental prerequisite in order to do business in subsistence markets followed by a description of existing approaches for BoP innovation. Furthermore, the need for participatory innovation and the involvement of BoP consumers into the new product development is set forth.

2.3.1 The role of innovation at the BoP

The results of an extensive literature research on the topic suggest that the BoP specific challenges arising from the harsh economic life of the poor, severe market constraints and extremely demanding product requirements can only be overcome with the help of innovative approaches. An important lesson learned by MNCs engaging in the BoP is that simply applying and leveraging existing business solutions, knowledge and capabilities to the BoP proves to be unsuccessful (London, Hart 2004). The BoP and developing countries in general exhibit great differences compared to the developed world. It is also erroneous to assume that the development of these underdeveloped markets with follow the path of the already more advanced markets (Arnold, Quelch 1998). Achieving the combination of necessary product or service attributes such as low cost, sustainability, good quality and profitability (Prahalad, Hart 2002) requires innovative approaches and business models (Dos Santos et al. 2009). Indeed successful business at the BoP requires “…innovation to create or adapt products, services and business models” (Altman,

Rego 2009, p. 51) applying to all areas ranging from market creation to entire business models (Hart, London 2005). In order to create a market or to shape an unorganized market (Prahalad 2000), organizations need to start with non-consumers instead of building up new markets from existing ones (The Economist 2010a).

The literature proposes specific areas guiding innovation efforts (see Figure 7) to handle the severe market constraints and to meet the unique product requirements at the BoP as referred to in Section 2.2. According to Prahalad and Hart (2002), innovative solutions are needed to ensure necessary buying power, improve access, tailor product and service solutions to local circumstances and shape aspirations to realize and meet needs. Subrahmanyan and Gomez-Arias (2008), however, applied the marketing framework known as the four P's (product, price, place, and promotion) to the BoP market in order to deduct where innovation is required when approaching the BoP market in comparison to traditional, wealthier markets. Hence, products and services have to be deliberately tailored to the specific use situations and BoP needs to increase the quality of life. BoP solutions that are affordable for the poor should be delivered by leveraging existing physical infrastructure. In order to promote BoP solutions, existing communication infrastructure such as radio, billboards or local methods of entertainment can be beneficial.

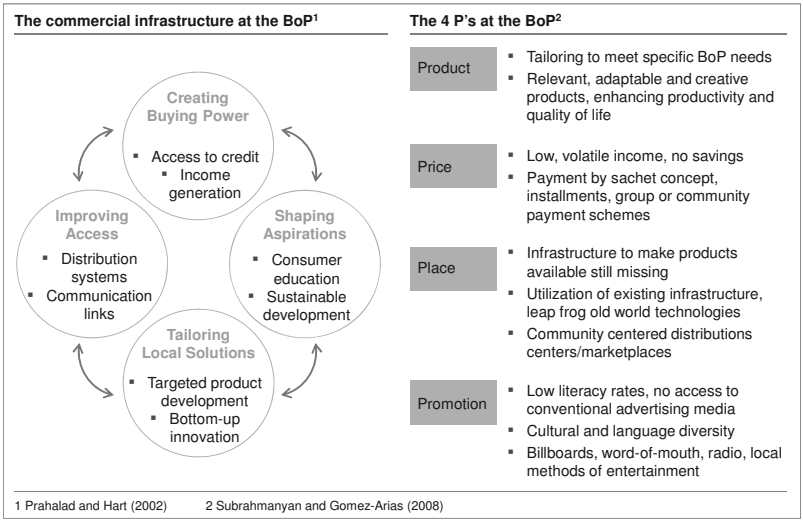

Figure 7: Key requirements for innovation at the BoP (cf. Prahalad, Hart 2002; Subrahmanyan, Gomez-Arias 2008)

The example of Smart Communications Inc. illustrates the importance of innovation for the success of a BoP business. Until 2002 mobile phone services were more or less unavailable for the poor in the Philippines given the high price of prepaid cards. Even the least expensive card was out of the range of their daily income; hence, the mobile service market basically did not exist at the BoP. Smart introduced prepaid pricing plans and over-the-air recharge technology allowing BoP consumers to transfer even small cent amounts to their accounts via this new and affordable service. Mobile services enabled people at the BoP to benefit from multiple usages such as saving expensive and time-consuming trips to get information on prices or medical advice. In the Philippines the poor averaged five trips per week to local, small so-called sari-sari stores. Previously, these stores rarely sold prepaid cards due to their reluctance to stock and guard the expensive cards. Hence, Smart eliminated the obstacles and the store owners' reluctance with their over-the-air technology and small prepaid amounts. By leveraging the existing sari-sari store distribution network, Smart now ensures good access to their products. Instead of the conventional advertising strategies that are of little use at the BoP, Smart provides in-shop marketing materials for the sari-sari stores, invests in billboards and advertising on local transportation vehicles and sponsors local events. Furthermore, Smart provides trainings and workshops to dealers, sub-dealers and other members of the distribution chain and teaches new BoP dealers retail skills (Anderson, Markides 2007). In reference to the framework by Prahalad and Hart (2002), Smart managed to develop a locally adjusted product based on modern technology while ensuring the necessary buying power at the BoP. Furthermore, it leverages existing distribution networks to assure access and makes use of local circumstances to promote the product. Smart trains its dealers via workshops, and they in turn educate the customers.

The BoP with its constraints and specific product requirements forces businesses to innovate and shows great promise for becoming a veritable seedbed of innovations on a worldwide basis (Altman, Rego 2009). Consumption opportunities of resources are restricted at the BoP. If consumption levels of the poor corresponded to today's level of a typical American, three or four planets earth would be necessary to deliver raw materials, handle the waste and to roughly keep our climate constant (Simanis et al. 2008). Thus, business with the BoP can only take place with the help of sustainable and environmentally compatible solutions. Consequently, the BoP can serve as a path to innovation and sustainability (Nakata, Viswanathan 2012) providing exceptional opportunities for disruptive innovation[6] (Hart, Christensen

[6] Disruptive innovation occurs when simpler, more practical and cheaper products or service

2002). These constraint-based innovations can even leapfrog the developed, wealthy world (The Economist 2010e) and move up the economic pyramid (London, Hart 2004).

The handheld electrocardiogram (ECG) by General Electrics (GE) is a good example of disruptive innovation guided by the constraints of a developing country (Immelt et al. 2009). Conventional ECGs are complex, heavy and solid machines costing around $10.000 in the United States. GE developed an ECG for rural India with a severe price target and the given infrastructural constraints such as limited access to electricity and hospitals or poorly trained physicians as a starting point. The outcome was an extremely simplified handheld ECG with an integrated printer that is light-weight and fits into a backpack. At the same time the machine is very easy to handle and works on batteries as well as on power (Prahalad 2012). Finally it costs only around $1.000 (Prahalad 2012) in India and allows physicians in rural India to visit the poor and to administer ECG tests to BoP patients at a cost of $1 per patient (The Economist 2010b). Today, GE successfully sells the handheld ECG in the developed world due to its low price and superior performance and functionality (Prahalad 2012).

Additional terms for this phenomenon other than “disruptive innovation” are “reverse innovation” meaning taking the needs of the poor as starting point instead of distributing products from wealthy, developed home markets to the developing countries (Immelt et al. 2009) or “frugal innovation” including the notions of simplicity and spare use of resources in combination with high quality (Tiwari, Herstatt 2012; The Economist 2010b). First examples of successful disruptive innovation from emerging markets led Prahalad to predict, “Participation in BoP markets and innovation will set the global competitiveness agenda for the next decade” (Prahalad 2012, p. 12).

2.3.2 Approaches for BoP innovation

Not only product and service offerings but also the very process used to develop these innovative BoP solutions needs to be reviewed (Viswanathan, Sridharan 2012). Designing products that are compatible with the specific environment at the BoP may be more time-consuming and complex than designing for the wealthy world (Dos Santos et al. 2009). BoP development efforts involve experimentation as well as

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alternatives enter a market where customers are excessively served by existing, increasingly sophisticated and sustainably improved ones aiming at profitable high-end customers. Disruptive technologies, such as e.g. personal computers in the mid 1980s, can evolve into new markets with major growth opportunities (Christensen et al. 2001).

continuous learning, refinement and trial-and-error procedures accounting for the entire BoP ecosystem (Prahalad 2012). Access to a company's resources and capabilities while simultaneously allowing for time independence and freedom of action with regard to deadlines, funding or research scope are essential for a successful BoP venture (Simanis et al. 2008). Therefore, standard new product development processes aimed at the developed world may not be applicable to the BoP (Nakata 2012) and have to be replaced by innovative research and development strategies and approaches (Hammond, Prahalad 2004). Research and development has to focus on the poor (Prahalad, Hart 2002) forcing businesses to reconsider and rethink innovation sources, processes, strategies as well as business partnerships, finances and objectives and finally organizational learning (Nakata 2012; Prahalad 2012).

However, only very limited theoretical and practical knowledge and experiences are available to guide innovation efforts for the BoP (Viswanathan, Sridharan 2012). As firms are starting to approach and respond to the product and service needs at the BoP (Nakata 2012) there still remains an important lack of regard to general management, consumer behavior or innovation research on the topic (Nakata, Weidner 2012). First attempts to identify some essential ingredients of successful product development processes at the BoP (see Figure 8) highlight the relevance of a deep and detailed understanding and knowledge of the unique BoP circumstances at every process step from understanding the market, product design and development to delivery. Viswanathan and Sridharan propose that "…context-driven design processes that are consistent with local conditions, are user-centric, and that optimally involve local skill can be successful in BoP markets" (Viswanathan, Sridharan 2012, p. 3).

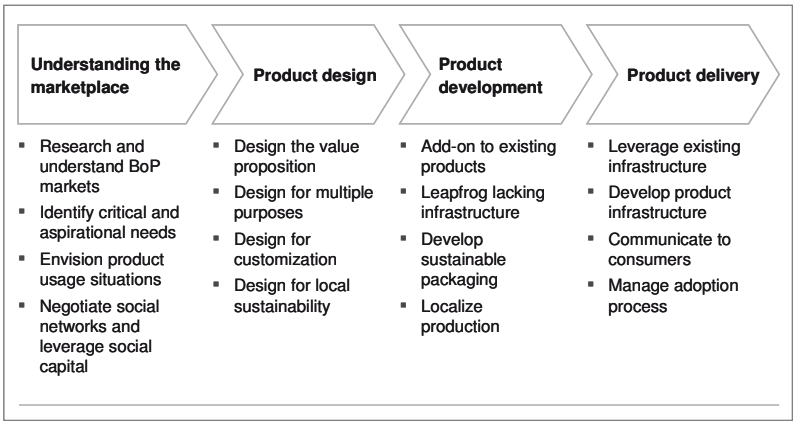

Figure 8: Key steps for new product development processes at the BoP (cf. Nakata, Weidner 2012; Weidner et al. 2010; Viswanathan, Sridharan 2012)

The innovation process starts with a profound immersion into the consumers' lives at the BoP (Prahalad 2012) and a deep and extensive understanding of subsistence markets (London, Hart 2004). The development of solutions must follow a bottom-up approach (Prahalad, Hart 2002) starting with identifying and understanding the unique circumstances and needs at the BoP (Bang, Joshi 2008) and then tailoring not only products but entire production processes and business models to meet these needs (The Economist 2010d). For that reason not only information on the specific needs is crucial but also information on the entire ecosystem including social networks, specific usage situations and existing products, local production opportunities, existing infrastructure, communication channels, adoption processes, etc. (Viswanathan, Sridharan 2012; Weidner et al. 2010).

However, companies operating in wealthy markets, especially if they stem from the Western world, are hardly capable of accessing the detailed and in-depth information necessary in order to innovate for the BoP (Viswanathan, Sridharan 2012). They simply do not know what kind of products and services the poor need and want (Pitta et al. 2008). Due to huge local differences at the BoP (Ireland 2008), there is no universal BoP solution, and foremost it differs significantly from solutions for wealthier customers (Prahalad 2012). An effective mixture of local and global knowledge would be required (Hart, London 2005), but managers are unfamiliar with the BoP and typically do not have any relevant personal experiences (Olsen, Boxenbaum 2009). Hence they cannot relate to the BoP and may even regard these ventures with incertitude and disapproval (Olsen, Boxenbaum 2009).

2.3.3 The need for participatory innovation

Given companies' inability to access essential BoP information, the need for external support to help them understand and relate to the BoP is obvious (Prahalad, Hart 2002). Literature emphasizes the importance of a local base of support and the role of collaboration with partners who are familiar with subsistence markets (London, Hart 2004). In this context traditional business partners lack relevant knowledge and experience (London, Hart 2004), but relationships with non-traditional partners of the formal and informal economy such as local delivery providers, local entrepreneurs (Altman, Rego 2009), governments and non-profit organizations can be key for the success at the BoP (Karnani 2009).

In fact organizations that engage existing social capital in BoP undertakings have proven to be most successful, e.g. in the case of group lending for micro credits[7] (London, Hart 2004). Vachani and Smith (2008) advise outsourcing the last mile of product delivery to the BoP and engaging with communities in order to achieve market entry and to overcome infrastructural hurdles. For example, the Fanmilk Company in Ghana employs microfranchises that sell ice cream and yogurt from equipped bicycles (Christensen et al. 2010). Coca-Cola built a distribution network in Venezuela using BoP housewives who vended Coca-Cola from their kitchens and helped to develop them into neighborhood convenience stores (Ireland 2008). A network of Shakti women acted as a rural sales force for Hindustan Lever in India (Prahalad 2010). By employing and enhancing native capabilities, firms can establish and maintain relationships (Simanis et al. 2008) and become an embedded part of the BoP community instead of remaining intruders (Hart, London 2005). Involvement of the poor creates jobs, enhances income and savings (Viswanathan, Sridharan 2012) and thus contributes to a general development at the BoP (Karnani 2009). The increased purchasing power improves general business conditions at the BoP (Bang, Joshi 2008) and lays a foundation for further business development (Fu et al. 2010).

The poor can play an important role as consumers, producers (Ramachandran et al. 2012), entrepreneurs, franchisees (Christensen et al. 2010) and even innovators (London, Hart 2004). In fact the lesser the distance of innovation efforts to the BoP end user, the higher the chances of meeting the needs and designing suitable solutions (London, Hart 2004). Thus innovations should be co-created with the poor

[7] Muhammad Yunus and the Grameen Bank in Bangladesh pioneered the concept of microfinance. Micro credits are very small loans given to poor people who lack collateral. The high credit risk and missing enforcement mechanisms are mitigated though group lending, where credits are given via a group (typically five women), who control and evaluate each other. Despite the high risk profile, the social pressure stemming from the group responsibility resulted in payback rates of 95% (Prahalad, Hart 2002).

(Nakata 2012) because “[o]nly through a process of co-creation can a BoP venture truly hear and respond to the voices at the BoP” (London 2008, p. 3). The integration of BoP users into the innovation process via collaborations, co-inventions and user innovation (London, Hart 2004) allows companies to incorporate deep market knowledge, insights into solution spaces and instant user feedback into the development process. They become truly embedded into the BoP context, which is particularly important in contexts where there is only very limited commonality between companies and consumers (Viswanathan, Sridharan 2012). A perception shift from classifying BoP consumers as mere passive recipients toward recognizing the poor as a source for innovations is key to success at the BoP (Gupta 2006).

3 Conceptual foundations of user innovation

This section aims to lay the conceptual foundations of user or consumer innovation before investigating the concept in a new context at the resource-scarce, subsistence BoP. Fundamental definitions and the evolution of user innovation research are provided before explaining the phenomenon itself and its antecedents. Next the individual user's characteristics are portrayed and this section concludes with approaches to identify promising users and techniques to take advantage of their innovation-related potential.

3.1 Definitions and background

The term "innovation" incorporates the notions of the generation of a new idea, its realization and ensuing exploitation. In this context, the Organization for Economic Co-operation and Development (OECD) places emphasis on the first notion, namely newness, in their definition of product innovations:

> "…a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics" (OECD 2005, p. 48).

The necessary degree of newness or innovativeness required for an idea to qualify as an innovation is not specified. It, therefore, ranges from radical to incremental as well as from new to world to new to the individual consumer (cf. Garcia, Calantone 2002). The other important notions of innovation consist in the realization and exploitation of a new idea or invention. Roberts accentuates this in the following definition of innovation:

> "… innovation = invention + exploitation. The invention process covers all efforts aimed at creating new ideas and getting them to work. The exploitation process includes all stages of commercial development, application, and transfer, including the focusing of ideas or inventions toward specific objectives, evaluating those objectives, downstream transfer of research and/or development results, and the eventual broad-based utilization, dissemination, and diffusion of the technology-based outcomes" (Roberts 1987, p. 3).

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According to the traditional value system model, innovations are primarily generated by producers or manufacturer firms and subsequently offered and sold in the form of new products to intermediate or end users (Bogers et al. 2010). While this traditional viewpoint corresponds to a manufacturer-active paradigm, meaning new product ideas are stemming from producers with consumers assuming a passive role, research in the 1970s gave rise to the discovery and acceptance of a customer-active paradigm where customers act as the source of new product ideas and manufacturers select customer generated ideas for development (von Hippel 1978; Bogers et al. 2010).

Initially, the importance of customer input and a detailed comprehension of user needs became evident. Rothwell et al. (1974) compared successful with unsuccessful innovations in the field of chemical processes and scientific instruments and came to the conclusion that understanding and meeting user needs was essential in order to succeed. Firms with a broader and more detailed knowledge of user needs and specific product or service requirements were able to detect problems earlier and had fewer problems with after sales. More specifically the input provided by the users themselves played an important role for the development of new products.

The majority of successful innovations are generated as a response to an unmet user need (need-pull) instead of the realization of a technical opportunity (technology-push) (Rothwell 1977; Herstatt, Lettl 2004). A study of successful new product processes identified that successful teams and business units "…pay special attention to the voice of the customer" (Cooper 1996, p. 470) and are thus able to offer exceptional benefits and greater value to the customers (Cooper 1996). It was especially the work of von Hippel (1995) that pushed the research field one step further by explicitly focusing on the user himself as the source of innovations. Von Hippel (1976) analyzed the customer role in the case of the development of scientific instruments and provided evidence that users can also be a key source of innovations. Having generated and developed approximately 80% of the sampled innovations, users featured as the single dominant source of scientific instrument innovations (Bogers et al. 2010). In this context I adopt the following definition of users:

> "…firms or individual consumers that expect to benefit from *using* a product or a service. In contrast, manufacturers expect to benefit from *selling* a product or a service." (von Hippel 2010, p. 3)

Thus, the term "user" embraces both end consumer users as well as intermediate

users who employ a producer's products and components to the creation process of another product or service (Bogers et al. 2010), such as surgeons (Lettl et al. 2006), librarians (Morrison et al. 2000), builders (Slaughter 1993) or firms applying industrial instruments (von Hippel 1976).

3.2 Relevance of user innovation

Empirical research shows that users of product and services often play an essential role in the development of new products and can be an important source of innovation (von Hippel 1995). In fact many of the most important and industry shaping product innovations that we can now buy from producers were originally initiated, invented and developed by users (de Jong, von Hippel 2009). Shah (2000) shows that 100% of all first type innovations relating to three different outdoor-sports activities originated from innovative users. Users often create a previously nonexistent market and start a new industry, which was the case, for example, in the beginnings of the windsurfing or snowboarding industry (Shah 2000). Users often first develop and prototype products meeting specific and tacit needs in a very unsecure and quickly changing environment. As demand increases users might even start selling based on a low cost production, and once market and demand reach a certain size and stability, manufacturers eventually enter the market and take over production and commercialization (Hienerth 2006). Furthermore, user innovation can be classified as a quite common phenomenon. Herstatt and von Hippel (Herstatt, von Hippel 1992) found that 36% of industrial pipe hanger hardware users innovate and Lüthje (2004) identified 37% of all consumer users of outdoor-sports equipment developed ideas for new or improved products. These findings demonstrate that user innovation is not restricted to a marginal group of users (Lüthje, Herstatt 2004).

Several studies explore and confirm the relevance of user innovation for the production of industrial goods in various industries. For example Foxall (1985) investigated user innovations at a manufacturer of aircrafts. Users of computer aided systems for designing printed circuit boards show clear preferences for a system concept developed by users over the best commercially available system even if priced higher than competing systems (Urban, von Hippel 1988). User-builders instead of component manufacturers represent with over 80% the major source of almost all innovations with regard to a specific component used for residential housing construction (Slaughter 1993) and automotive as well as electronics manufacturers as users have enormously contributed to the innovation of machine tools in Japan (Lee 1996). Morrison et al. (2000) found that 26% of all libraries using a certain library search system in Australia performed major or minor modifications to the search system and a multiple case study in the area of medical equipment

technology identifies medical doctors as originators and inventors of all innovations (Lettl et al. 2006).

Subsequently, research has been extended to innovating end consumers typically consisting in end user communities or individual users engaging in the generation of leisure time or sports-related innovations (Bogers et al. 2010). Similar patterns and relevance apply to user innovations in the field of consumer goods. Providing first evidence of the phenomenon, Shah (2000) identifies users as source of all first type industry innovations and 58% of the most important improvements of snowboarding, skateboarding and windsurfing equipment. Likewise Baldwin et al. (2006) analyzed the dominant role of end users for the evolution of rodeo kayaking over time and discover that users generated 100% of all techniques, 62% of all major and 83% of all minor equipment innovations with relevance for the advancement of the sport between 1970 and 2000. Furthermore, nearly a third of all surveyed members of other leisure sports communities, more specifically sailplaning, canyoning, boardercross and handicapped cyclists, declare to have already innovated with regard to their community topic (Franke, Shah 2003). Additional studies have obtained comparable results for users of climbing/ mountaineering, hiking, cross-country skiing and mountain biking equipment (Lüthje 2004; Lüthje et al. 2005). Giving another example of innovative consumers, Hippel and Oliveira (2009) investigated innovations of banking services and found a share of 85% out of 47 novel and relevant banking services were in fact self-provided by users before any bank offered them.

However, user innovation research with regard to innovative end consumers so far has only focused on a relatively narrow niche of leisure and sports-related consumer goods generated predominantly within community environments (von Hippel et al. 2010). Very limited research and knowledge exists on the extent and pattern of innovations generated across an entire consumer population without limiting the observation focus to extracts such as communities or specific leisure categories. A holistic view on the comprehensive consumer population corresponds to the idea of a household sector (Hienerth et al. 2011), which “comprises all resident households and includes unincorporated enterprises” (Ferran 2000, p. 23). Hence household innovation represents consumer innovation on an aggregated and comprehensive level and “[t]he development and modification of consumer products by consumers, as occurs in whitewater kayaking, is a component of ‘household sector’ innovation” (Hienerth et al. 2011, p. 2). To avoid any confusion among the terms “household innovation” and “consumer innovation,” I will adopt the term consumer innovation in this dissertation similar to Hienerth et al. (2011) in order to emphasize the source of innovation rather than the macroeconomic aggregate.

Household or comprehensive consumer innovation is a new research topic and no

official innovation statistics or data has thus far been collected on a national or international level (Hienerth et al. 2011). Only recently two single comprehensive studies in the UK (von Hippel et al. 2010) and the USA and Japan respectively (Ogawa, Pongtanalert 2012) started examining the phenomenon across entire consumer populations and consequently opened up a new research stream within user innovation research. Both consumer innovation studies show an explorative approach by screening a large population sample for evidence and patterns of comprehensive consumer innovation. While the telephone (UK) and online surveys (USA and Japan) generated first descriptive findings of the phenomenon, further thorough research is necessary to generalize the results, enrich them with further details and to generate reliable statistical measures (cf. von Hippel et al. 2010). However, the identified consumer innovations patterns, especially in the case of the extensive UK study, represent first insights on the phenomenon and may be valid starting points for further investigations.

The broad study on innovating end users in the UK (von Hippel et al. 2010) suggests that consumer innovation is a phenomenon of considerable size and scope with a share of 6,1% in a representative sample of 1.173 consumers. With an estimated number of 2,9 million there seem to be more innovating consumers than there are professional developers employed by manufacturer companies in the UK. Furthermore, the analysis shows that the users apply their innovative efforts mainly to UK's most popular leisure-related activities such as sports, use of the Internet and arts and crafts (von Hippel et al. 2010). The second research study yielded mostly similar results for Japanese and US consumers (Ogawa, Pongtanalert 2012). A share of 5,2% innovating users was identified in a representative sample of 1.992 US American consumers and 3,7% of the representative sample of 2.000 Japanese consumers are innovating consumers (Ogawa, Pongtanalert 2012). Considering the estimated effective money spent as well as time invested valued at average national wage levels, consumers in all three countries seem to invest billions of dollars per year on their innovation activities. These estimated consumer investments have reached as high as 144% of commercial enterprises' yearly spending on consumer product research and development in the UK (von Hippel et al. 2011).

3.3 Users as source of innovation

The following section portrays antecedents and motivations of users to develop products and services. Beyond typical characteristics of innovating users and their development activities, the approaches used to identify and leverage innovating users are described.

3.3.1 Antecedents and motivation of user innovation

The concept of sticky information and appropriability of benefits

The concept of "information stickiness" (von Hippel 1994) helps to understand why user innovation occurs at all. In order to solve a problem one has to combine the need information associated with the problem and appropriate problem-solving capabilities (von Hippel 1994). While need information and information required for evaluating solutions is clearly in the hands of the user, producers mostly possess the related technical information of problem-solving (von Hippel 1998). By bringing together these two types of information or knowledge, a suitable solution to the problem can be generated. In other words innovation takes place (von Hippel 1994). But acquisition, transfer and use of information can be difficult and costly when it is sticky. Information stickiness can be defined as "…the stickiness of a given unit of information in a given instance as the incremental expenditure required to transfer that unit of information to a specified locus in a form usable by a given information seeker. When this cost is low, information stickiness is low; when it is high, stickiness is high" (von Hippel 1994, p. 430).

Reasons for information stickiness can be manifold and refer 1) to the nature of the information itself as well as 2) information provider and seeker characteristics (von Hippel 1994). First, knowledge can be tacit and encoded instead of being explicit (Tyre, von Hippel 1997). The sheer amount of required information may be large and consist in a very huge number of incremental units (von Hippel 1994), or it can also involve very specific designs, experiences and practices versus simply generic knowledge (Nelson 1982). A study conducted by Teece (1977) shows how costly information transfers can be by analyzing several technology transfer projects with information transmittal costs reaching 59% of the total project costs, which explains the need to carefully organize and plan acquisition and development of technologies (cf. Tschirky et al. 2000; Tschirky, Trauffler 2011). Second, the information seeker's existing stock of knowledge and experience influences his ability to exploit external information (Nelson 1982). "Thus, prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen, Levinthal 1990, p. 128). This appropriability of information is known as absorptive capacity. Information close to existing knowledge can become absorbed and exploited. Accordingly, the more relevant absorptive capacity in an organization or in possession of an individual, the better it can recognize, evaluate and utilize external information and hence, the lesser the degree of information stickiness (Cohen, Levinthal 1990). These findings are supported by a study of information transfers within several companies that identified the information seeker's lack of absorptive capacity, insufficiently encoded knowledge and difficult relationships

between information sources and seekers as drivers for information stickiness (Szulanski 1996). If either the need or problem-solving related information is relatively sticky, innovation-related problem-solving will rather take place at the locus of the sticky information (von Hippel 1994; Ogawa 1998). High costs associated for example with the transfer of use and need information drives the locus of problem-solving "…away from the problem-solving by specialist suppliers, and towards those who directly benefit from a solution and who have difficult-to-transfer local information about a particular application being solved, such as the direct users of a product or service" (von Hippel 1998, p. 629). Thus, user innovation is likely to take place when the user and needed information are relatively sticky and information stickiness of associated problem-solving capabilities and technology is relatively low.

Industries or product categories differ with regard to the prevailing source of innovations (Pavitt 1984). This can be explained by different degrees of information stickiness regarding specific problem-solving technologies and user needs (Rothwell 1986). The appropriability of innovation benefits is another influencing factor of the innovation locus as "…the player who expects the highest profit from the innovation is most likely to innovate" (Ogawa 1998, p. 778). Appropriability of innovation benefits favoring producers as source of innovation may consist in solutions that give certain advantages to manufacturers, e.g. cost advantages, quasi-monopoly positions or protection of trade secrets, but users may not experience a need for this innovation due to the existence of sufficient alternatives (von Hippel 1978, 1982). However, if the target market is small in scale (Shah, Tripsas 2007), involves high agency costs due to e.g. time lags (von Hippel 1998) and other misaligned interests between user (principal) and manufacturer (agent) (von Hippel 2010) or variety of demand is high, it will be too expensive for producers to offer solutions satisfying all the different need clusters (Lüthje, Herstatt 2004). Consequently, users will not be satisfied with the existing product or service offerings and will be prone to develop solutions themselves. In such cases appropriability of innovation benefits is low for producers but high for users, which therefore favors users as a source of innovation (Lüthje, Herstatt 2004).

Incentives to innovate for individual users

The previous section deals predominantly with antecedents and favorable circumstances of user innovation in a general industry or at a product specific level. However, this section will now take a closer look at the individual user's motivation and incentives to innovate. Favorable views toward a specific product category influence an individual's propensity to innovate. If producers, for example, decide not to serve an unprofitable niche market because of its low appropriability of innovation benefits, this will affect the individual user's motivation to find a solution to the

existing and unsolved problem. The incentive to develop a solution consists in the benefit a user expects to derive from the innovation (Riggs, von Hippel 1994). The greater the expected benefit from a solution, the greater the effort to find it (von Hippel 1986).

Typically, the major expected benefit from an innovation is its usage. In fact an unmet need and dissatisfaction with existing products and services is typically the trigger for user innovation (Lüthje 2004). In an imperfect market with an unsatisfying supply, the users try to fill the gap with an appropriate user innovation (Baldwin et al. 2006). A user's propensity to innovate increases if the user experiences a unique need and developing a solution on his own is less expensive than the search for and acquisition of existing innovations (Morrison et al. 2000). Other important benefits that users expect to derive from their innovations consist of financial rewards (Lüthje 2004), learning and enjoyment of problem-solving and development activities (Lakhani, Wolf 2003), improved status in the user's reputation (Henkel, von Hippel 2005), fulfillment of community or society-related obligations and norms (Lakhani, Wolf 2003) as well as the opportunity to help others (Hienerth et al. 2011).

3.3.2 Characteristics of innovating users

User innovation not only takes place because a user is motivated to derive its benefits, but also because the user possesses the appropriate abilities and expertise to do so (Lüthje 2004). Individuals and groups tend to apply their own stock of knowledge, skills and experiences to problem-solving activities (Marsh et al. 1999). Hence, a user applies his locally available solution resources to the generation and development of an innovation (Lüthje 2004). The better a user's local resources are with regard to their relevance for the problem-solving task at hand, the higher the user's propensity to innovate and the more sophisticated the commercial attractiveness of the innovation (Franke et al. 2006). Prerequisite local resources such as detailed information on needs and use experience (Schreier, Prügl 2008) allow for a deep understanding of the problem and solution specifications as well as evaluation and comparison of potential solutions. Equipment, technical knowledge and skills associated with the underlying technology more specifically product design, materials and technologies, are particularly important local resources for the generation of user innovations (Lüthje 2004; Lüthje et al. 2005). In this context Morrison et al. (2000) identify the in-house availability of relevant technical skills as discriminating factors in distinguishing between innovating and passive users.

The outcome of the innovation process is likewise influenced by the specific set of resources employed by the user. Prior knowledge derived from work experience or a user's education influences an individual's capabilities to recognize opportunities and

to process and apply information (Shane 2000). A former watchmaker, now a surgeon, who applied his mechanical knowledge to the development of medical equipment technology, provides a good illustration of this phenomenon (cf. Lettl et al. 2006). Users also tend to rely on immediately available, familiar physical resources, such as job-related equipment (Slaughter 1993). The context, however, in which user innovation takes place also has an influence on the solution. Burroughs and Mick (2004) find that situational factors such as time constraints and higher personal involvement increase the creativity of a user's problem-solving activities.

Research shows that innovation is concentrated among a particular group of users with unique needs and use information who expect high innovation- related benefits. These people are referred to as "lead users" (von Hippel 1986) and exhibit the following two characteristics:

> "– Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, *and*
>
> – Lead users are positioned to benefit significantly by obtaining a solution to those needs." (von Hippel 1986, p. 796)

Lead users draw the highest benefit from the solution to an unmet need and as a result they dedicate the greatest efforts to the understanding of the need and the search for appropriate solutions (von Hippel 1986). Lead users' expectations of superior benefits increase their propensity to innovate, and being ahead of the trend exerts a positive impact on the commercial attractiveness of the resulting innovation (Franke et al. 2006).

3.3.3 Identifying and taking advantage of innovating users

Users draw on a different knowledge base than producers and can, therefore, be a source of unique solutions (Bogers et al. 2010). "Because they have a privileged window into both needs and solutions, users can generate creative ideas." (Shah, Tripsas 2007, p. 132) An experimental study on service innovations illustrates how users generate more original ideas than professional service developers (Kristensson et al. 2002), while another study demonstrates that userness relates to the likelihood of commercially attractive innovations (Franke et al. 2006). It is, therefore, not surprising that producers can profit considerably through integration of users in their innovation process (Rothwell 1986). Need information and solution specifications provided by users can improve productivity of new product development (Urban, von Hippel 1988; Herstatt 2007) and firms may even leverage the users' creative

potential or draw new product ideas directly from existing user innovations (Prügl, Schreier 2006). This section deals with approaches to identify innovating users, notably lead users, and to integrate users into the new product development process.

Due to their higher propensity to innovate as well as their superior innovations compared to ordinary users, lead users are of exceptional interest to producers. Several studies following von Hippel's first proposal (1986) have refined and further developed methodologies and techniques to integrate lead users into the new product development process. Herstatt and von Hippel (1992) successfully applied a four-step approach at a manufacturer of construction equipment and materials: 1) In order to identify users who exhibit advanced unmet needs regarding a major industry trend they first identify major industry trends and the kind of user who would highly benefit from the associated solution. 2) The project team then identifies lead users based on the discovered trend and characteristics of benefiting users. 3) Next a joint problem-solving takes place with a sample of these lead users and suitable personal from the producer's side. 4) Finally generated concepts and concrete product ideas are tested to see if they also appeal to ordinary users.

Various authors have explored the value of lead user involvement in the innovation process. For example Lilien et al. (2002) conducted an experiment at 3M to compare the lead user method with conventional approaches and found that lead user generated ideas are of higher novelty, address more original needs and have significantly higher sales forecasts. According to a study on electronic home banking services (von Hippel, Riggs 1996) lead user approaches develop better information and service concepts in a faster and cheaper way than conventional marketing research.

Nevertheless, identification and recruiting of experts for trend analysis (Schreier, Prügl 2008) and lead users for joint innovation-related problem-solving activities proves to be very difficult and requires enormous efforts (Olson, Bakke 2001). Screening the entire user population for lead users can be very costly and time-consuming (Morrison et al. 2000). Simplifications such as the network approach can facilitate the process. Assuming people engaged in a topic know someone with more expertise in the field of interest, this means one simply has to continue asking third parties for experts until lead users are identified (Lilien et al. 2002). However, identification of promising innovating users by means of defined lead user characteristics does not seem suitable for all situations such as those with unmanageably large consumer populations (Schreier, Prügl 2008). Faullant et al. (2012) analyzed a consumer mass market that does not allow for the typical lead user identification because of a lack of clear, identifiable market trends and a broad base of benefiting consumers who cannot easily assess their own relative user status. However, there might still be a lot of innovating users among them who

improve existing offerings or create new solutions. Faullant et al. (2012), therefore, propose the investigation of antecedents as determinants of lead userness instead of using descriptive traits in order to find innovative users. Similarly Lettl et al. (2006) find that users generating radical innovations in the field of medical equipment technology do not exhibit the typical lead user characteristics but share certain antecedents of lead userness. In this context literature identifies the following antecedents or user characteristics that may improve the search process for innovating users: availability of product-related knowledge and use experience (Faullant et al. 2012; Schreier, Prügl 2008), access to relevant technological know-how and competencies, supportive environment with sufficient resources such as time and funds and high motivation to develop a solution (Lettl et al. 2006).

Studies show that ordinary users can even be more creative than lead users, (Magnusson 2009) but "…ordinary users should not be expected to contribute ideas that can be directly put into the new product development process; rather, ordinary user involvement should be regarded as a process whereby a company learns about users' needs and is inspired to innovate." (Magnusson 2009, p. 1) Beyond the lead user method, there are other approaches to take advantage of innovative users and to integrate their creative potential into the new product development process.

An innovation process can be partitioned into several process steps, where some steps are completed at the producers' and others at the users' site (von Hippel 1994). Following the logic of the concept of information stickiness, each process step takes place at the locus of sticky information. Hence, users may carry out, for example, need- and functionality-related innovation steps for a producer. Manufacturers can transfer these process steps to users by equipping them with toolkits (von Hippel 2001). A toolkit reduces the stickiness of problem-solving information and provides users with standard components and tools enabling them to perform trial-and-error and learning-by-doing solution seeking (von Hippel 1998) in a solution space that ensures producibility of results (von Hippel 2001). Instead of putting immense efforts in understanding the customer, these toolkits allow users to design exactly what they want, which saves costly and time-consuming iterations between customers and the manufacturer (Thomke, von Hippel 2002). The toolkit approach is especially valuable whenever new product development involves a lot of sticky information on needs and applications (von Hippel, Katz 2002), demand is heterogeneous (Thomke, von Hippel 2002) and users ask for customization (Franke, von Hippel 2003). Franke and Piller (2004) analyzed the effects of toolkits using the example of watches and found a twice as high willingness to pay for self-designed models compared to the bestselling standard watch on the market. Among other methods to involve users in the new product development process are idea competitions used for brainstorming and generation of product or service ideas (Piller, Walcher 2006).

4 Research focus

This section aims at laying out the overarching research design for this dissertation. The two previously discussed research fields, BoP and user innovation, are brought together introducing the topic of consumer innovation at the BoP. Considering the current state of research, this leads to identification of the research gap and formulation of resultant research questions. A framework is introduced to provide structural guidance for the analysis of antecedents of BoP consumer innovation. The research framework is based on the social cognitive theory (Bandura 1986) and the componential concept of creativity by Amabile (1983). The elements of the research framework are then presented in greater detail with explanations for their operationalization. Based on assumed relationships between the individual framework elements, this section concludes by formulating research hypotheses, which will be tested in subsequent chapters.

4.1 Research gaps and questions

In the introduction two high-level questions on consumer innovation at the BoP were raised. In the following sections I first emphasize the relevance of the research topic and then detail the following guiding questions into more specific research questions respectively: 1) What characterizes the phenomenon of consumer innovation at the BoP? and 2) What factors influence the development of attractive innovations by BoP consumers? A research framework is developed and hypotheses are derived for the second question on antecedents of BoP consumer innovation.

4.1.1 Relevance of user innovation research in subsistence markets

The discussion on business conditions at the BoP in Section 2.3 revealed the pronounced need for innovation and emphasized the importance of BoP consumer participation in new product development. Considering the concepts of sticky information (von Hippel 1994) and absorptive capacity (Cohen, Levinthal 1990) introduced in Chapter 3 on user innovation, it becomes apparent why companies from the wealthier world find it so difficult to conduct business at and innovate for subsistence markets. BoP-related information and knowledge appear to be extremely sticky.[8] Understanding subsistence markets involves a huge amount of data on the market as a whole with all its relevant e.g. social, economic and cultural facets. This

[8] See Section 3.3.1 on determinants and implications of information stickiness and Section 2.3.3 on reasons for the stickiness of innovation related information on the BoP.

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knowledge, however, is largely tacit, rarely encoded, and requires close observation and interaction in order to understand people and life at the BoP (cf. Viswanathan, Sridharan 2012). Extraction of sticky information on the BoP that is crucial for innovation, such as information on needs and application specifications, is costly and complicated to obtain. Furthermore, the notion of absorptive capacity implies that the existing stock of knowledge guides an organization's invention activities and determines its ability to exploit external information (Nelson 1982). The more expertise and existing knowledge in a given field, such as the BoP, the better a firm can recognize and realize opportunities in that field (cf. Cohen, Levinthal 1990). Firms are still quite inexperienced with regard to conducting business at the BoP (Olsen, Boxenbaum 2009; Nakata 2012). They lack significant knowledge about the lives, needs and preferences of the poor (Ansari et al. 2012; Pitta et al. 2008), which results in only very little absorptive capacity with regard to the BoP. This lack of absorptive capacity explains the general difficulty of firms to exploit information on the BoP. Thus, development of appropriate products, services and business models for subsistence markets and identification of suitable innovation processes remains challenging. This applies all the more if firms also want to allow for participation of BoP consumers (Nakata 2012).

In addition to the difficulty of developing solutions for the BoP, the lack of knowledge and experience with subsistence markets leads to high risk and uncertainty levels that companies encounter when entering the BoP market.[9] As a consequence firms are even more reluctant to serve and innovate for the BoP (Henkel, von Hippel 2005).

Sticky need information, the difficulty for inexperienced firms to exploit BoP- related knowledge, and their high perceived risk levels, represent favorable antecedents for user innovation.[10] The destitute are poorly served or not served at all due to difficult business conditions in subsistence markets[11] and the relatively recent discovery of the BoP as a business opportunity (London, Hart 2004). Research on user and consumer innovation in the wealthier world suggests that if markets are imperfect, needs are heterogeneous and supply is unsatisfying, users will step in. They complement manufacturer innovations and search for solutions themselves (Baldwin et al. 2006; Henkel, von Hippel 2005). In the case of market failure, which is comparable to the situation at the BoP, consumers are assumed to fill in the resultant

[9] For more details see Section 2.2 and Hienerth (2006) and Olsen and Boxenbaum (2009) on the reluctance of firms to enter a market in the case of high perceived risk levels and inexperience in the field.
[10] See Section 3.3.1 for more details.
[11] See Section 2.2 for more details.

innovation gap with consumer innovations (cf. Hienerth et al. 2011). Hence a pronounced tendency toward a locus of innovation at the consumers' site can be expected (cf. von Hippel 1998; Ogawa 1998; Lüthje, Herstatt 2004) suggesting a high relevance of consumer innovation for the BoP.

Researching these pioneering consumer innovations at the BoP can decrease innovation-related information asymmetries (cf. Henkel, von Hippel 2005). Manufacturers may build on ideas drawn from these user innovations or may directly leverage the creative potential of the BoP consumers (Prügl, Schreier 2006). These are further reasons for the importance of leveraging local social capital (Ansari et al. 2012), the clearly articulated need for customer co-creation (Viswanathan, Sridharan 2012), and the high hopes for successful new product development through identification and integration of innovative users at the BoP (Viswanathan, Sridharan 2012) as discussed in Section 2.3.3. However, the concept of consumer innovation originates from developed markets and builds on wealthier, resource-rich consumers under completely different living conditions. It remains unclear whether and how consumers innovation takes place in strongly deviating contexts of resource-scarce, subsistence markets (cf. Viswanathan, Sridharan 2012). General research on consumer innovation at the BoP "…is in a state of infancy…" (George et al. 2012, p. 662). The research deficit ranges from a general lack of basic knowledge on subsistence markets since "…we know very little about the lives of the extremely poor…" (Ansari et al. 2012, p. 817) to the need for approaches to lead BoP innovation activities as "…there is limited practical and theoretical knowledge to guide these efforts" (Nakata 2012, p. 1). Hence a call has been articulated for investigation of innovating BoP consumers and adaptation of the lead user concept to accommodate subsistence markets (Viswanathan, Sridharan 2012).

Despite the relevance of the topic a scarcity of research exists on user innovation at the BoP. For example, van der Boor et al. (2012) examine the extent of user contributions from emerging countries to global mobile banking service innovations. Most of the existing publications deal with the so-called grassroots innovations in India. Regarding the notion of grassroots innovations Bhaduri and Kumar define the term as follows: "[t]he term refers to individual innovators, who often undertake innovative efforts to solve localized problems, and generally work outside the realm of formal organizations like business firms or research institutes" (Bhaduri, Kumar 2011, p. 29). Grassroots innovation is similar to general consumer innovation.[12] It

[12] Household innovation or consumer innovation can be defined as innovations developed by entities of the household sector (Hienerth et al. 2011), which "comprises all resident households and includes unincorporated enterprises." (Ferran 2000, p. 23). Hence, innovators of the household sector also do not innovate in the context of formal organizations. Also, a study on household

extends the traditional definition to the poor at the BoP and includes traditional knowledge and practices (cf. Gupta 2006) in addition to new ideas. Most authors refer to grassroots innovations in a political context with reference to India's innovation system and institutions as well as strategies to improve the livelihoods of the poor (e.g. Gupta; Gupta 2006; Sieg 2011; Utz, Dahlman 2007; Pastakia 1998) describing some selected cases in an anecdotal way (cf. Gupta 2006). "What little evaluation has been done mostly lists activities and number of innovations" (Utz, Dahlman 2007, p. 115). Bhaduri and Kumar (2011) have attempted a more scientific approach to this quite new research field and conducted a quantitative analysis on extrinsic and intrinsic motivations of grassroots innovators based on a dataset comprised of 87 individuals.

The research objective of this dissertation is, therefore, to shed light on the phenomenon of consumer innovation at the BoP and to investigate the role of the poor as source of innovations. The focus lies on generating insights on differences and commonalities to innovating consumers in the developed world as well as influencing factors of consumer innovation at the BoP.

4.1.2 Characteristics of consumer innovation at the BoP

The focus of the first two research questions is to discover patterns of consumer innovation and to compare them with findings on consumer innovation from the wealthier world. Hence, these subsequent research questions will be of descriptive and comparative nature. As research on household or consumer innovation on a comprehensive and aggregated level is an emerging research field with findings from only a few developed countries (cf. von Hippel et al. 2011; Hienerth et al. 2011), any additional findings from other population groups or countries contribute to a generalization of findings (von Hippel et al. 2010). The BoP is a new population group for consumer innovation research that has, to my knowledge, not yet been analyzed. Furthermore, it not only covers a population group from developing economies but also their poorest inhabitants, which adds new richness of detail to the current state of research.

User innovation research[13] suggests that innovating consumers apply their local stock of knowledge and experience to detect unsatisfied needs and find appropriate solutions. New technologies allowing for Internet-based communication, access to information and digitalized designs are facilitating and fueling user innovations

innovation in the UK by von Hippel et al. (2010) suggests that these innovators solve localized problems as well (e.g. hobby, housing-related). See Section 3.2 for more details.

[13] Please see Section 3.3.2 for more details.

(Baldwin, von Hippel 2011). Hienerth et al. (2011) determined that these consumer innovators spend significant amounts of money and time on their innovation activities. Considering the living conditions at the BoP,[14] it becomes evident that innovation context and conditions are considerably different for the poor. Low education levels and isolation from the wealthier and developed world have among other things an impact on the BoP consumers' local stock of knowledge and experience. The poor hardly ever benefit from new technology and access to information sharing and infrastructure such as the Internet, libraries and community memberships. Living at the BoP involves daily confrontation with constant resource scarcity and severe constraints. The unsatisfied needs of the poor are manifold and apply even to the most basic requirements such as the need for drinking water. Hence, one cannot expect consumer innovations and innovators at the resource-scarce BoP to exhibit the same traits and characteristics than they do in wealthy and resource-rich areas. Therefore I intend to characterize innovating consumers at the BoP as well as their innovation-related behavioral patterns.

Research question 1a (R1a):

How can consumer innovators at the BoP be characterized?

Bearing in mind the very basic needs of the poor as well as their resource, technology and knowledge scarcity, it is also of interest to see what the poor actually invent and develop at the BoP. For that reason, the results of their innovation activities will also be examined.

Research question 1b (R1b):

How can consumer innovations at the BoP be characterized?

After investigating the first two research questions on the characteristics of consumer innovation at the BoP, the findings will be compared with available results regarding consumer innovations in the UK. Does BoP consumer innovation differ fundamentally from consumer innovation by comparatively wealthy people from developed countries? Or is consumer innovation a universal phenomenon that occurs identically among the poorest of the poor as well as among people from the wealthy, developed world? Therefore, the following will be investigated:

[14] Please see Chapter 2 for more details on living conditions and the economic life at the BoP.

Research question 2 (R2):

What are similarities and differences of consumer innovation at the BoP compared to consumer innovation in the wealthier, resource-rich world?

4.1.3 Antecedents of BoP consumer innovation

The integration of BoP consumers into the innovation process requires as a logical precondition the identification of appropriate and promising consumer candidates. For this purpose user innovation research suggests identifying and involving users exhibiting lead user characteristics (von Hippel 1986). Lead users show a higher propensity to innovate and experience emerging needs ahead of ordinary users (von Hippel 1986; Franke et al. 2006) The literature also suggests they develop more novel and original innovations of greater commercial success (Lilien et al. 2002). However, the BoP is not suited for the typical lead user identification process (cf. Section 3.3.3). The overall market is huge and includes more than 1 billion people throughout the world (World Bank 2012). Products and service offerings for the BoP should target high volumes in order to be successful despite low profit margins (Prahalad 2010). Faullant et al. (2012) suggest that normal mass consumer markets in developed economies lack clear, identifiable market trends and have a too broad of a consumer base to apply the typical approach for lead user identification. This specifically applies to the BoP that is a huge mass market even if allowing for segmentation. Identification of trends and leading edge consumers is even more aggravated because BoP consumers are frequently future rather than current consumers (Anderson, Markides 2007) and companies are missing experiences with subsistence markets (cf. Olsen, Boxenbaum 2009). The poor are hardly interconnected and cannot be easily contacted (Vachani, Smith 2008; Prahalad 2012). Even if they were easily reachable, it would be extremely difficult to assess their relative user status. In this case literature strongly suggests abandoning the typical lead user identification process to find lead users via their descriptive, definitional traits and focus on antecedents of lead userness instead (Faullant et al. 2012). These antecedents need to be determined and converted into variables that enable a systematic screen of a population for the right consumers to be integrated into the new product development process (Faullant et al. 2012).

To the best of the author's knowledge, no comprehensive investigation has been carried out on antecedents of user innovation at the BoP. However, it represents a key prerequisite in order to identify promising, innovating BoP consumers, to leverage their creative potential and to co-create products and services. "Learning to identify such people and including them in the market research process can prove a

key BoP NPD capability for product development teams" (Viswanathan, Sridharan 2012, p. 67). The aim of this dissertation is to identify and test hypotheses on antecedents of BoP consumer innovation at the BoP in order to derive generalizable results. This investigation contributes to the search for "…the adaptation of the 'lead user' concept to accommodate BoP nuances" (Viswanathan, Sridharan 2012, p. 66).

While research has investigated the impact of lead userness on the innovative outcome of consumer activities, research lacks knowledge on general antecedents of attractive consumer innovations (cf. Schreier, Prügl 2008). Therefore, a call has been formulated for more investigation of personal user characteristics and preconditions affecting consumers' propensity to create commercially attractive innovations (Franke et al. 2006; Faullant et al. 2012). The analysis at the BoP allows for an investigation of knowledge, context and demographic factors in a less diluted, noisy way. This is due to the limited access to information sharing and infrastructure such as the Internet, libraries and community memberships. Hence, research on antecedents of consumer innovation at the BoP also contributes to general research of antecedents of lead userness and their impact on the innovative outcome.

Early findings identify availability of applicable resources such as product-related knowledge, use experience (Schreier, Prügl 2008) and the ability of divergent thinking[15] (Faullant et al. 2012) as drivers of lead userness. Few researchers have analyzed the direct effect of antecedents of consumers' propensity to create attractive innovations without detouring via the assessment of lead userness. Also in this context Franke et al. (2006) determined that local, innovation-relevant resources, more specifically technical expertise and community-based resources, increase commercial attractiveness of consumer innovations. However, the directly opposed distribution of resources is the key distinguishing element between the wealthier world and the resource-scarce BoP in the context of consumer innovation. Therefore the investigation of the effect of innovation-relevant resources on the commercial attractiveness of consumer innovations at the BoP is of specific interest and will be investigated:

Research question 3 (R3):

How do innovation-related resources influence the commercial attractiveness of consumer innovation at the BoP?

[15] Divergent thinking ability refers to the cognitive ability to recognize problems, structure information and find solutions without being hindered by functional-fixedness, more specifically finding solution beyond usual and familiar solution patterns (Faullant et al. 2012).

The context in which innovation activities take place and the innovative consumer is situated plays another important role in addition to innovation- relevant resources (Janssen 2005). Lettl et al. (2006) analyzed the development of radical innovations by users in the field of medical equipment technology and identified a supportive environment and high motivation to develop solutions as antecedents of user innovation. Accordingly, the role of contextual influences as antecedents of consumer innovation at the BoP will be explored:

Research question 4 (R4):

How do contextual factors influence the commercial attractiveness of a consumer innovation at the BoP?

4.2 Research framework

The aim of the following section is to refine the overarching research Questions 3 and 4 on antecedents of BoP consumer innovation into testable research hypotheses. First the relevant theoretical foundations will be laid out and a subsequent research framework to provide structural guidance will be derived. Presentation of the framework elements and their assumed relationships will lead to the deduction of the research hypotheses.

4.2.1 Theoretical foundations

Understanding antecedents of consumer innovation in subsistence markets implies understanding why an individual consumer exerts a certain creative behavior that ultimately leads to the creation of an innovation. Hence, theoretical explanations for general human behavior are considered before focusing more closely on behavioral determinants of creativity.

Social cognitive theory

Behavioral research recognizes two central influencing factors for human behavior, which are the person and the environment (Davis, Luthans 1980). As a result there are either opposing or integrative theoretical approaches to explain human behavior. First, the individual difference approach interprets behavior as a function of the person and "…proposes that a person's behavior can best be predicted by measuring his or her personality traits, values, motives abilities, and affect because such elements are both stable are reflected in behavior" (Chatman 1989, p. 333). Representatives of this research stream (e.g. Staw, Ross 1985; Weiss, Adler 1984)

believe that characteristics of a person determine his or her behavior regardless of the situation (Chatman 1989). The opposing behavioral research stream, however, defines human behavior as a function of a person's environment (Davis, Luthans 1980). Accordingly, representatives of this situationist approach (e.g. Salancik, Pfeffer 1978) believe that "…a person's behavior can best be predicted by assessing the characteristics of his or her situations" (Chatman 1989, p. 333). Thus, external stimuli and contextual aspects are assumed to predominantly predict a person's behavior.

The long research dispute between advocates of the individual difference approach and scientists favoring the situationist approach finally resulted in the interactional perspective (Terborg 1981). This interactional approach integrates both situational and personality factors into a theoretical explanation of human behavior (Chatman 1989). Today, the majority of behavioral researchers share this integrated view. "In order for researchers to understand and predict behavior, they must consider both person and situation factors and how these factors interact" (Chatman 1989, p. 333). Representatives (e.g. Schneider 1983; Terborg 1981) recognize that neither personality traits nor the environment remain stable and particularly stress the need to reflect the "…continuous and multidirectional interaction between person characteristics and situation characteristics" (Terborg 1981, p. 569). Behavior itself is recognized as an interacting variable and, therefore, the interplay between personality, environment and behavior ultimately determines human behavior (Davis, Luthans 1980). In order to investigate antecedents of innovative behavior, an interactional approach is applied hereafter. Aforementioned behavioral research as well as the social cognitive theory of the following section focuses on organizational behavior. However, researchers also adopt interactional perspectives to explain individual human behavior disregarding organizational settings (e.g. Higgins 1990). Burroughs and Mick (2004) apply an interactional person-situation perspective to detect antecedents of creative consumption by individual consumers.

Bandura (1986), an advocate of the interactional approach, translates this theoretical perspective on behavioral research into the social cognitive theory. According to this theory, the "…best explanation of behavior is in terms of a continuous, reciprocal interaction between cognitive, behavioral, and environmental determinants" (Davis, Luthans 1980, p. 282). Hence person, environment and behavior are three independent factors that respectively influence the other two determinants of human behavior and are simultaneously influenced by their interplay (Stajkovic, Luthans 1998) (see Figure 9).

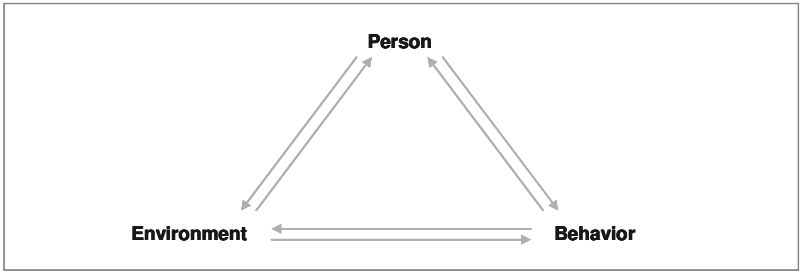

Figure 9: Reciprocal causation in social cognitive theory (Stajkovic, Luthans 1998)

Such reciprocal relationships and the exerted behavior can clearly entail consequences that in turn develop triadic interactions as new environmental stimulations (cf. Davis, Luthans 1980). The development of an innovation as behavioral element and the innovation itself as behavioral consequence are possible applications of this social cognitive theoretical process. The next step aims to concretize theoretical explanations of general human behavior to more specifically depict innovative behavior of individual consumers. Therefore, a theoretical concept to explain creative behavior is introduced in the following paragraph.

Componential conceptualization of creativity

The concept of creativity relates closely to the generation of innovations. Amabile argues that "[c]reativity is the seed of all innovation…" (Amabile et al. 1996, p. 1155) because "[all] innovation begins with creative ideas" (Amabile et al. 1996, p. 1154). Therefore, innovation can be defined as the "…successful implementation of creative ideas…" (Amabile et al. 1996, p. 1155). Similarly Im and Workman (2004) argue that creativity plays a decisive role in the success of new product development in manifold ways. It motivates the generation of new ideas in the first place; it enables product differentiation through relative product superiority; and it represents a competitive advantage as an intangible and imperfectly substitutable resource. It is not surprising that various scientists have applied creativity in their user innovation research in order to describe the degree of innovativeness or innovation quality (cf. Kristensson et al. 2002; Mahr, Lievens 2011; Grant, Berry 2011; Matthing et al. 2006; Burroughs, Mick 2004; Soukhoroukova et al. 2010). The concept of creativity also shows potential to contribute to the investigation of antecedents of lead userness and thus antecedents of consumer innovation at the BoP. In this connection findings of Matthing et al. (2006) suggest that lead users develop more creative ideas.

Theresa M. Amabile (1996) is one of the leading and most influential researchers on creativity (cf. Rickards, Moger 2006; Faullant et al. 2012). Her work has influenced

various user innovation researchers. Especially Amabile's definition, operationalization and the concept of creativity contribute considerably to the foundations of a range of user innovation studies (e.g. Kristensson et al. 2002; Piller, Walcher 2006; Mahr, Lievens 2011; Grant, Berry 2011; Magnusson 2009; Matthing et al. 2006; Burroughs, Mick 2004). As a step forward from predicting general human behavior, Amabile's componential conceptualization of creativity (Amabile 1983) explains creative behavior. Application of her framework on antecedents of creative performance (see Figure 10) can serve as a framework on antecedents of lead userness (e.g. Faullant et al. 2012).

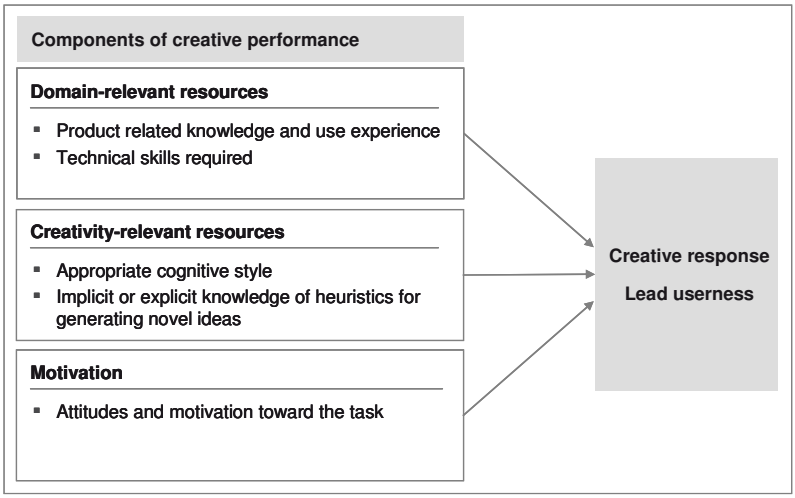

Figure 10: Components of creativity as antecedent of lead userness (adapted framework from Amabile 1983 and Faullant et al. 2012)

Similarly to the interactional perspective on human behavior, Amabile's framework considers person and environmental factors as well as their interactions with the creative performance to explain creative behavior. She identifies three components of creativity that are respectively based on personality as well as the specific task context: 1) *Domain-relevant resources* comprise general knowledge in the given domain (e.g. general knowledge on nuclear physics for creativity in nuclear physics), technical skills (e.g. special laboratory techniques or mastering of complex tools). These skills can be acquired through formal and informal education but may also depend on certain individual cognitive or physical talents. 2) *Creativity-relevant resources* are cognitive skills determining one's ability to understand complex

connections, structure problems and to apply heuristics.[16] Personality as well as training and experiences with creativity-related tasks may be factors that enhance creativity-relevant resources. Finally 3) *Motivation* to perform a creative task relies mainly on external social and contextual influences and determines the approach to this task. Also intrinsic motivation may be affected by environmental events. The ultimate hallmark of creativity is finally the degree of creativity of the product and response to the task or behavior (Amabile 1983).

4.2.2 Elements of the research framework

The introduction of componential conceptualization of creativity (Amabile 1983)[17] in the preceding Section 4.2.1 reveals a strong connection between explanations of creative performance, innovative behavior, and the development of innovations. The concept qualifies to investigate antecedents of innovative behavior or lead userness (e.g. Faullant et al. 2012). Consequently, the componential conceptualization of creativity (see Figure 10) is built upon to derive a research framework for this dissertation that aims to investigate antecedents of consumer innovation at the BoP.

Innovation-relevant resources

The research framework of this dissertation represents a more aggregated view on antecedents of innovative behavior. Amabile's proposed two skill factors, domain- and creativity-relevant resources, are combined in one category called *innovation-relevant resources.* Based on the original concept as well as Faullant et al.'s (2012) application to investigation of lead userness, I include *technical experience* and skills with the respective product domain and *use experience* as the two domain-relevant resources. Also*, innovation experience* denotes the individual's experience with the generation of new ideas and problem-solving activities and qualifies as creativity-relevant resource as defined by Amabile.

Education plays a role in domain and creativity-relevant resources. Formal education increases general knowledge with regard to multiple domains, facts, principles and paradigms. It also increases and trains an individual's cognitive abilities serving as a creativity-relevant resource (cf. Amabile 1983). Education is already of importance according to the general concept, but it even plays a more differentiating and relevant

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[16] Heuristics can be defined as "…a general rule that can be of aid in approaching problems or tasks. […] Clearly, creative heuristics are best considered as methods of approaching a problem that are most likely to lead to set-breaking and novel ideas rather than as strict rules that are applied by rote" (Amabile 1983, p. 365).

[17] Following references to Amabile's concept of componential conceptualization of creativity in this chapter all apply to the same source by Amabile (1983).

role in a BoP context where some people do not receive any formal education at all (Banerjee, Duflo 2007).

The research framework includes another domain and creativity-relevant resource, namely *cooperation* that is not explicitly mentioned by Amabile. Nevertheless, assistance by others is considered to be an important resource for innovating users (Franke, Shah 2003; Schettino et al. 2008; Wuchty et al. 2007). Assistance provides additional access to others' knowledge, feedback and support during problem-solving activities. With regard to limited access to other additional knowledge sources at the BoP (cf. Vachani, Smith 2008; Prahalad 2012), cooperation as an available BoP resource is included in the framework as an innovation-relevant resource.

Contextual factors

Social and contextual components determining the general approach toward problem-solving tasks are more comprehensively called *contextual factors* of the framework instead of motivation. Amabile emphasizes general task motivation meaning the innovator's attitude toward the problem-solving task and perception of the reason to carry out the task. Typically one differentiates motivation between intrinsic motivation, which is "…the doing of an activity for its inherent satisfactions rather than for some separable consequence" (Ryan, Deci 2000a, p. 56) and extrinsic motivation meaning "…a construct that pertains whenever an activity is done in order to attain some separable outcome" (Ryan, Deci 2000a, p. 60). However, people are motivated to exert a particular behavior by multiple reasons, experiences and events and an originally external motivation may be internalized and become an intrinsic motivation as well (Ryan, Deci 2000b). Within the scope of their research on antecedents of lead userness in a consumer mass market, Faullant et al. (2012) could neither confirm nor deny that intrinsic or extrinsic motivations are related to lead userness. However, research recommends considering another motivational factor. Prosocial motivation, which refers to "…the desire to benefit others…" (Grant, Berry 2011, p. 74), plays a considerable role for the generation of creative and useful ideas (cf. de Dreu et al. 2000; Grant, Berry 2011). Therefore, *prosocial motivation* has been included in the framework. A study on comprehensive consumer innovation in the UK (von Hippel et al. 2010) shows that prosocial motives are an important reason for people to innovate.[18] Social aspects are of a particular interest for BoP settings. As previously discussed in Section 2.2.1, social capital is fundamental in resource-scarce settings in which the poor depend heavily on their social networks

[18] 42% out of the 104 consumer innovators declare they were motivated by their desire to help someone else (multiple answer options were possible) (von Hippel et al. 2010).

(George et al. 2012). A culture of reciprocity as well as collective allocation of community resources provide social network members with safety and insurance (Ansari et al. 2012). Therefore, the poor may even be more motivated to contribute to the social network than to be concerned with their individual well-being (cf. Subrahmanyan, Gomez-Arias 2008).

Resource scarcity also applies to another contextual factor, namely innovation *type*, which influences innovative behavior. The componential conceptualization of creativity lists external constraints as a motivational component of creativity. Resource scarcity is clearly an external constraint that limits the solution space, in which the innovative behavior takes place and, therefore, affects innovative performance. Development efforts at the BoP are often described as "bricolage," a term coined by Claude Lévi-Strauss (2000) (e.g. George et al. 2012). Bricolage applies to resource limited settings with finite material and tools and refers to creative recombination of resources at hand in order to create value and use for new purposes (Baker, Nelson 2005). Innovation type can be either creation of a new solution or modification of an existing solution (e.g. von Hippel et al. 2010). It refers to the availability of an existing solution as innovation-related input resource that the consumer innovator can respectively build on or not.

Attractiveness of innovation

While Amabile's original componential conceptualization of creativity predicts creative performance that can assume different degrees of creativity (Amabile 1983), the objective in this context is to assess degrees of innovative performance. I aim to analyze which factors are related to the value of BoP consumer innovations, or in other words: What are these antecedents and do they induce "better" or "worse" innovations? The value of innovations and new product and service ideas is frequently referred to commercially as *attractiveness* (Franke et al. 2006; von Hippel 2010). The term implies both the degree of quality of the innovation as well as the subsequent appeal to the general population of users (cf. Franke, von Hippel 2003). In the present framework consumer innovation quality is operationalized via 1) *creativity* and 2) *technical elaboration* of a given innovation (similar operationalization by e.g. Kristensson et al. 2002; Franke et al. 2006; Magnusson 2009; Matthing et al. 2006; Piller, Walcher 2006; Mahr, Lievens 2011)[19]. Moreover, 3) *market recognition* addresses the general consumer population's response to it (cf. Magnusson 2009).[20]

[19] Although all listed authors build on Amabile's definition of creativity, their studies may employ different dimensions or facets of creativity (e.g. novelty and relevance, originality) and technical elaboration (e.g. producibility).

[20] For example Magnusson (2009) assesses the goodness of an idea via its originality (refers to

1) Creativity indicates the degree of novelty, relevance and originality of a given response to a need. A highly creative response is, therefore, assumed to be appealing to other consumers facing the same need (cf. Im, Workman Jr 2004; Kristensson et al. 2002).

2) Technical elaboration, to the contrary, embraces the degree of technical functionality and efficiency of an innovation, which is in turn required to effectively ensure satisfaction of the need to be met (cf. Burroughs, Mick 2004).

3) Other users' response to the innovation is often determined via sales results or expectations (e.g. Lilien et al. 2002). In a BoP context, however, one cannot simply assess meaningful sales forecasts or actual results due to its informal, unorganized and unfamiliar nature (cf. Olsen, Boxenbaum 2009; Vachani, Smith 2008). Instead of a pure commercial measure, market recognition accounts for the degree of diffusion and adoption of a given innovation. Yet, the measure also includes a marketable dimension by considering whether an innovation is commercialized or not. Various researchers suggest that the quality of an innovation relates to its diffusion (e.g. de Jong, von Hippel 2009). "[D]iffusion can be taken as an indicator for innovative performance" (Prügl, Schreier 2006, p. 247), because the innovativeness of new product or service determines its extent of diffusion (Rogers 1995).

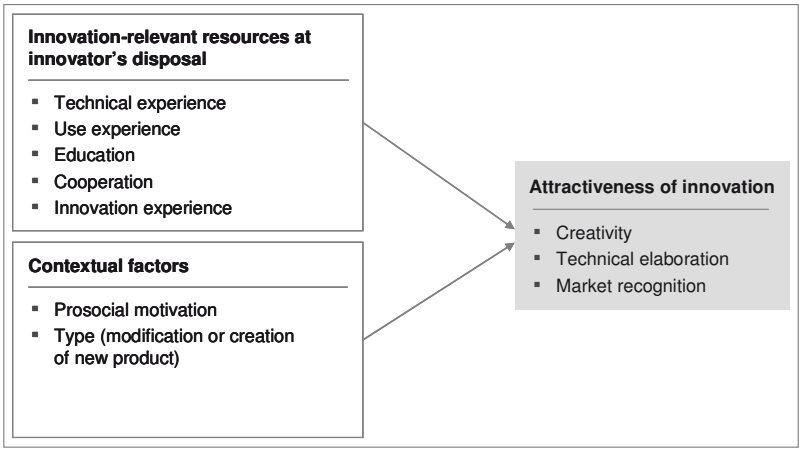

Figure 11: Research framework for following analysis

creativity), producibility (refers to technical elaboration) and a third dimension called *user value* representing the user's perspective.

All elements of the research framework and their rationale for further analysis have been introduced (see Figure 11). The objective of the next section is to derive assumptions regarding relationships between individual research framework elements and to formulate hypotheses that can be tested in the following.

4.2.3 Development of the hypotheses

I will start deriving hypotheses regarding the effects of the consumer's innovation-related resources on the innovation qualities of creativity and technical elaboration. Next an analysis of assumed influences on innovation quality exerted by contextual factors leading to the formulation of corresponding hypotheses will be given. Having derived the last hypotheses regarding the relationship between the quality of an innovation and its following market recognition, this section will conclude with an illustration of the research framework including all hypothesized relationships among its elements.

4.2.3.1 Resource-related hypotheses

Innovation-related resources and skills are fundamental for the generation and development of innovations because a consumer requires the suitable abilities and knowledge to do so (Lüthje 2004). An individual employs his or her local stock of expertise, skills and information to resolve a given problem (Marsh et al. 1999). Possession of relevant local resources enables identification of needs, recognition of solution specifications, development and evaluation of alternative solutions and finally the generation of a product and service meeting the need. The better a consumer's local stock of innovation- relevant resources, the higher his or her propensity to innovate and the higher the quality of the resultant innovation (cf. Franke et al. 2006; Lüthje 2004).

The availability of domain-related know-how and technical skills are a prerequisite for the development of an innovation within the respective technology domain (Lüthje 2004). Accordingly Morrison et al. (2000), in-house disposability of relevant technical skills discriminates between innovating and passive users. Hence, experience and knowledge associated with e.g. product design, materials and technologies are essential input factors for the generation of consumer innovations, which increases the consumer's propensity to innovate (Lettl et al. 2006; Lüthje 2004; Lüthje et al. 2005). Expertise with the underlying technology also positively relates to the degree of lead userness of a consumer (Faullant et al. 2012) and the quality of the consumer innovation (cf. von Hippel 2010; Magnusson 2009). "[Individuals] …with higher levels of knowledge have a wider repertoire of concepts and domains to draw from in formulating creative responses" (Burroughs et al. 2008, p. 1033). Accordingly, larger

stocks of knowledge "…increase the probability of outstanding responses," (Amabile 1983, p. 364) meaning developing a creative idea and its subsequent implementation into reality. Therefore, I hypothesize:

> *H1a: BoP consumers' technical experience with the underlying technology is positively related to their ability to generate creative innovations.*
>
> *H1b: BoP consumers' technical experience with the underlying technology is positively related to their ability to generate technically elaborated innovations.*

A consumer's use experience contributes to an increase in domain knowledge. Whereas domain-related knowledge may stem from various sources, use experience enables one to derive information through direct acquaintance with consumption patterns and problems (Schreier, Prügl 2008). Familiarity with similar products and the general application area of the innovation helps to detect unfulfilled needs and requirements (Magnusson 2009). It enables an innovator to know the performance attributes of an innovation, to generate suitable solutions and to put him or her into the distinctive position of evaluating whether or not a solution matches the requirements (cf. Lüthje 2004; Schreier, Prügl 2008). Furthermore, studies on lead userness present evidence for a positive association of use experience with the degree of lead userness (e.g. Faullant et al. 2012; Schreier, Prügl 2008). While a consumer can exploit his use information to develop useful and novel ideas on performance attributes, more specifically creative ideas, it is assumed that a consumer's use experience does not influence the elaboration of its technical implementation into reality (cf. Magnusson 2009). Accordingly, the following hypothesis is formulated:

> *H2: BoP consumer's use experience increases the ability to generate creative innovations.*

Evidence suggests education is an essential ingredient for creative performance (Amabile 1983). A higher education increases one's general information stock, i.e., domain-related knowledge, and increases one's cognitive skills (Amabile 1996). These abilities and knowledge are required to understand complexity, to structure problems, to apply analogies from other domains and to overcome established thought patterns (cf. Amabile 1983). Consumers can subsequently recognize opportunities and generate novel, useful and adequate thus creative solutions (cf. Shane 2000). Moreover, higher education levels are likely to increase the general

stock of technical knowledge and awareness of universally valid facts, paradigms and principles (cf. Amabile 1983), which can be applied to the technical realization of an innovation. Hippel et al. (von Hippel et al. 2010) emphasize the importance of education by finding that consumers with a university degree are more likely to innovate than consumers with lower education levels. Thus, I hypothesize:

H3a: BoP consumer's level of education relates positively to the ability to generate creative innovations.

H3b: BoP consumer's level of education relates positively to the ability to generate technically elaborated innovations.

Evidence from studies conducted by Wuchty et al. (2007) and Schettino et al. (2008) suggest that innovation quality of inventions generated by at least two innovators is higher than inventions developed by a single innovator. Cooperation with others does supply the consumer innovator with additional knowledge and resources (Franke, Shah 2003). The overall technical expertise, domain knowledge and experience pool available during the development of the innovation is augmented accordingly and allows for technically better results. However, involvement of others also offers more feedback and brainstorming opportunities and involves more idea input, which enhances creativity. Therefore, the following hypotheses are put forward:

H4a: Cooperation with others during the innovation creation process increases a BoP consumer's ability to generate creative innovations.

H4b: Cooperation with others during the innovation creation process increases a BoP consumer's ability to generate technically elaborated innovations.

Consumers who innovate frequently gain experience and draw every time on the personal knowledge pool at their disposition. Innovative creativity, however, is driven through a new combination of existing knowledge elements. Whenever a consumer innovates and combines parts of his knowledge into a creative innovation, another novel and unique combination of his personal knowledge pool becomes less likely (cf. Kalogerakis et al. 2010). Baldwin et al. (2006) observed a comparable phenomenon regarding design spaces, which include all possible combinations of a single class of objects such as rodeo kayaks. The more designs of a given design space are explored, the more the design space becomes exhausted. Further findings by Bayus (2012) on consumer communities suggest that serial ideators somehow experience a fixation (cf. Burroughs et al. 2008) regarding their initial successful idea

and as a result subsequently generate less original, novel and hence less valuable ideas. However, a consumer's innovation experience increases the technical knowledge and experience that he employs to generate his innovation analog to Hypothesis 1b. Thus, the following hypotheses:

> *H5a: BoP consumer's innovation experience is negatively related to their ability to generate creative innovations.*
>
> *H5b: BoP consumer's innovation experience is positively related to the ability to generate technically elaborated innovations.*

4.2.3.2 Context-related hypotheses

The innovation context describes the circumstances and conditions under which a consumer produces his innovation. Of course the BoP is special and differs significantly regarding its conditions from the developed world. The analysis on antecedents of BoP consumer innovations accounts for the effects of a BoP consumer's motivation to innovate as well as the effects of the external limitations, represented by the innovation type, meaning whether a product is available for modification or not (cf. Amabile 1983). Nakata and Weidner (2012) propose that the social context plays an important role in the new product adoption, thus market recognition at the BoP. The poor tend to place the needs of their social life above their individual necessities (Subrahmanyan, Gomez-Arias 2008) and rely on reciprocity and collective employment of community resources (Ansari et al. 2012). Social cohesion provides them a social safety net and is of immense importance (Ansari et al. 2012). Thus innovations are assumed to be more successful if oriented toward and motivated by social needs "…because of the group emphasis [the BoP's group-oriented social milieu], new product adoption is not motivated principally or exclusively by personal needs but rather by the welfare and preferences of the collective" (Nakata, Weidner 2012, p. 28).

Moreover, someone who is prosocially motivated is more likely to consider other consumers' perspectives on the need situation and in turn is likely to generate more useful innovations (Grant, Berry 2011). In that case an innovator shows more situational involvement (Burroughs, Mick 2004), paying attention to what others need, which helps him to select the most useful idea and implement it (cf. Grant, Berry 2011). The more useful the innovation seems to other users, the more success it achieves (cf. Grant, Berry 2011).

Regarding the innovation type, a user innovation study by Prügl and Schreier (2006)

provides evidence that innovations created from scratch are more successful and thus better received by other users than modifications. Furthermore, successful products for the BoP have to differ significantly from solutions for the developed world and maximize functionality and compatibility (London, Hart 2004; Prahalad 2004). Given that most existing products in circulation are based on developed world solutions addressing different needs, consumption patterns and restrictions, it requires more than just incremental changes to innovate successfully for the BoP. Therefore, it is expected that radically new created products would be more successful at the BoP than modified products. As a result the following hypotheses are derived:

H6: A BoP innovator's prosocial motivation increases the innovation's degree of market recognition.

H7: New products created from scratch attain a higher degree of market recognition at the BoP than product modifications.

4.2.3.3 Innovation quality-related hypotheses

New products that embrace novel and relevant ideas as well as their high quality implementation into reality are most likely to yield market success (cf. Mahr, Lievens 2011). According to Kock et al. (2011) successfully addressing unmet needs and offering new benefits increases customer value, which in turn translates into a higher commercial success of the respective product or service. More specifically, creative solutions are most likely to evoke positive responses and reactions by the general consumer population (cf. Im, Workman Jr 2004). Additionally, high quality levels of innovations are particularly important at the BoP and determine their success in the market (Prahalad 2012). Extreme requirements for new products at the BoP with regard to e.g. adaptability, robustness, compatibility and at the same time affordability call for technically highly elaborated products (Nakata, Weidner 2012; Prahalad, Hart 2002; Prahalad 2012). This leads to the following hypotheses:

H8: Innovation creativity is positively related to the innovation's degree of market recognition at the BoP.

H9 Innovation technical elaboration is positively related to the innovation's degree of market recognition at the BoP.

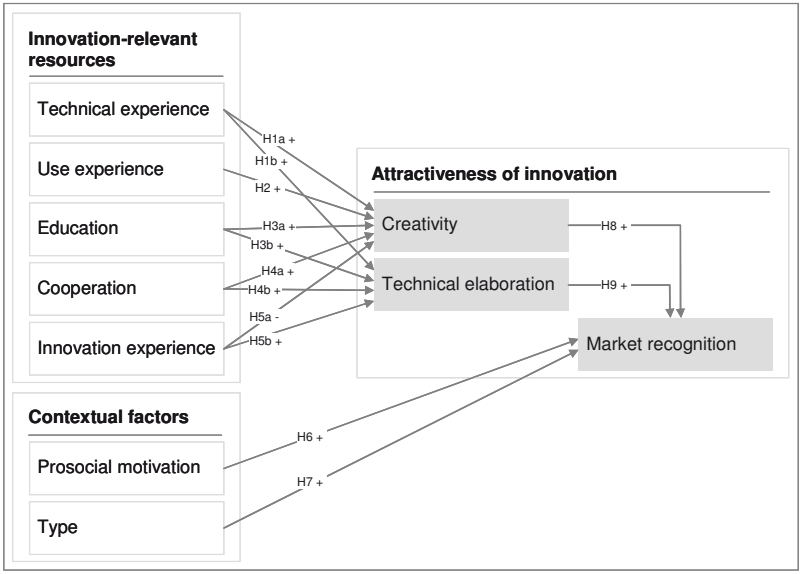

Figure 12: Research framework including hypothesized relationships

5 Methodology

In this section the application of descriptive and causal analysis will be explained to answer the previously raised research questions and to test the hypotheses. Furthermore, this chapter provides an overview of the data source, the collection of data as well as its operationalization from raw data into variables.

5.1 Analysis

The subsequent analysis aims at empirically answering the research questions raised in Section 4.1. Given that "…the content of the research (the research questions) has a logical priority over the method of the research" (Punch 2005, p. 20), an appropriate methodology needs to be selected based on the nature of the research questions. The context of the present study is the intersection of the relatively well explored research field of user innovation in a quite new and unfamiliar BoP setting (cf. von Hippel et al. 2010; Viswanathan, Sridharan 2012). As recommended for this kind of research, a quantitative approach has been chosen and applied to the analysis (cf. Edmondson, McManus 2007). At this time case descriptions and qualitative work are available on the topic (e.g. Gupta 2006; Pastakia 1998; Viswanathan, Sridharan 2012). Hence, the first set of research questions (see Section 4.1.2) calls for a quantitative investigation of the phenomenon and compilation of profiles on BoP consumer innovation based on field data. Additionally, it aims at generation of data in order to compare characteristics of the phenomenon taking place in the wealthier world versus the poor world. Based on the nature of these first research questions a descriptive approach has been applied. Sekaran and Bougie (2010) explain that descriptive analysis is appropriate when the research goal consists of describing a phenomenon in a certain situation through provision of a profile of factors and variables and depiction of significant aspects. It displays information in a meaningful way and helps us to think systematically about the phenomenon of interest (Sekaran, Bougie 2010).

The descriptive analysis of BoP consumer innovation lays the groundwork for the second set of research questions (see Section 4.1.3) because "[i]f we want to know why something happens, it is important to have a good description of exactly what happens" (Punch 2005, p. 15). Hence, the ensuing analysis of antecedents of BoP consumer innovation takes place in the form of an explanatory, causal study where the hypotheses of the previous chapter are tested (cf. Sekaran, Bougie 2010). In accordance with Edmondson and McManus (2007), the hypotheses development follows a logical argumentation building on preceding work on user innovation and BoP- related research. This hypothesis testing procedure examines the relationship

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between previously established constructs, aims at explaining variance in the dependent variables and determines cause-and-effect relations (cf. Edmondson, McManus 2007; Sekaran, Bougie 2010). Table 1 displays an overview of the type of analysis applied to investigate the research questions respectively.

Characteristics of consumer innovation at the BoP		Analysis type	Purpose
RQ 1a	How can consumer innovators at the BoP be characterized?	Descriptive	Descriptive profiles
RQ 1b	How can consumer innovations at the BoP be characterized?		
RQ 2	What are similarities and differences of consumer innovation at the BoP compared to consumer innovation in the wealthier, resource-rich world?	Descriptive/ comparative	Comparative profiles
Antecedents of BoP consumer innovation			
RQ 3	How do innovation-related resources influence the commercial attractiveness of a consumer innovation at the BoP?	Causal	Hypothesis testing
RQ 4	How do contextual factors influence the commercial attractiveness of a consumer innovation at the BoP?		

Table 1: Overview of type of analysis by research question

5.2 Data collection

The previously raised research questions apply to the entire consumer innovation population taking place at the BoP. In this context the unit of analysis is the individual consumer innovation (cf. Sekaran, Bougie 2010). Both the descriptive as well as the causal analysis are based on a population sample of innovations generated by consumers living at the Indian BoP. The National Innovation Foundation (NIF) in collaboration with the Honey Bee Network has extensive data on Indian BoP consumer innovations. This data represents a unique source of information given the unexplored and informal character of the BoP (cf. Utz, Dahlman 2007). Hereafter institutional background and information on the BoP consumer innovation database shall be provided followed by portrayals of exemplary cases from this database. Finally an explanation will be offered as to how the sample for analysis was derived from the Honey Bee Network database.

5.2.1 The Honey Bee Network

5.2.1.1 Institutional background

Founder Professor Anil Gupta started the Honey Bee Network in the late 1980s in India. The aim of the non-governmental network is to connect grassroots innovators, to add value through cross-pollination and sharing while respecting and protecting all members of the network, similar to a honeybee flying from flower to flower, which explains the naming. The founder's focus lies primarily on overcoming the anonymity and paying tribute to each grassroots innovator for their creative efforts. Today the Honey Bee Network maintains relationships with governmental, non-governmental and scientific institutions even beyond India, and similar efforts are being considered in other countries such as Malaysia, China, Brazil and South Africa. The National Innovation Foundation (NIF) was established by the Indian government to provide institutional support and is among others an important associated organization of the Honey Bee Network. (Gupta 2006; Gupta)

The Honey Bee Network and its collaborating partners carry out several activities in order to support, honor and learn from grassroots innovators. Extensive efforts have been endeavored in order to scout, document and share the various innovations across India. Since 1998 every year two exploratory journeys of over 200 km throughout rural India take place, and these are walked on foot. These so-called *shodh yatras* connect the poor. They share their innovations, learn from others, receive recognition and are above all motivated to generate further solutions. Moreover, scouting and sharing occurs via newsletters in various Indian languages,

on the website, at festivals and at award competitions. The initiative aims to protect intellectual property and to provide the grassroots innovators with patents when possible.

Research and development undertakings intend to further add value to promising innovations through testing, validation and further improvements. Finally the network and its partners seek to help grassroots innovators to develop some business either by supporting entrepreneurial activities or by bringing them together with companies or organizations interested in selling their innovation (Bhaduri, Kumar 2011; Gupta 2006; National Innovation Foundation). However, while the initiative struggles with the development and commercialization of grassroots innovations (Utz, Dahlman 2007), it has proven to be successful with their detection, documentation and dissemination. As of today the Honey Bee Network database that is maintained by the NIF comprises more than 100.000 innovations, ideas and traditional knowledge practices (Honey Bee Network). Also in the course of six prominent national award functions,[21] the NIF has rewarded and honored more than 400 grassroots innovations and awards, which have been bestowed by personalities such as the president of India. An expert jury selects the grassroots innovators awardees based on predefined criteria and a thorough screening process (Bhaduri, Kumar 2011). While limited data is available on the totality of the Honey Bee Network database (cf. Honey Bee Network), the NIF publishes detailed descriptions of the awardees and their grassroots innovations (cf. Bhaduri, Kumar 2011; National Innovation Foundation). Therefore, the BoP consumer innovation sample is based on the national award functions held by the NIF.

5.2.1.2 Example cases of the Honey Bee Network database

For a better illustration of the Honey Bee Network database, I will describe the following three awardees and their innovations (see Figure 13). All these BoP consumer innovations are subjects of the sample for subsequent analysis and are selected for representative reasons to convey a general picture of the sample (e.g. different award levels, innovator's education levels, motivations and satisfied needs). The source for all three cases is the official website of the NIF (National Innovation Foundation).

[21] Award functions were held in 2001, 2002, 2005, 2007, 2009 and 2012.

Cycle operated water pump	Fridge made out of clay	Biomass based gasifier
By Vikram Rathore	By Mansukhbhai Prajapati	By Rai Singh
		
Consolation award 3rd innovation award function	National third award 5th innovation award function	National second award 5th innovation award function

Figure 13: Exemplary cases of the Honey Bee Network Database (cf. National Innovation Foundation)

Cycle operated water-lifting pump

The innovator's name is Vikram Rathore who was 38 years old at the time of the third award function and won a consolation award. He repairs bicycles and small machines in order to earn his living and had to quit school after the 5th grade standard.[22] Besides his awarded innovation, he had also created a manual flour mill.

Vikram Rathore's district in Andrah Pradesh is a region with only sparse and irregular rainfall. When the innovator tried to grow a paddy field, his crop wilted because he neither possessed an engine to pump water nor could he borrow one for the purpose of irrigation. In order to solve this problem he wanted to build a manual water pump and observed the mechanism of an electrical water pump whose engine rotated a fan. After having arduously rotated a fan by hand, he thought of using pedaling energy to create more pumping power. Vikram Rathore sold some household equipment so he could afford an old bicycle and collected other scrap parts to manufacture his pump. His innovation consists of a centrifugal water pump where the rear wheel of a fixed bicycle is connected to an impeller via rims, pulleys and a flywheel. The device can be used to pump water from various water sources such as wells and rivers. Given that it is made from commonly accessible parts, the pump is relatively inexpensive. Furthermore, it does not involve any expense for electricity or fuel and it is low maintenance. Up to the award function, there had been no adoption or commercialization of the innovation. Nevertheless, the NIF has filed a patent for

[22] The 5th grade standard falls into elementary or primary education. The student's age at this grade is typically 10 or 11 years (cf. Government of Tamil Nadu; Maps of India).

Vikram Rathore and his innovation.

Fridge made out of clay

Mansukhbhai Prajapati, 44 years old, is a clay craftsman from Gujarat. He studied up to the 10th grade standard[23] and has already developed a range of other innovations made out of clay, including a cooker, a frying pan and a water filter. The grassroots innovator received a national third award for his earthed kitchen products at the fifth national award function in 2009.

In 2001 Gujarat experienced a fatal earthquake. The resultant loss suffered by the poor population of Gujarat inspired Mansukhbhai Prajapati to develop a fridge for the rural poor that would not require any electricity. After years of efforts he finally succeeded and finalized a small refrigerator. The so-called "Mitticool" is made out of clay and takes advantage of the evaporative cooling effect of water. It does not require any electricity and keeps its interior at a temperature of 4-5 degrees Celsius below the outside temperature. Tests conducted by a partner organization of the Honey Bee Network show that the fridge allows for the fresh keeping of vegetables, milk and fruits at a prolonged shelf life. For example, the shelf life of coriander was prolonged from 1,5 or 2 days to 4 days and its original taste was preserved. The Mitticool has a storage capacity of approximately 5 to 7 kilograms. The earthen fridge has been commercialized and coverage by regional and national media increased its diffusion. Furthermore, the NIF has reported an expression of interest by Bosch Siemens Hausgeräte in Germany.

Biomass based gasifier (and engine)

The grassroots innovator Rai Singh has no formal education and earns his living through the repair of engines, agricultural and other small machinery. The man from Rajasthan received a national second award in the course of the fifth national award function for his biomass based gasifier.

Due to the increased price of diesel, Rai Singh was looking for alternative energy sources for diesel and liquefied petroleum gas engines and thought of using biomass for this purpose. He wanted to develop a device that would allow converting biomass into producer gas to run the engines. After some experimentation he successfully added a biomass gasifier to the conventional engine design so that his modified engine now runs on biomass such as fire wood and agricultural waste. A gasifier system including filtration, cooling and a mixer unit instead of the regular diesel

[23] The 10th grade standard falls into secondary education, the students' age at this grade is typically 15 or 16 years (cf. Government of Tamil Nadu; Maps of India).

injector provides the engine with clean producer gas at fuel-to-air ratios adapted to the respective engine. Clean producer gas is required to ensure smooth operation and high efficiency, thus creating a low biomass consumption of the engine. A modified 30 horsepower engine runs approximately for one hour on 20 kilograms of biowaste. Rai Singh's innovation is less expensive and consumes less combustible material than comparable engine designs and can be applied to operate simple machinery such as flour mills, saw mills and pumps or to charge alternators. By means of a micro venture innovation fund, the NIF supported Rai Singh in the commercialization of his innovation. The grassroots innovator was able to start manufacturing engines and had sold over 50 units at the time of the 5th award function.

5.2.2 The sample

The NIF publishes a total of 382 award profiles online from each of the first five award functions (cf. National Innovation Foundation). A typical award profile features one innovator and one innovation. However, sometimes several innovators were involved and in some rare cases an innovator may receive an award for more than one innovation. Furthermore, there are profiles describing additional, non-awarded innovations of the laureate. All consumer innovations and innovators are considered in order to generate a comprehensive sample. In Section 4.1.1 it was suggested that grassroots innovations differ from user and consumer innovations mainly with regard to their inclusion of traditional knowledge and practices beyond innovations (cf. Gupta 2006). Therefore, the sample does not include these traditional practices. The same is true for insufficiently detailed innovations, pure ideas that have not been translated into any prototype as well as awards for certain personalities detached from any specific innovation.[24] Starting with a total of 382 awards, 74 were deducted to finally consider 308 awards featuring 425 awarded and non-awarded innovations (see Table 2). Accordingly, the final sample database includes 425 BoP consumer innovations derived from the first 5 awards functions by the NIF.

[24] These awards honor people for certain lifetime achievements and other role model behaviors and attitudes (cf. National Innovation Foundation).

Award function	1st	2nd	3rd	4th	5th	Total
Total number of awards	86	52	98	69	77	**382**
Excluded awards	8	9	24	18	15	**74**
▪ No or insufficient information disclosed	3	3	1	5	3	15
▪ Ideas only	5	3	-	5	4	17
▪ Traditional and community practices	-	3	21	8	1	33
▪ Innovation independent awards	-	-	2	-	7	9
Total awards considered	78	43	74	51	62	**308**
Additional innovations mentioned in award profile	17	17	25	12	46	**117**
Total innovations included into database	95	60	99	63	108	**425**

Table 2: Sample database derived from NIF award functions

Researchers such as Bhaduri and Kumar (2011) also based their quantitative research on the publicly assessable NIF award competitions. Their sample includes 87 innovations and individuals from the first idea competition. Their study analyzes the sources of motivation (intrinsic versus extrinsic) along a three-stage innovation process, which they defined.

Most definitions of innovation include the term “exploitation” (e.g. Roberts 1987). The innovations in the sample do not exhibit the same level of exploitation and not all of them have so far been commercialized. Nevertheless, for purposes of this study, all sample subjects are referred to as innovations for simplicity, which is in line with the OECD (2005) definition[25] for product innovations. The Honey Bee Network database and the associated award functions offer a unique and rich data source for consumer innovations at the BoP. However, there are certain drawbacks to it specifically because it represents a secondary source of data (cf. Sekaran, Bougie 2010). Although an expert jury carefully selects the grassroots innovations to be awarded based on predefined criteria (cf. Bhaduri, Kumar 2011), they may exert a certain bias. Also, different scouts document the innovations and generate the respective profile (cf. Honey Bee Network). Therefore, format, structure, style and richness of detail vary by profile description. Finally, the Honey Bee Network focuses on the rural poor

[25] “…[A] good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics” (OECD 2005, p. 48).

in India. While obvious from the innovators' living conditions described in their profiles and the purpose of the Honey Bee Network, there is no systematic income inquiry to determine whether each innovator belongs to the BoP per definition or at which income threshold (cf. Section 2.1).

5.3 Data preparation

All innovations selected for the sample database are available in the form of running text profiles. Coding procedures have to be applied in order to operationalize all relevant information into variables. Furthermore, the profiles do not contain any objective information on innovation quality, namely its degree of creativity and technical elaboration. Yet, these two variables are required to test the hypotheses developed in Section 4.2.3. Therefore, an assessment technique that allows for an objective and valid measurement of creativity and technical elaboration has been applied.

5.3.1 Codification of award profiles

The NIF publishes the profile descriptions on the awardees and their innovations in the form of a running text on its website. This raw data needs to be processed and prepared through codification so its content can be seized and analyzed (cf. Krippendorff 2004; Strauss, Corbin 1991; Miles, Huberman 2008). In this context the codification procedure quantifies the formerly qualitative case descriptions (Strauss, Corbin 1991). There are two general coding approaches, inductive and deductive coding (Bernard 2006). Inductive coding or open coding will be applied if there is no theory available to derive an appropriate category system. In this case the coding process emanates from the raw data itself and starts to develop codes that best capture and highlight its content (cf. Strauss, Corbin 1991; Joffe, Yardley 2004). Deductive coding, however, is typically used for theory testing. In order to test hypotheses one needs to operationalize and measure the respective variables. Here a coding system is first derived from existing theories or concepts and then applied to the analysis of raw data (Neuendorf 2001; Joffe, Yardley 2004). For this dissertation all categories were derived deductively with two exceptions. The category classifications for the need addressed by an innovation as well as its award status are developed inductively based on the sample database. All other coding systems emanate from the objective to either test hypotheses or to contrast with a study (von Hippel et al. 2010) on the phenomenon taking place in the wealthier world.

In the following section the coding framework is described (cf. Joffe, Yardley 2004) and categories are applied to the content analysis of the individual consumer innovation descriptions. With regard to demographic codes, the data is categorized

according to the innovator's *gender* (male, female), place of *residence* (Indian state) and the individual's respective *age* group (0-17, 18-24, 25-23, 35-44, 45-54, 55-64, 65+). The age categories are taken from the UK consumer innovation study (von Hippel et al. 2010) and expanded by the youngest age category below 18 years that could not be addressed in the UK due to legal constraints. Furthermore, the innovators are coded based on their main pursued *profession* (farmer, craftsman, education and health, administration, students, simple workers and unemployed). Comprehensive classification structures for organizing occupations by the German Bundesagentur für Arbeit (2010) and the International Labour Organization (2008) provide the basis for the derived profession categories.[26]

The next set of codification categories serves to measure innovation-related resources. *Technical experience* (yes, no) with the underlying technology and product domain is attributed to an innovator if his profession falls into the same industry (cf. Lüthje 2004). An innovator possesses *use experience* (yes, no) (e.g. Shah 2000) if the profile description characterizes him or her explicitly as a user or it is absolutely clear from the context. Furthermore, the innovator's highest completed *education* level (cf. von Hippel et al. 2010) is coded into seven categories (illiterate, primary (level 1-5), middle (level 6-8), secondary (level 9-10), higher secondary (level 10-12), graduated, higher studies) based on the Indian education system.[27] The data is also categorized according to the use of *cooperation* (yes, no) during the innovation process (e.g. von Hippel et al. 2010). Cooperation and collaboration mean that there are either two or more innovators or substantial collaboration efforts were reported with at least one other person during the innovation process. Finally the data is coded according to the *innovation experience* (yes, no) of the innovator, whereby the individual gains innovation experience with more than one innovation (e.g. Bayus 2012).

Among the contextual factors are classifications for the *industry* of origin or creation industry of the innovation (agriculture, manufacturing, water & sewerage, construction, information, arts). The industrial classification system by the United Nations (United Nations Statistics Division 2012) serves as basis for the derived

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[26] The data was first grouped according to the first order structure of the Bundesagentur für Arbeit (2010) supplemented by the additional category "elementary occupations" by the International Labour Organization (2008) structure. As a next step these five classifications were renamed to better describe their content and complemented by the additional category "student" (see Appendix for more details).

[27] Sources for the education structure in India are the Indian Ministry of Human Resource Development (Ministry of Human Resource Development India 2012), the Indian National Council of Educational Research and Training (National Council of Educational Research and Training (India) 1992) as well as the governments of individual Indian states (e.g. Government of Tamil Nadu). Please note that minor differences may exist between states.

industry codes.[28] However, inductive coding is applied to generate a coding system for the addressed *need* (food production, food preparation, water supply, clothing, hygiene and health, energy, transportation, household, tools and crafting, hobby and sports, other). Categories were developed based on the entire sample in a way that they best captured the different needs satisfied by the innovations (cf. Strauss, Corbin 1991). Furthermore, the data is coded as a function of *prosocial motivation* (yes, no) to help someone or to comply innovation requests and impulses (e.g. von Hippel et al. 2010) and of *innovation type* (creation, modification)[29] (e.g. von Hippel et al. 2010; Lüthje 2004).

Before measuring the four-item scale (cf. Ng and Feldman 2010) *market recognition* (0-4)[30], the data is coded for all four underlying items. An innovation receives scores according to its diffusion (yes, no), adoption (yes, no) and commercialization (yes, no) (cf. von Hippel et al. 2010). The codes for the innovation's award status (yes, no) were developed inductively. The positive coding or scores (yes) on these four underlying items are finally summed up to generate the market recognition scale. Hence, an innovation's market recognition can assume values from 0 to 4.

[28] The data was first grouped according to the first and second order structure of the International Standard Industrial Classification of All Economic Activities (ISIC) (United Nations Statistics Division 2012) and then these 5 first order categories and 18 second order categories were renamed to better describe their content (see Appendix for more details).

[29] A modification of an existing product aims at changing or improving its performance whereas creation means a product is built from scratch or through assembly of existing products to introduce a new functionality or to achieve an existing functionality via a totally new product or technique (cf. Lüthje 2004).

[30] The scale from 0 to 4 corresponds to: 0 times yes, 1 times yes, 2 times yes, 3 times yes, 4 times yes.

Variable	Description	Values
Demographic traits		
Gender	Innovator's gender	male; female
Age	Innovator's age group	0 (0-17); 1 (18-24); 3 (25-23); 4 (35-44); 5 (45-54); 6 (55-64); 7 (65+)
Residence	Innovator's residence	22 different Indian states
Profession	Innovator's main occupation	1 (farmer); 2 (craftsman); 3 (simple worker/ unemployed); 4 (administration); 5 (education/ health); 6 (student)
Innovation-relevant resources		
Technical experience	Work experience in industry	0 (no); 1 (yes)
Use experience	Innovator is a user	0 (no); 1 (yes)
Education	Innovator's highest completed education level	0 (illiterate); 1 (primary); 3 (secondary); 4 (higher secondary); 5 (graduated); 6 (higher studies)
Cooperation	Joint development effort	0 (no); 1 (yes)
Innovation experience	More than one innovation by innovator	0 (no); 1 (yes)
Contextual factors		
Industry	Industry of origin	1 (agriculture); 2 (manufacturing); 3 (water/sewerage); 4 (construction); 5 (information); 6 (arts)
Need	Addressed need	1 (food production); 2 (food preparation); 3 (water supply); 4 (clothing); 5 (hygiene/health); 6 (energy); 7 (transportation); 8 (household); 9 (tools & crafting); 10 (hobby/sports); 11 (other)
Prosocial motivation	Innovation for someone else	0 (no); 1 (yes)
Innovation type	Modified or newly created	0 (modification); 1 (creation)
Innovative outcome and behavior		
Creativity	Degree of creativity	Metrical (interval) assessed via CAT
Technical elaboration	Degree of technical elaboration	Metrical (interval) assessed via CAT
Market recognition	First-order construct based on 4 coded variables	Ordinal measure (0-4) as sum of 0 (no); 1 (yes) for: diffusion, adoption, commercialization, award status

Table 3: Overview of the variables

Due to the award profiles' different degree of detail, not all 425 innovations can be categorized according to these 14 variables (see Table 3). Thus, only 267 ideas are complete with regard to the entire set of coded variables and, therefore, sample size varies by variable under investigation. The two remaining variables, namely *creativity* and *technical elaboration*, are not measured via the coding framework but by means of the Consensual Assessment Technique (Amabile 1982), which is described in the

following section.

5.3.2 Assessment of creativity and technical elaboration

The innovation sample contains no comparable technical parameters or other indicators that could serve to evaluate the innovativeness or quality of an individual innovation. Due to this lack of functional measures the Consensual Assessment Technique (CAT) developed by Amabile (1982) was applied, whereby expert raters individually evaluate the quality of a given set of innovations. CAT was originally designed to assess creativity, but beyond that researchers have successfully applied it to determine product innovativeness as well as innovativeness of user ideas or user contributions (e.g. Piller, Walcher 2006).

5.3.2.1 Definition of creativity

CAT is rooted in the social psychology and emerged a result of the extensive search for a clear definition and an assessment methodology for creativity. The notion of creativity is a rather conceptual one, which lacks clear operational characteristics that are an indispensable precondition for any measurement method (Amabile 1982). Thus the concept of creativity needs to be operationalized. Creativity can be best observed via the outcome of a creative performance, which may be a product or solution to a given problem (Amabile 1983). Creativity research relies mainly on product characteristics instead of personality traits for instance (e.g. Nicholls 1972). In this context “novelty” and “appropriateness” are the most widely used product characteristics associated with creativity (cf. Barron 1955; Amabile 1982). “A product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct, or valuable response to the task at hand and (b) the task is heuristic rather than algorithmic.” (Amabile 1983, p. 360). Nevertheless it remains unclear how novelty or appropriateness of a product should be measured (Amabile 1982).

According to Amabile (1982) judging and recognizing creativity relies on a social context similar to measuring the attractiveness of people (cf. Walster et al. 1966). Hence people recognize creativity and identify the same product characteristics as being creative based on a subjective understanding of creativity without relying on any objective criteria (Amabile 1982). Amabile argues that it might even be impossible to identify objective definition criteria for creativity (Amabile 1983). It seems to be almost impossible to express what creativity is. However, people recognize creative products or solution characteristics when they see them. Thus, the operational definition of creativity can be formulated as:

> "A product or response is creative to the extent that appropriate observers independently agree it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated. Thus, creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers, and it can also be regarded as the process by which something so judged is produced." (Amabile 1982, p. 1001)

5.3.2.2 The Consensual Assessment Technique

Assumptions and preconditions

The consensual assessment technique builds on the definition of creativity stated above. It is a well-proven and reliable subjective assessment method[31] of creativity employing a jury of raters who are familiar with the creation field of the product (Amabile 1979). This jury independently rates a set of responses or products. Its consensual and reliable agreement upon the same creativity scores confirms the validity of this technique to determine creativity. Thus, a consensually identified level of creativity for a given product can be accepted as the product's degree of creativity (Amabile et al. 1996).

Consequently Amabile (1982) emphasizes the following two underlying assumptions for the consensual assessment technique:

1. There is one fundamental type of creativity that people can identify and a group of people sufficiently acquainted with the domain can consensually agree on their observations.
2. There exist degrees of creativity, products or solutions that can exhibit higher and lower levels of creativity.

CAT requires several stringent procedural conditions in order to ensure independent and subjective assessment by the jury. Table 1 provides an overview of these procedural conditions.

[31] CAT has been applied in the context of various studies and yielded reliable results for measuring creativity, e.g. artistic task creativity (Conti et al. 2001), verbal creativity of writing poems (Amabile 1982), essays (Conti et al. 1995), storytelling (Amabile 1996), project creativity at an electronics company (Amabile et al. 1996), and problem-solving creativity (Amabile 1996).

	Requirements for the CAT procedure	Rationale
1	Judges need to be familiar with the product creation field	Some experience and familiarity is for most product or response domains necessary to form an opinion about its quality
2	Independent judgments without prior training and explicit definition of the dimensions	The assessment technique relies on subjective criteria that should not be influenced through training or explicit instructions
3	At least one more dimension in addition to "creativity" dealing with technical aspects	Keeping subjective opinions on technical fit apart from creativity judgments
4	Items should be rated in comparison with each other instead of absolute standards	Most studies' items would be rated very low relative to their best ever produced counterpart
5	Every judge rates the items in another order	Prevention of influences on judgments through the order in which items are rated
6	Construct validity is tested via an inter-judge reliability analysis	The consensual definition of creativity implies the reliability of the independent judgments

Table 4: Procedural requirements for CAT (cf. Amabile 1982)

The jury composition requires neither experts in the product or response creating domain nor a same level of experience across all raters. As prior studies have shown,[32] no specialized skills are necessary for the evaluation work and judges simply need to dispose of a basic understanding of the creation activity without actually having themselves created a similar product or response (Amabile 1982). However, it is evident that everyone can act as judge for some evaluation objects such as cartoons (Amabile 1982), contrary to more specialized domains such as computer programming tasks (Amabile 1996).

Application of CAT within User Innovation research

The concepts of creativity and innovation are closely related (cf. Section 4.2.1). Various authors support this point of view and describe creativity as the production of new and valuable ideas, products, processes and services (cf. Woodman et al. 1993). According to Soukhoroukova et al. (2010), creativity increases the quality and value of new ideas that ultimately turn into commercially successful product innovations. Consequently, several researchers have already successfully applied CAT to user innovation research to determine the creativity or quality of ideas and innovations (e.g. Matthing et al. 2006; Kristensson et al. 2002; Magnusson 2009; Mahr, Lievens 2011; Piller, Walcher 2006). Table 5 provides an overview of three

[32] Studies applying two juries for CAT consisting of expert and non-expert judges respectively show strong correlation between experts' and amateurs' ratings, e.g. (Amabile 1982; Amabile 1996).

exemplary user innovation studies employing CAT. If studies are missing clear objective criteria to compare innovations, this technique represents a valid method to generate impartial evaluations and comparisons of objects (Piller, Walcher 2006). Accordingly, Magnusson (2009) utilized CAT to determine the goodness of user ideas for SMS-based services; Mahr and Lievens (2011) applied the method to assess the value of user contributions to mobile service innovation projects; whereas Piller and Walcher (2006) evaluated and ranked user contributions as well as product ideas for sports goods by using CAT.

	Mahr & Lievens	**Magnusson**	**Piller & Walcher**
Journal	Research Policy, 2011	Journal of Product Innovation Management, 2009	R&D Management, 2006
Ratings	1352 rating/jury team ▪ 676 user contributions ▪ on 2 dimensions	1287 ratings/judge ▪ 429 user ideas ▪ on 3 dimensions	328 ratings/judge ▪ 82 user ideas ▪ on 4 dimensions
Dimensions	▪ Novelty ▪ Relevance	▪ Originality ▪ User value ▪ Producibility	▪ Novelty/originality ▪ Expected customer benefits ▪ No. of expected beneficiaries ▪ Level of elaboration
Jury	2 jury teams (3-5 judges each)	6 Judges	5 Judges
Reliability	Pearson bivariate correlation tests highly significant ($p<0,001$; r is 0,38 and 0,32)	Pearson's "r" shows significant agreement (r between 0,30 and 0,54)	Interclass-correlation coefficients indicate high degree of consensus (0,74 – 0,81)

Table 5: Examples for CAT application to user innovation research (cf. Magnusson 2009; Mahr, Lievens 2011; Piller, Walcher 2006)

5.3.2.3 Approach and results

A reasonably homogenous subsample needs to be selected from the entire sample in order to apply CAT and to generate a relative assessment of innovation quality. For this purpose all manufacturing and construction innovations have been grouped into a comparative subsample of technical innovations. Pharmaceutical and chemical innovations officially form part of the overall manufacturing category. Nevertheless, these innovations are excluded from the sample because of their different nature considering materials, performance, production tools and processes. Further analysis requires innovations that are complete regarding all 14 coded variables (see Section 5.3.1) in order to investigate their hypothesized relationships among each other. Therefore a final subsample including 195 complete technical ideas is derived for the evaluation (see Figure 14).

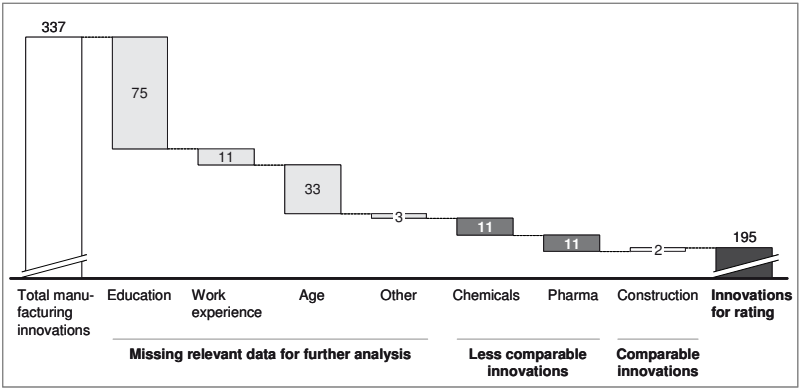

Figure 14: Innovation sample for evaluation

A jury rates all innovations on two dimensions with scales ranging from 1 (corresponding to "very low") to 4 (corresponding to "very high") in order to avoid the judges' potential tendency to give central scores. In addition to "creativity," the evaluation work includes a second dimension called "technical elaboration" to differentiate between the creativity of an idea and its realization (cf. Amabile 1982). The judges were asked to apply their own, subjective definition of creativity and technical elaboration[33] to the assessment. Furthermore, they were asked to evaluate every innovation relative to the entire sample, therefore making use of the full evaluation scale. Given the vague character of the concept of creativity, Amabile (1996) recommends introducing the twonotions of "novelty" and "relevance" as rough definitional guidance if other factors such as commercial success could manipulate an important proportion of rating variance. Therefore, it was stated on the instruction page: "[c]reativity corresponds to the level of *novelty* (uniqueness and originality) and *relevance* (meaningfulness and appropriateness for the application) of a given product" to exclude other irrelevant factors. Also the judges were asked to keep these two dimensions as separate from each other as possible (Amabile 1996).

The jury consisted of eleven master level students in engineering of different nationalities (German, Indian, Mexican, Swedish, and Malaysian) and gender (two females and nine males) who all had relevant experience in engineering and product design. An overview by Amabile on various studies using CAT shows a typical use of

[33] Exact wording on the instruction page: "the degree to which the idea is creative" for creativity and "the degree to which the work is good technically (quality or fit of the technical solution)" for technical elaboration (see Appendix, cf. Amabile 1982).

three to ten judges for the evaluation work (cf. Amabile 1996). However, the more demanding the judging job becomes in terms of time and difficulty to sustain consistent criteria, the more judges should be employed (Amabile 1996). Therefore I employed 11 judges for a total of 390 ratings per judge. This number exceeds the jury size of comparable user innovation studies that apply CAT to even higher amounts of total ratings (see Table 5).

First the judges were given an initial explanation regarding the evaluation task, background information on the BoP and the innovation sample. Then all judges independently completed their work in the course of five to six sessions of approximately four hours each. The supervised evaluation work took place at the institute. No training with regard to the judging task was provided, and no discussion of concrete ratings and innovations was allowed. Every judge received his or her evaluation paper sheets containing short descriptions of all technical ideas in a different order to avoid bias through fatigue or sequencing. Every student read through the complete list of short descriptions to familiarize himself or herself with the sample before the actual evaluation. This procedure is important, because every innovation was to be rated relative to the entire sample. Afterwards the judges received an Excel file, which was transferred to their computers, which they had brought with them. The Excel file contained the same list of innovations including web links to the respective NIF award profile providing more details and typically pictures. Finally the students started to analyze and rate each innovation one by one on a scale of 1 to 4 for both dimensions. (cf. Amabile 1982, Amabile 1996)

A final discussion round, which I led, took place to review innovations with strong disagreements in the ratings (cf. Mahr, Lievens 2011). An analysis of standard deviation and delta between first and third quartile of ratings was applied to identify relevant ideas (cf. Bortz, Weber 2005; Jarvis et al. 2003). Thirty-four innovations (17% of the sample) exhibited relatively higher levels of disagreement on one or both dimensions and were thus addressed in the final discussion. Wherever a misunderstanding with regard to innovation functioning or lifestyle at the BoP (e.g. frequent short circuits due to instable electricity supply) caused the disagreement, the judges were allowed to adjust their evaluations (cf. Table 6).

	Ideas	Ratings	Idea selection for discussion if one of the conditions below was met	
Total sample	195	4290	Standard deviation:	>= 0,95
Thereof revised	34	123	Δ 1st and 3rd quartile:	>= 2
▪ On both dimensions	14	63		
▪ Creativity only	8	19		
▪ Technical elaboration only	12	41		
Share of entire sample	17%	3%		

Table 6: Revision of ideas with highest variance in CAT ratings

Results and reliability of ratings

Analysis of inter-judge reliability has two purposes. 1) First it proves methodological and construct validity for the measurement of creativity and technical elaboration while 2) it validates averaged, single scores per dimension for subsequent analysis (cf. Osborne 2008). Amabile (1996) recommends Cronbach's Alpha coefficient (Cronbach 1951) to calculate inter-judge reliability. The coefficient allows appraising a single estimate for consistency across multiple raters and takes into account systematic variance[34] (Osborne 2008). Hence Cronbach's Alpha is an appropriate coefficient to analyze reliability across raters and to justify aggregated measures for further analysis (Hayes 2007). Analysis of Cronbach's Alpha shows acceptable reliability levels for creativity (0,76) as well as technical elaboration (0,78). Both values exceeded the threshold of 0,70 for acceptable results (Osborne 2008) even before the final discussion round. Final discussion and clearance of disagreements between raters yielded even higher reliability coefficients on both dimensions with 0,80 for creativity and 0,83 for technical elaboration. The validity of the measurement results shows that the jury agrees with its evaluations regarding the innovations' degree of creativity and technical elaboration despite the judges' different backgrounds and nationalities. In accordance with Amabile's (1982) definition of creativity, there seem to be general attributes of creativity and technical standards that people everywhere recognize and identify. Thus, given the proven inter-judge reliability, the individual evaluations were averaged into single scores for creativity and elaboration (cf. Magnusson 2009). Table 7 shows the five best ranked innovations within the sample according to their averaged scores for creativity and technical elaboration.

[34] Systematic variance is caused through judges' consistent and predictable differences in definition and application of the scale.

	Idea title	Description	Innovator	Averaged scores: Creativity	Averaged scores: Technical elaboration
1	**Small diesel engine for motorbikes**	Robust, exceptionally small and light weight diesel engine that can therefore be used for 2-wheelers or various other applications	Mansukhbhai Sanchaniya Suthar	3,3	3,7
2	**Biomass based gasifier**	Efficient, inexpensive device that allows to convert biomass such as agricultural waste into clean producer gas at appropriate fuel-to-air ratios to run engines; the gasifier system includes filtration, cooling, and a mixer unit and replaces regular diesel injectors	Rai Singh	3,6	3,3
3	**Air pump for scooters**	Simple, inexpensive tube device to inflate tires of two-wheelers, uses the compressed air obtained when the engines' cylinders are cranked at the built-in kick-start mechanism of the two-wheelers	Arvindbhai Patel	3,7	3,2
4	**Onion transplanter**	This agricultural implement is a tractor drawn trailer that performs three functions at a time: transplanting onions, applying the fertilizer and making the irrigation channels	Pandharinath Sarjerao	3,2	3,7
5	**Electric shock proof converter**	Device fitted to the main electricity board of a building that converts all electrical lines to shock-free power lines; if someone accidentally touches these electrical lines, the electricity circuit will be opened and the electric shock will be prevented	Kshetrimayum Nickolson Singh	3,4	3,5

Table 7: Top 5 innovations based on overall averaged CAT evaluations

A correlation analysis between *creativity* and *technical elaboration* (cf. Figure 15) shows significant results ($r=0,63$; $p<0,001$). Despite a substantial correlation the two variables are not the same. Indeed, *creativity* accounts for almost 40% of the variance in *technical elaboration* and vice versa[35] but other factors explain more than 60% of their respective variance accordingly. Therefore, the two variables can be treated and used to further analysis as two individual variables (cf. Amabile et al. 1996). The Kolmogorov-Smirnov test (Osborne 2008) confirms a normal distribution for both variables.[36]

[35] A linear regression model is applied to assess the variance explained by the other variable: ($R^2=0,395$; adjusted $R^2=0,392$; $F_{(1;198)}=129,138$; $p<0,001$).

[36] No two-sided asymptotical significances to dismiss the null hypothesis of normal distribution (p-value for creativity=0,469; p-value for technical elaboration=0,504), thus the null hypothesis of normal distribution can be accepted (Osborne 2008).

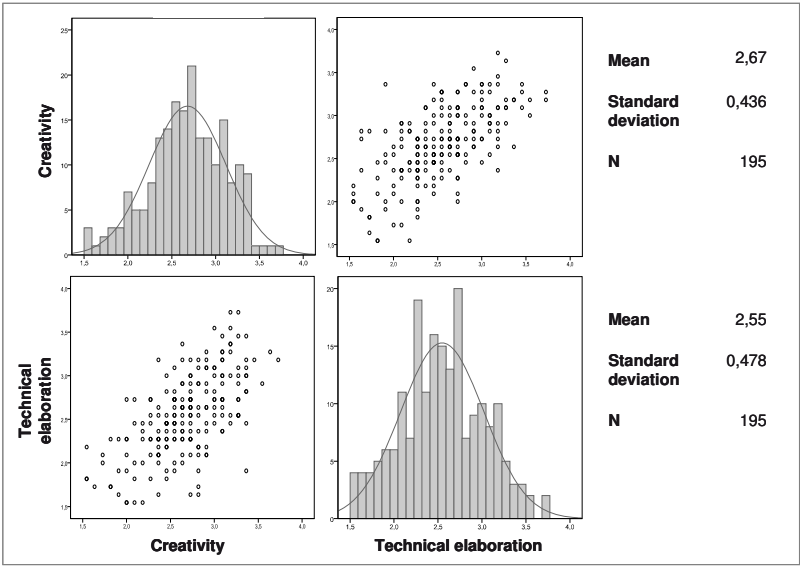

Figure 15: Distributions of creativity and technical elaboration

6 Patterns of consumer innovation at the BoP

Chapter 6 addresses the first set of research questions. By means of descriptive analysis in a first study, the characteristics of BoP consumer innovators and BoP consumer innovations are investigated. Secondly they are compared with a study on consumer innovation in the wealthy world (Research Questions 1a, 1b and 2 respectively). The analysis includes examination and comparison of variables with regard to their frequency distribution and distribution types. The presentation of these descriptive findings is for both studies followed by a discussion of the latter.

6.1 Study 1: Characteristics of consumer innovation at the Indian BoP

6.1.1 Characterization of the consumer innovator

Consideration of demographic traits as well as innovation-relevant resources in the hands of the innovating individual serves as characterization of the BoP consumer innovator.

S. Praceus, *Consumer Innovation at the Base of the Pyramid,* Forschungs-/Entwicklungs-/Innovations-Management, DOI 10.1007/978-3-658-05105-1_6, © Springer Fachmedien Wiesbaden 2014

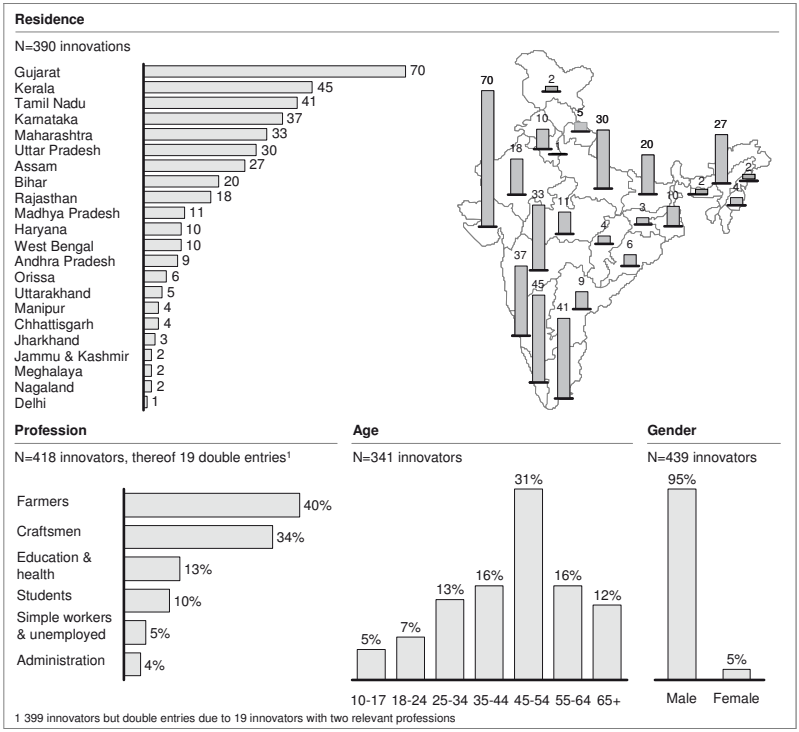

Figure 16: Overview of demographic traits

Figure 16 displays frequency distributions of demographic traits of the BoP consumer innovators. The sample covers innovations that stem from almost every Indian region, more specifically from 21 of the total 28 different Indian states (Indian Government Ministries and Departments) as well as the Delhi union territory. Approximately 5% of the innovators were between 10 and 17 years old; 7% were between 18 and 24 years old; 13% were between 25 and 34 years old; 16% of the innovators were 35 to 44 years old; 31% were 45 to 54 years old, 16% were 55 to 64 years old and 12% were aged 65 years or older at the time of the respective award function. Hence, almost half of the innovators were middle-aged between 35 and 54 years old (47%) and almost two-thirds of the innovators were aged 35 to 64 years (63%). The median age of the sample was 47 years, which is much higher than the general Indian median age of 27 years (2012 estimate Central Intelligence Agency of the United States of America). The vast majority of the consumer innovators at the Indian BoP were male (95%) and female innovators only accounted for 5%. The innovators' main professions were given as: farmers (40%), craftsmen (34%),

education and health-related occupations such as teachers and clergymen (13%), students (10%), simple workers and unemployed people (5%) and finally administration-related occupations mostly in the context of inferior positions in public services (4%).

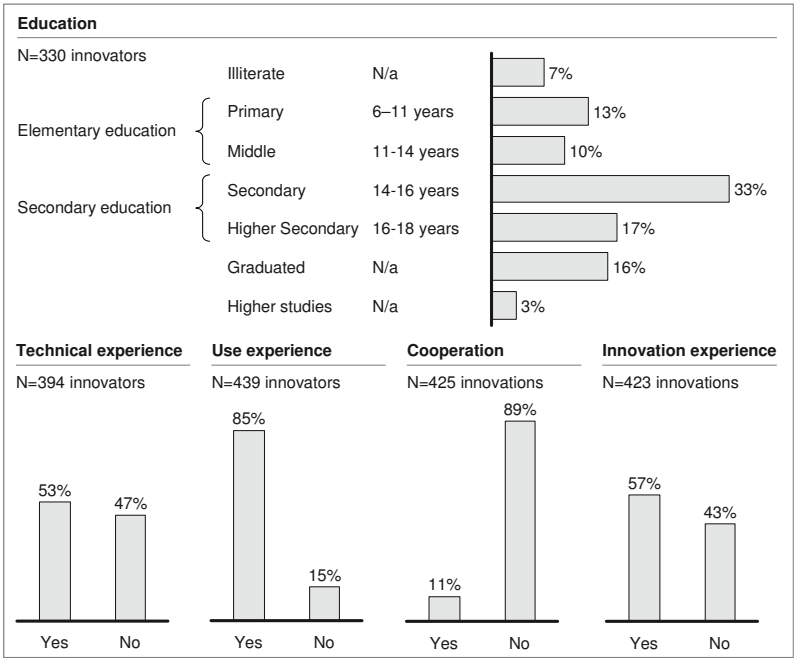

Figure 17: Overview of innovation-relevant resources

Analysis of innovation-relevant resources on Figure 17 shows that 7% of the innovators did not receive any formal education, 13% dropped out at a primary school grade (Grades 1 to 5; pupils typically between 6 and 11 years old), 10% of the innovators completed at least one of the three middle school levels (Grades 6 to 8; pupils are usually aged between 11 and 14 years), 33%, the majority of the innovators, finished Grades 9 or 10 of secondary school (typical pupil age between 14 and 16 years), 17% completed Grades 11 or 12 of higher secondary school (pupil age normally between 16 and 18 years), 16% of the innovators graduated with a bachelor or bachelor equivalent degree and 3% completed higher studies with a master, diploma or PhD. The median for the innovators' highest completed education level lies in the secondary school category. Just over half of the innovators possess

relevant technical experience in the creation industry of the innovation (53%) and individuals having innovated on more than on occasion developed slightly more than half of the innovations (57%). The vast majority of the innovators (85%), however, were also a user of their innovation and therefore had related use experience. Almost all innovations (89%) were the result of a single innovator who did not cooperate with anyone during idea generation and development.

6.1.2 Characterization of the consumer innovation

Analysis of contextual factors and the innovative outcome in the form of the different elements of market recognition permit characterizing the BoP consumer innovations themselves.

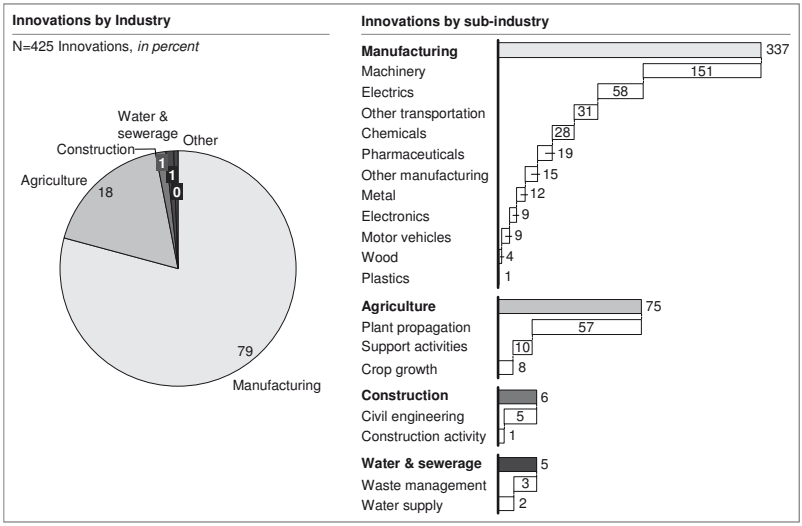

Figure 18: Innovations by industry and sub-industry

The innovations are classified into industries and sub-industries based on the nature of their creation activity, not the industry targeted for utilization. For example, an agricultural implement falls into manufacturing and not agriculture where it is ultimately utilized. Figure 1 displays the breakdown of all 425 innovations by industry and sub-industry. The majority of innovations can be assigned to the manufacturing industry (79%). Thus, the consumer innovators create or modify machinery, electrics, diverse transportation equipment, chemicals, pharmaceuticals, other manufactured items, metal products, electronics, motor vehicles, and wooden and plastic products.

A smaller share of innovations falls into the agricultural industry (18%) covering plant propagation, support activities and crop growth techniques. Among the remaining negligible innovations are 1% passing for construction that includes civil engineering and construction activities and finally 1% of innovations falls into water and sewerage covering waste management and water supply.

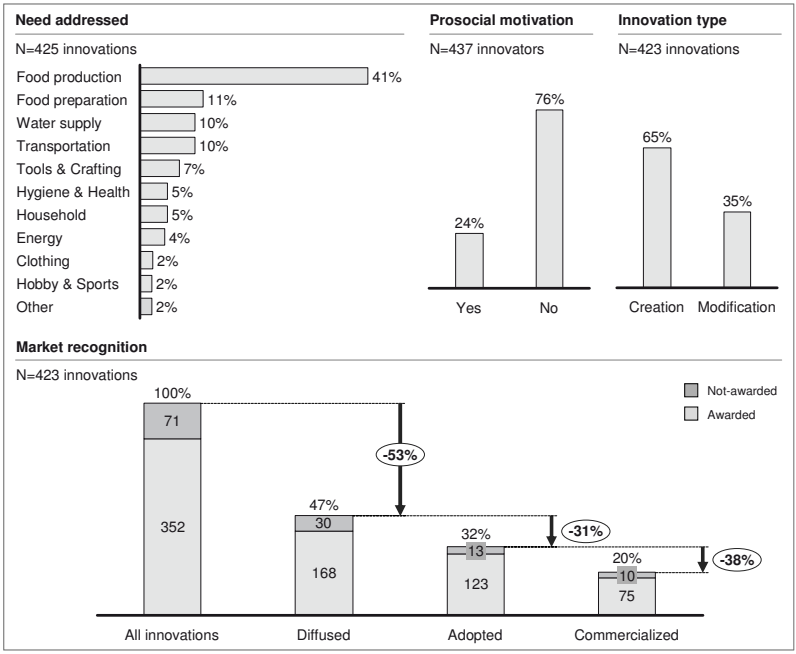

Figure 19: Overview of contextual factors and market recognition

Having investigated the creation industry of the innovations, an analysis of their purpose reveals the underlying need for the addressed products and techniques. Almost half, more specifically 174 of the 425 innovations, aim at satisfying needs related to food production (41%). Food production covers application areas including plant propagation, cultivation techniques, fertilizers and agricultural machinery and implements. Another 11% of innovations help with processing and preparation of food, more specifically with turning raw, unprocessed food into edibles. Further innovations aim at supplying water (10%) for domestic and agricultural purposes or at satisfying transportation-related needs (10%). Creation or modification of tools, production processes and craft supplies destined to repair or produce goods account for 7% of the innovations. Approximately 5% of innovations offer hygiene and health-

related solutions to help handicapped persons, fight diseases with drugs, repel vermin or to increase general hygiene, while another 5% of innovations consist of household items such as lights, clocks or fans excluding cooking utensils that classify as food preparation. Further innovations such as generators or regulators address energy needs (4%); others aim at producing, processing and colorizing cloth (2%); and some were targeted to hobby and sports-related activities (2%). A few other innovations (2%) are rather one-of-a-kind products or techniques that do not fit in any of the given categories.

In the case of approximately one-quarter of the innovations (24%), the innovators' prosocial motivation to innovate consists in either helping others or complying with an innovation impulse by someone else. Hence, 76% of the innovations originate from rather egoistic motives. Almost two-thirds (65%) of the sample's products and techniques were created from scratch versus 35%, which were modified and improved products and techniques. The four different variables forming the elements of the market recognition construct serve to examine the degree of circulation and reception of the respective innovation in the BoP market. Among the 423 innovations with full information on their degree of market recognition, 83% received an award at one of the award functions. The remaining 17% were non-awarded innovations that were included in the award profiles. Almost half of the 423 innovations (47%) were diffused to at least one other person beyond the innovator's direct social environment; almost one-third (32%) were adopted; and 20% of the innovations were commercialized.

6.1.3 Discussion of findings

The following discussion of findings aims at discovering typical characteristics of consumer innovators and their innovations at the BoP in response to Research Questions 1b and 1b. The vast majority of male innovators in the sample (95%) strongly suggest that the typical innovating BoP consumer is a male. Strong gender inequality with clear disadvantages for women exist in developing regions on a worldwide basis (United Nations 2010) and especially in India (Maps of India). Women are generally less educated and tend to be overworked by carrying out unskilled labor in the agricultural sector (cf. United Nations 2010). It is less likely that they learn how to handle tools and machines that may be required in order to manufacture technical innovations (manufacturing innovations account for almost 80% of the innovations). The lack of education and skills together with persistent traditional role models (cf. Maps of India; Banerjee, Duflo 2007) may be a driver for male dominance in consumer innovation at the BoP.

The distribution of age does not indicate any apparent linear relationship between

age and consumer innovation activity. However, the median age of the consumer innovators lies considerably above the median age in India (47 years versus 27 years) (2012 estimate of Central Intelligence Agency of the United States of America). BoP consumer innovators seem to be rather older members of the overall BoP population. Possible explanations could be in this context more life experience or more free time after having raised the children compared to younger people.

An overview of the innovators main occupations shows a typical pattern for poor populations. The major and most important source of income and employment is represented by the agricultural sector, especially in the case of the rural poor (Banerjee, Duflo 2007; Hammond et al. 2007). Other typically minor occupations are craftsmen, other self-employed and non-public occupations, daily laborers and unemployed poor and students (cf. Banerjee, Duflo 2007; United Nations Development Programme 2008; Bandyopadhyay 2007). Yet, compared to the results by the National Sample Survey Organization of the Government of India in the year 2000 (analyzed by Bandyopadhyay 2007), the relative share of craftsmen seems to be particularly high in the case of the BoP consumer innovators. Bandyopadhyay (2007) estimates that the main occupation of 12,3% of the Indian rural poor is artisan while almost three times as many (34%) of the consumer innovator sample earn their living as craftsmen. Accordingly, craftsmen seem to show a higher propensity to innovate than consumers of other professions.

Starting with the investigation of the highest completed education level, the discussion now turns to innovation-related resources. Frequency distribution of the innovators' educational attainments shows a pattern similar to age distribution. It does not necessarily suggest any obvious linear relationship between education and consumer innovation activity. However, it seems as if educated BoP consumers are more likely to innovate than illiterate BoP consumers. According to a survey from 2004 to 2005 (National Sample Survey Organization 2006) the overall illiteracy rate in India has reached approximately 25%.[37] There are only 7% of illiterate BoP consumer innovators in the sample. This share is considerably lower than the percentage for the entire Indian population, which includes the rich and well-educated Indians.

Approximately half of the innovators have technical experience and skills related to product domain and seem to apply their knowledge and skills to develop solutions to given problems. The other half of the innovations do not appear to require any prior technical experience and skills. In this context the craftsmen are an exception again.

[37] Given that the BoP typically shows the lowest education levels of a national population, I assume these 25% illiterate Indians belong to the Indian BoP.

Almost 80% of the innovating craftsmen (78%) apply their specific technical experience to the development of their innovations. The vast majority of BoP consumer innovators is a user (85%) and therefore possesses use information with regard to the application of the desired solution as well as its specific requirements. There are two potential explanations that probably coexist: 1) the development of BoP consumer innovations may require specific usage information or 2) the needs to be satisfied may be so universal and mundane that most BoP consumers would be users.

The findings on cooperation show that surprisingly almost 90% of the innovators do not collaborate with others during the development of their innovation. Despite the high degree of social cohesiveness, social dependency and joint use of community resources at the BoP (e.g. George et al. 2012; Ansari et al. 2012), the BoP consumer innovators seem to prefer innovating on their own.

Finally, the BoP consumer innovations seem to be roughly equally developed by one-time innovators solving a one-of-a-kind problem and repeated innovators with innovation experience who are familiar with addressing and solving problems and who might enjoy doing so.

The contextual factors shed light on the nature of the consumer innovation and their purposes. The overwhelming majority of innovations (79%) are manufactured goods, more specifically the development of technical products such as machinery and electrics account for almost half of all innovations. The only other significant category accounts for 13% of all innovations and consists in the breeding of economic plants, whose propagation is part of the agricultural sector. These innovations aim at fulfilling predominantly basic and essential needs of daily life. More than half of the innovations are dedicated to food production and preparation. If one adds solutions to improve and ensure water supply and hygiene and health, this covers more than two-thirds of the BoP consumer innovations. All needs except for hobby and sports and others represent an underlying desire to increase and ameliorate food provision, income and living standards.

Approximately one in four innovations originates from a prosocial motivation to help someone else. Despite the previously discussed high degree of social cohesiveness and reciprocal dependency at the BoP (e.g. George et al. 2012; Ansari et al. 2012), most consumers at the BoP develop solutions based on their individual, egoistic motives.

The innovators create the majority, more specifically two-thirds, of their innovations from scratch. This finding may be caused by the fact that the poor at the BoP hardly own existing products that qualify to be modified and improved. The resource-scarce BoP consumers probably apply a bricolage approach (Lévi-Strauss 2000; Baker,

Nelson 2005)[38] to creatively deploy and combine their few existing or available resources to create something new that satisfies a previously unmet need.

The market recognition displays the consumer innovations' success and acceptance in the market. Almost half of the consumer innovations seem to be interesting enough to diffuse in the market via the media, fairs, through adoption or commercialization. Approximately one-third of all innovations appear to be relevant and helpful to other users in the market, because they adopt or replicate these innovations.

Finally, there exists commercial market demand for one out of five innovations, more specifically consumers who are willing to buy the innovation. However, one has to keep in mind that these consumer innovations were selected in the course of award competitions. Therefore a bias might exist toward higher results in the degree of market recognition of these potentially superior consumer innovations.

6.2 Study 2: Comparison to studies in wealthy, developed markets

6.2.1 Comparative analysis of consumer innovation patterns

This section will compare the characteristics of BoP consumer innovation to findings from the wealthy, developed world. The principal reference for this purpose consists of a study on consumer innovation in the UK by Hippel et al. (2010).[39] A sample of 1.173 UK consumers was contacted by telephone between the fall of 2009 and the beginning of 2010.[40] Due to legal reasons all contacted UK consumers were 18 years or older. Based on this survey the researchers were able to collect data on 104 consumer innovation cases. In the following section UK consumer innovation findings will be compared to the equivalent BoP consumer innovation findings. For the discussion of comparative findings, I shall also draw on selected user innovation studies (Franke, Shah 2003; Hienerth et al. 2011; Lüthje 2004; von Hippel et al. 2010; Franke, Shah 2003; Franke et al. 2006).

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[38] See Section 4.2.2 for more details on the concept of bricolage.

[39] The analysis is based on the working paper version. Some selected findings have been published in *Management Science*: von Hippel et al. 2012.

[40] Please note that the UK study mostly presents its findings as percentage of the entire consumer sample including consumer innovators and non-innovators (N=1.173). For comparative purposes I shall convert all results into percentage of the consumer innovation subsample. Please note that the UK study oversamples male as well as consumers with a higher education (beyond high school).

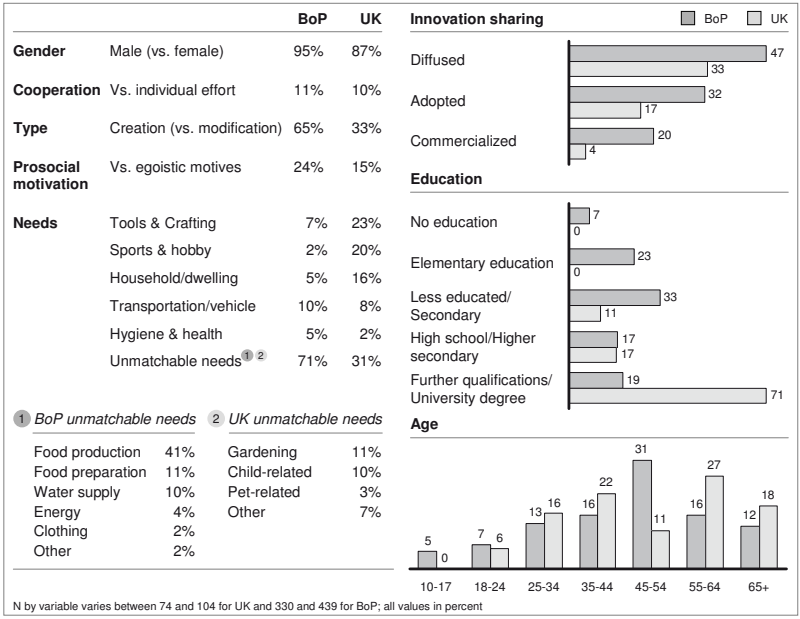

Figure 20: Comparison of BoP with UK consumer innovations patterns (cf. von Hippel et al. 2010)

Figure 20 provides an overview of the comparative analysis of BoP and wealthy, developed world consumer innovation characteristics. By contrasting the BoP consumer innovation sample with the outcome of the UK study, similar patterns as well as differences become evident. The typical innovator of both consumer populations is a male (95% at the BoP and 87% in the UK) and very rarely develops his innovation in cooperation with others (only 11% at the BoP and 10% in the UK). However, almost two-thirds (65%) of the BoP consumer innovation are new products created from scratch, whereas UK consumers focus on incremental improvements and modifications of existing products and create only 33% of their innovations from scratch. Both consumer innovators are less prosocially motivated than inspired by their own needs and egoistic motives. Yet, with a share of 24% the BoP consumer innovators are more socially motivated than their counterparts from the wealthy, developed country (15% of prosocially motivated innovations in the UK). There are a few comparable need categories that inspire both consumer innovators to innovate although to diverging extents: tools and crafting (7% at the BoP and 23% in the UK), sports and hobby (2% at the BoP and 20% in the UK), household-related (5% at the BoP and 16% in the UK), transportation- and vehicle-related (10% at the BoP and

8% in the UK) as well as hygiene and health (5% at the BoP and 2% in the UK). Among these comparable categories transportation and vehicle as well as hygiene and health-related needs are the only categories that are similar in their share of innovations. Total similar needs are of far more importance to the developed country and cover 69% of all innovations. Among the remaining 31% of consumer innovations in the UK, 11% refer to gardening, 10% to and child-related and 3% to pet-related needs. In contrast, these comparable needs play a minor role for consumer innovation at the BoP. With coverage of merely 29% of the innovations, the majority of innovations (71%) are caused by different problems. BoP consumers primarily fulfill needs with regard to food production (41%), food preparation (11%), water supply (10%), energy (4%) and clothing (2%).

Comparing the patterns of consumer innovation sharing, one can observe a higher share of diffused innovations (47% vs. 33%), adopted innovations (32% vs. 17%) and commercialized innovations (20% vs. 4%) at the BoP as opposed to the developed country. Unsurprisingly, the BoP consumer innovators are less educated than their counterparts in the UK. The majority of BoP innovators have completed some level of elementary or secondary education (56%) while the majority of UK innovators have completed further qualifications or a university degree (71%). However, the UK sample shows more consumer innovators with relatively higher educational attainments and no such patterns can be observed in the BoP sample. The distributions of innovator age display different modes for age groups with 45 to 54 years for the BoP versus 55 to 64 years in the developed country. However, both consumer innovator samples show quite comparable average ages (47 year at the BoP and 50 years in the UK).[41]

6.2.2 Discussion of findings

BoP consumer innovation patterns display similarities and differences in comparison to consumer innovation by a developed, wealthier consumer population represented by the UK sample. The major differences seem to be explainable through the discrepancy of living standards between the two populations. The distribution of innovations based on underlying needs suggests that BoP consumers are far more concerned with basic needs and serious day-to-day problems such as food production and preparation as well as water and energy supply. On the other side UK consumers appear to mostly innovate with reference to leisure activities. The needs

[41] Please note that consumer innovators under 18 years were disregarded in the UK study due to legal reasons. Given the comparative purpose calculation of the average age excludes all BoP innovators under 18 years.

and problems inspiring the typical UK consumer to innovate correspond to the top leisure activities in the UK (von Hippel et al. 2010). Thus, while UK consumers seem to be preoccupied with improving their free time, BoP consumers appear to innovate in order to address problems that are rather essential for survival.

Another discrepancy exists with regard to innovation type. UK consumer innovators focus on incremental innovation by modifying products, as opposed to BoP consumer innovators who create new solutions from scratch. A plausible explanation may be the limited resources affordable and available to the consumers of the unserved BoP (cf. Viswanathan, Sridharan 2012). Without existent products nothing can be modified or improved; rather the innovation must be created from scratch. Furthermore, solutions for the BoP require distinct functionality (Prahalad 2004) that may not exist in any products. In the UK, however, consumers possess more products or can easily buy solutions to a need. Hence UK consumers have products that roughly meet a particular need but could be improved or individualized in order to better meet that need. This finding is supported by additional examples of user innovation in developed countries. Franke and Shah (2003) analyzed user communities and discovered that one in seven user innovations is created from scratch while Lüthje (2004) found a share of 70% of modifications versus 30% of creation in sport-related product consumer innovations.

Furthermore, consumer innovations by BoP innovators seem to be shared more widely than in the developed, wealthy world. Imperfect market conditions and people's partially urgent need in particular for products to improve and ensure their living (Nakata, Weidner 2012; Viswanathan, Sridharan 2012), possibly create a more welcoming environment and higher demand for consumer innovation at the BoP. Certainly, most of the BoP consumer sample received an award, and could, therefore, be a sample of "superior" and more appealing innovations of the entire BoP consumer innovation population. However, every award competition[42] bestows nearly one hundred awards rather than honoring only a few outstanding innovations. Considering this together with the pronounced deviation in innovation sharing patterns, the difference between consumer groups is still remarkable.

Finally, it is not surprising that consumer innovators from the developed and wealthy world are better educated than their poor counterparts from a developing country, all the more because the UK study oversampled highly educated consumers. Yet, in contrast to the UK, a higher educational attainment does not seem to translate into a higher likelihood to innovate for the less educated BoP consumers.

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[42] Please see Section 5.2.2 for details on the NIF award competitions.

The similarities of consumer innovation at the BoP and by wealthy consumers of a developed country show similar preferences and demographic dispositions toward innovation activities. The results suggest that both innovator types prefer to create alone (89% of the BoP and 90% of the UK consumer innovators) and are predominantly driven by their own, egoistic motives. With 24% versus 15% of prosocially motivated innovations, BoP consumers seem to be slightly more occupied with helping others, which could be explained by the importance of social cohesion and a culture of reciprocity at the BoP (George et al. 2012; Ansari et al. 2012). However, a study by Hienerth et al. (2011) reports similar percentages (10% to 30%) for the innovation motivation to help others. This consumer innovation pattern may apply to consumer innovators in general.

The predominance of male consumer innovators seems to be a general consumer innovation pattern. Traditional role models and gender inequalities may reinforce the 95% of males in the BoP sample (cf. Section 6.1), but the vast majority of UK consumer innovators are also males (87%). The UK sample over-represented males based on prior findings, but the pattern is also supported by other studies with a preponderant proportion of male user innovators (e.g. von Hippel et al. 2010; Franke, Shah 2003; Franke et al. 2006).

Despite very different age structures with a lower median age in India of 27 years versus 40 years in the UK and a lower life expectancy of 67 years in India[43] versus 80 years in the UK (estimates for 2012 Central Intelligence Agency of the United States of America), the average age of consumer innovators in the UK and at the BoP are quite comparable (47 years for the BoP and 50 years for the UK). Middle-aged male consumers appear to show the highest propensity to innovate.

[43] Median life and life expectancy can be assumed to be less for the Indian BoP than for India in general due to lower living standards.

7 Antecedents of consumer innovation at the BoP

Beyond the inquiry of consumer innovation patterns at the BoP, this dissertation aims at investigating its antecedents. Full comprehension of the antecedents of consumer innovation involves many aspects. In this context the research questions specify the influence of innovation-related resources and contextual factors on commercial attractiveness of BoP consumer innovations (Research Questions 3 and 4, respectively). In order to address and answer these research questions in their complexity I developed hypotheses that shall be tested in the course of this chapter.[44]

Inferential statistics are applied in order to test the hypotheses. The investigation takes place in form of two separated, however interrelated, causal studies.[45] The analysis includes data only on the technical BoP consumer innovations because of their required CAT evaluation scores. Prior to presenting the actual study results, the basic principles will be explained and a justification for the choice of applied statistical methods will be given. In both cases the validity of underlying statistical assumptions will be assessed before finally discussing the findings.

7.1 Choosing appropriate statistical techniques

The choice of an appropriate statistical technique is essential for analysis and depends on the specific requirements. Major aspects to consider are how one can divide the variables into dependent and independent variables, how these variables are measured and how they are finally distributed (Hair et al. 2010). The purpose of the third study consists in the investigation of the influence of innovation-related resources on innovation quality. Innovation quality is operationalized through the two dependent variables *creativity* and *technical elaboration*. The study, therefore, splits into two separate, interconnected analyses to account for innovation *creativity* and *technical elaboration* as dependent variables respectively. The fourth study aims at analyzing the effects of contextual factors and innovation quality on market recognition. Thus, both dependent variables of the first study assume the role of an independent variable in the context of the second study. The dependent variable of the second study is *market recognition*. Figure 21 provides an overview of the hypothesized relationships that are tested in each of the two studies and their corresponding analyses.

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[44] Please see Section 4.1 for more details on the raised research questions and Section 4.2.3 for the development of hypotheses.

[45] Please see Section 5.1 for more information on the general research approach and methodology.

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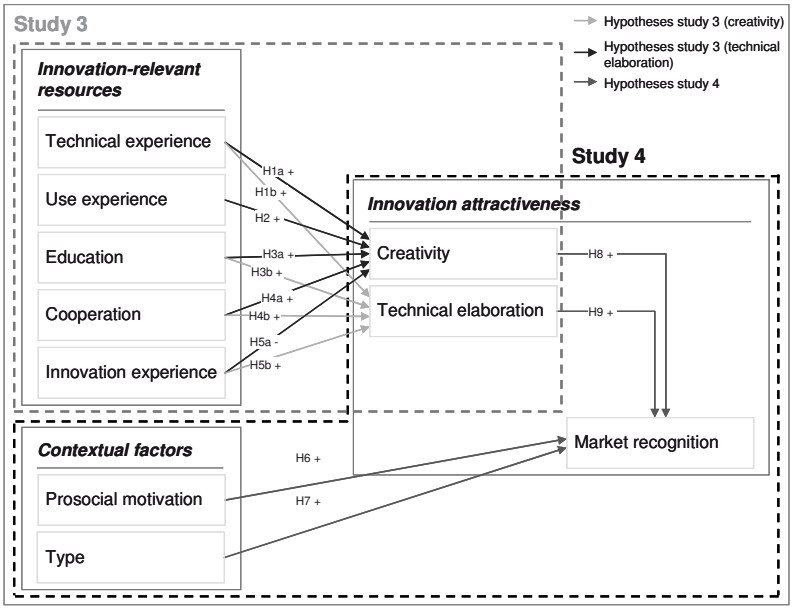

Figure 21: Scope of Study 3 and Study 4

The statistical techniques applied to both studies are multiple regression analyses. Hair (2010) recommends a multiple regression to measure and predict the response in a single metrical dependent variable caused by changes in multiple independent variables:

> "Multiple regression analysis is a statistical technique that can be used to analyze the relationship between a single dependent (criterion) variable and several independent (predictor) variables" (Hair et al. 2010, p. 158).

A multiple linear regression is the most widely used multiple regression technique (cf. Sekaran, Bougie 2010; Backhaus 2008). The dependence technique requires a single metric dependent variable normally distributed while the predictor variables may be metric, dichotomous or ordinal (Hair et al. 2010). Despite the large number of dichotomous predictor variables (see Table 3 and Figure 21), no analysis of variance (ANOVA) can be applied since the technique requires all independent variables to be categorical (cf. Hair et al. 2010). Both dependent variables of the first study, namely

creativity and *technical elaboration*, are measured via CAT and possess a metric scale. Hence, two separate multiple linear regression analyses for each dependent variable were performed respectively. Beyond presentation and discussion of results the following section on Study 3 aims at explaining and verifying important prerequisites as well as fundamental statistical assumptions.

No multiple linear regression can be applied to the fourth study because the dependent variable, more specifically *market recognition*, is measured on an ordinal scale and does not follow a normal distribution (cf. Figure 19 in Section 6.1.2). Given the limitations associated with the single dependent variable, an ordinal logistical regression was conducted.

> "Logistic regression is a specialized form of regression that is formulated to predict and explain a binary (two-group) categorical variable rather than a metrical dependent measure" (Hair et al. 2010, p. 314).

> "Regression models for ordinal response variables […] are extensions of the logistic regression model for dichotomous data" (O'Connell 2006, p. 27).

Ordinal logistical regressions have an important advantage over multi-nominal logistical regressions in that they allow one to maintain information on order and sequence of categories (Gerpott, Mahmudova 2006). The technique permits statements regarding direction and strength of the influence exercised by metrical, ordinal or categorical variables on a single ordinal dependent variable (Janssen, Laatz 2010). The following section on Study 4 (Section 7.3) presents findings of the ordinal logistical regression and provides further details on the technique and its related statistical assumptions.

7.2 Study 3: The impact of resources on innovation quality

A general lack of knowledge in research and in management exists on consumer innovation at the BoP as outlined in Section 4.1. To shed light on the phenomenon and to contribute to the identification of promising consumer innovators, Study 3 aims at investigating antecedents of consumer innovation quality at the BoP. Multiple linear regressions are applied in order to assess the impact of changes in innovation-related resources, namely *technical experience*, *use experience,*[46] *education*,

[46] There is a hypothesized relationship between *use experience* and *creativity* but not between use

cooperation and *innovation experience* on innovation quality. Two separated, however interrelated, regression analyses for both dependent variables *creativity* and *technical elaboration* respectively were conducted. Beyond *age* and *gender* as control variables, the analysis also controls for contextual factors to generate a more comprehensive model that is consistent with the overall research framework.

Study 3 starts with a verification of general prerequisites for multiple linear regressions. The subsequent testing of hypothesized relationships between independent variables and *creativity* as well as *technical elaboration* respectively is followed by a verification of underlying statistical assumptions in both cases. Finally, the findings of the two interconnected analyses are addressed in a joint discussion section.

7.2.1 Prerequisites to the multiple linear regression

First sample size and then normal distribution of variables will be examined as prerequisites for the multiple linear regressions.

1) Hair (2010) identifies sample size as "… the single most influential element under the control of the researcher in designing the analysis." Sample size for a given regression model determines its statistical power for testing significance as well as the generalizability of its results. Statistical power is best described as the probability of detecting an effect in the dataset, which depends at the same time on sample size, number of independent variables and a chosen significance level. The risk associated with a very small sample consists in not detecting an existing relationship between variables, whereas a large sample size might be oversensitive and detect nonexistent relationships (Hair et al. 2010). Considering my dataset with a size of 200 cases and 9 independent variables, the analysis design seems appropriate to detect even small R^2 values without being oversensitive.[47] With regard to the generalizability of findings, a general rule of thumb indicates a minimum ratio of at least five observations per independent variables. A desirable ratio, however, consists in 15 to 20 observations per independent variable (Hair et al. 2010). Exceeding the desired 135 to 180 observations for the 9 independent variables of this dissertation, generalizability of the outcome can be assumed.

2) Multiple linear regressions require a normal-like distribution of their metrical independent and dependent variables (Bortz, Weber 2005). Kolmogorov-Smirnov tests confirm the assumption that both dependent variables *creativity* and *technical*

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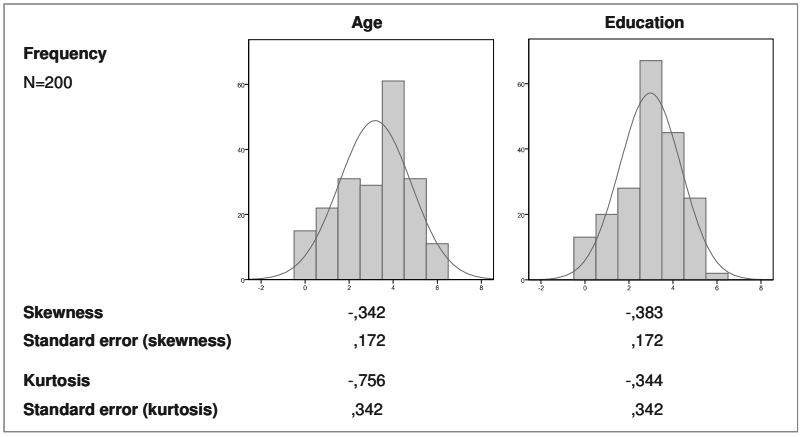
experience and technical elaboration (see Section 4.2.3).

[47] An analysis with a sample size of 250 and 10 independent variables can detect minimum R^2 values of 0,06 at a significance level (α) of 0,05 with a probability (power) of 80% (Hair et al. 2010).

elaboration are normally distributed (see Section 5.3.2.3). For most of the independent variables no investigation of distribution type is applicable given their dichotomous scale. The normal distribution of *education* and *age*, on the other hand, still needs to be investigated.



	Age	Education
Skewness	-,342	-,383
Standard error (skewness)	,172	,172
Kurtosis	-,756	-,344
Standard error (kurtosis)	,342	,342

Figure 22: Distributional information for age and education

Kolmogorov-Smirnov tests for distributions of *age* and *education* attain highly significant results (p<0,000), thus do not support the null hypothesis of normal distribution. However, D'agostino et al. (1990) classify the Kolmogorov-Smirnov test as highly conservative. An alternative approach to ensure that a distribution does not significantly differ from a normal distribution consists in the assessment of skewness and kurtosis. If a distribution's skewness and kurtosis statistic falls below 1,0, Miles and Shevlin (2001) suggest it does not deviate significantly from normality. Skewness and kurtosis values both lie considerably below 1,0 for *age* and *education* respectively. Normality is, therefore, assumed for the two variables and both are applied to the multiple linear regressions.

7.2.2 Analysis of creativity

Correlations of independent variables with *creativity* as well as among independent variables are investigated prior to the regression analysis. An investigation of correlations of independent variables with *creativity* as well as among independent variables precedes the regression analysis. Correlations may be an early sign for an independent variable's potential to explain the dependent variable. Correlations between independent variables are primarily consulted to verify underlying

assumptions. Boxplots serve as a graphical representation of the relationship between a dichotomous or categorical variable and a metrical variable (cf. Hair et al. 2010). Table 8 shows significant results for *innovation experience* and *cooperation* with *creativity*. The investigation of the corresponding boxplots (see Figure 23) supports these findings. The possession of innovation experience, more precisely conducting innovating activity repeatedly, shows a negative correlation (r=-0,215; p<0,01) with the dependent variable. *Cooperation*, specifically a joint innovation effort by more than one innovator, on the other hand is positively correlated (r=0,167; p<0,05) with *creativity*. Furthermore, *technical experience* and *creativity* show a weak positive correlation with p close to the 0,05 threshold (r=0,137; p=0,054).

	N=200	1	2	3	4	5	6	7	8
1) Creativity	Correlation Sig. (2-tailed)	1							
2) Technical exp.	Correlation Sig. (2-tailed)	,137 ,054	1						
3) Use exp.	Correlation Sig. (2-tailed)	-,037 ,599	-,197** ,005	1					
4) Education	Correlation Sig. (2-tailed)	-,048 ,501	-,235** ,001	-,037 ,599	1				
5) Cooperation	Correlation Sig. (2-tailed)	,167* ,018	-,176* ,013	-,009 ,900	-,008 ,909	1			
6) Innovation exp.	Correlation Sig. (2-tailed)	-,215** ,002	,120 ,089	-,147* ,038	-,023 ,744	-,171* ,016	1		
7) Prosocial	Correlation Sig. (2-tailed)	,103 ,147	,215** ,002	-,550** ,000	,030 ,673	,069 ,330	,039 ,581	1	
8) Type	Correlation Sig. (2-tailed)	-,004 ,953	,119 ,093	-,090 ,203	-,062 ,380	,040 ,578	-,022 ,756	,111 ,118	1

** Correlation is significant at the 0,01 level
* Correlation is significant at the 0,05 level

Table 8: Correlations for creativity and independent variables

Among the independent variables, one can observe several highly significant correlations of low to moderate strength.[48] *Technical experience* and *prosocial motivation* are correlated positively (0,215; p<0,01) while *technical experience* shows negative correlations with *use experience* (-0,197; p<0,01), *education* (-0,235; p=0,001) as well as *cooperation* (-0,17; p<0,05). Also, *use experience* correlates negatively with *innovation experience* (-0,147; p<0,05) and shows a substantial

[48] See Vaus (2002) for interpreting the strength of correlation coefficients.

negative correlation with *prosocial motivation* (-0,550; p<0,001). Finally *cooperation* and *innovation experience* correlate negatively too (-0,171; p<0,05).

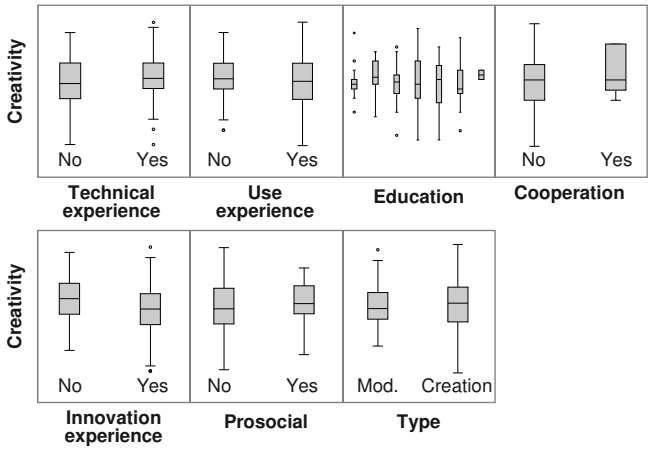


Figure 23: Boxplots for independent variables with creativity[49]

In order to analyze their relationship with *creativity*, the regression analysis includes all five independent variables with hypothesized relationships, contextual factors and two control variables. The overall model proves to be valid predicting a statistically significant share of the dependent variable's variance with p<0,01. Hence, the multiple linear regression model explains 7% of the variance of *creativity* (R^2=0,113; adjusted R^2=0,071; $F_{(9;190)}$=2,702; p=0,006).

[49] Boxplots are a graphical method to examine the relationship between a metrical and a dichotomous or ordinal variable. The boxplots above display the distribution of the metrical variable *creativity* for each value of the dichotomous variables: the lower and upper end of the box represent the 25th and 75th quartile respectively (hence the box contains 50% of the values with the median represented by the line within the box); the two lines extending from the box are called whiskers connecting the lower and larger values outside the box respectively (with a maximum distance from the box of 1,5 times the box length); finally the dots below or above the whiskers are outliers or extreme values with a distance of >1,5 times the box length (Hair et al. 2010).

		B	SE	β	t	p value
Intercept		2,684	,166		16,127	,000
Technical exp.	Technical experience (vs. none)	**,143**	**,067**	**,162**	**2,156**	**,032 ***
Use exp.	User (vs. no user)	,009	,087	,009	,103	,918
Education		-,001	,023	-,004	-,053	,957
Cooperation	Cooperation (vs. solitary effort)	**,232**	**,098**	**,175**	**2,361**	**,019 ***
Innovation exp.	Serial innovator (vs. one-time effort)	**-,211**	**,066**	**-,230**	**-3,207**	**,002 ****
Prosocial	Prosocial motivation (vs. egoistic motives)	,067	,078	,071	,854	,394
Type	Creation (vs. modification)	-,040	,071	-,040	-,569	,570
Age		,017	,021	,064	,801	,424
Gender	Female (vs. male)	-,165	,185	-,064	-,889	,375

N= 200; R^2= 11,3%; Adjusted R^2= 7,1%; * = p < 0,05 ** = p < 0,01

Table 9: Multiple linear regression model explaining creativity

Investigation of the individual regression coefficients by independent variable in Table 9 provides insights with regard to magnitude and direction of their relationships with *creativity*. Keeping all other independent variables controlled, three independent variables significantly predict *creativity*. The results suggest accepting Hypotheses 1a given that the existence of innovation-related *technical experience* results in about 0,143 points higher creativity scores than innovations generated without technical experience (B=0,143; p=0,032). Significant correlations of *cooperation* and *innovation experience* with the dependent variable already indicated their potential to predict *creativity*. Indeed, innovations developed including *cooperation* activities achieve about 0,232 points higher creativity results (B=0,232; p=0,019) than innovations by a single innovator. This regression result, therefore, supports Hypothesis 4a. *Innovation experience* results in about 0,211 points lower creativity scores than one-time innovation efforts (B=-0,211; p=0,002), which proposes in turn affirmation of Hypothesis 5a. The regression results provide no evidence to support Hypothesis 2 and Hypothesis 3a.

Relative importance of independent variables is assessed through comparison of standardized beta coefficients. Consequently *innovation experience* (β=-0,230) is identified as the variable with the highest predictive power followed by *cooperation* (β= 0,175) and finally by *technical experience* (β=0,162). (cf. Backhaus 2008).

7.2.2.1 Statistical assumptions

Several important assumptions underlie a linear regression model regarding the relationships between variables. They apply to the variate, more specifically the

combination of independent variables, individual independent variables as well as the dependent variable. In most cases one can best verify compliance with assumptions through the analysis of residuals. For this purpose the residuals are plotted versus the predicted variable and deviations of observed values from predicted values are investigated. Thus, in order to validate regression results an inspection of the residual statistics (see Figure 26) serves to examine elementary assumptions of the regression analysis (cf. Hair et al. 2010).

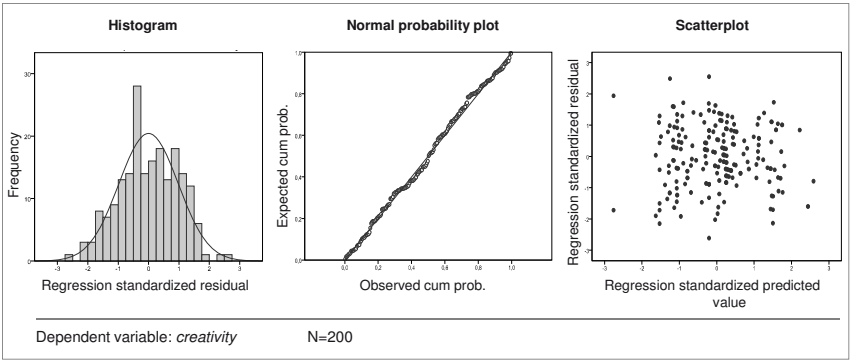


Figure 24: Analysis of standardized residuals for creativity

Linearity and homoscedasticity

A linear relationship between independent and dependent variables represents the fundamental assumption for the concepts of correlation and linear regression. This means that the beta coefficient or effect on the dependent variable caused by change in the independent variables remains the same across the entire range of values. The scatterplot of predicted values against residual values shows a typical pattern of linearity (see Figure 24, graph on the right). Furthermore, inspection of the relationship between individual independent variables and *creativity* (illustrated by boxplots on Figure 23) does also not signal any problems with non-linearity. Therefore the assumption of linearity can be confirmed (cf. Hair et al. 2010).

Homoscedasticity, on the contrary, applies directly to the residuals and signifies constant variance of error terms. The assumption implies that all independent variables produce equal effects on the dependent variable's variance level. A visual inspection of the scatterplot of predicted values against residual values allows for verification of this assumption (see Figure 24, graph on the right). Here the uniformly unshaped pattern displayed by the graph confirms the assumption of homoscedasticity (cf. Backhaus 2008).

Normality and independence of error terms

Another assumption demands normal-like distributed error terms. Normally distributed residuals are required in order to validate t-test and F-test results (cf. Backhaus 2008). One can verify this assumption in two ways: 1) A histogram (see Figure 24, graph on the left) shows the distribution of residuals resembling a normal distribution, which is supported by 2) the normal probability plot (see Figure 24, graph in the center). Residuals plotted closely follow a diagonal line that represents the normal distribution and, therefore, confirm the normal distribution of error terms (cf. Hair et al. 2010).

Independence of error terms is analyzed through visual inspection of residuals. The absence of any consistent pattern on the scatterplot of predicted values against residual values (see Figure 24, graph on the right) proves the nonexistence of another explaining factor influencing *creativity* levels.[50] Additionally the Durbin-Watson test provides arithmetical evidence for independence of error terms[51] (cf. Backhaus 2008; Hair et al. 2010; Bühl 2006).

Multicollinearity and absence of influential outliers

Correlation among two or more independent variables is called collinearity and multicollinearity respectively. If multicollinearity occurs, total explained variance of the dependent variable will be lower because the affected variables will share a certain amount of variance; thus, the ability of an overall model to explain its dependent variable decreases. Moreover estimation and assessment of regression coefficients and the unique roles of individual independent variables becomes less reliable (cf. Backhaus 2008). At first glance, the binary regression coefficients between independent variables (see Table 8) suggest the absence of problematically high correlations that usually provide a first indication of multicollinearity effects.[52] Variation inflation factors (VIF) represent a direct measure of multicollinearity. VIF is the inversed tolerance value, which itself measures "…the amount of variability of the selected independent variable *not explained by the other independent variables*" (Hair et al. 2010, p. 198). VIF values with a maximum of 1,490[53] fall considerably below the suggested cut-off threshold of 10,0 and consequently confirm the absence

[50] Typically time series or systematic differences in data collection may influence the dependent variable and cause dependence of error terms.

[51] The Durbin-Watson test generates values between 0 and 4. Values close to 2 indicate no autocorrelation thus independence of error terms. This regression model has a Durbin-Watson value of 1,779, which is close to 2 (cf. Bühl 2006).

[52] Hair et al. (2010) define correlations of 0,90 and higher as substantial. Given that the highest correlation of -0,55 between *use experience* and *prosocial motivation* falls considerably below the threshold of 0,90, I conclude the absence of high correlations.

[53] All VIF values vary between 1,043 and 1,490.

of multicollinearity effects (cf. Hair et al. 2010).

A final inquiry consists in the identification of influential outliers. Influential outliers exert a disproportionally large influence on the regression results. A cook's distance analysis provides a maximum value of 0,104 for the regression model, which is considerably below the critical threshold of 0,5 (Pardoe 2006; Cook 1977). Therefore the non-existence of excessively influential cases can be concluded.

Ultimately no violation of assumptions is detected, which, therefore, validates the results of the multiple linear regression.

7.2.3 Analysis of technical elaboration

An investigation of correlations of independent variables with *technical elaboration* as well as among independent variables precedes the regression analysis. Correlations may be an early sign for an independent variable's potential to explain the dependent variable. Correlations between independent variables are primarily consulted to verify underlying assumptions. Boxplots serve as a graphical representation of the relationship between a dichotomous or categorical variable and a metrical variable (cf. Hair et al. 2010). The overview of the correlation results (see Table 10) shows significant correlations for *technical experience* and *prosocial motivation* with *technical elaboration*. An innovator's possession of *technical experience*, more precisely work experience with the technology underlying the innovation, correlates positively ($r=0,258$; $p<0,001$) with *technical elaboration*. Furthermore, *prosocial motivation,* or the motivation to create the innovation for someone else, also shows a positive association ($r=0,152$; $p<0,05$) with *technical elaboration*. An investigation of the corresponding boxplots provides graphical support for these findings (see Figure 25).

	N=200	1	2	3	4	5	6	7	8
1) Technical elaboration	Correlation Sig. (2-tailed)	1							
2) Technical exp.	Correlation Sig. (2-tailed)	,258 ** ,000	1						
3) Education	Correlation Sig. (2-tailed)	,061 ,387	-,235 ** ,001	1					
4) Cooperation	Correlation Sig. (2-tailed)	,006 ,931	-,176 * ,013	-,008 ,909	1				
5) Innovation exp.	Correlation Sig. (2-tailed)	-,023 ,742	,120 ,089	-,023 ,744	-,171 * ,016	1			
6) Use exp.	Correlation Sig. (2-tailed)	-,126 ,075	-,197 ** ,005	-,037 ,599	-,009 ,900	-,147 * ,038	1		
7) Prosocial	Correlation Sig. (2-tailed)	,152 * ,031	,215 ** ,002	,030 ,673	,069 ,330	,039 ,581	-,550 ** ,000	1	
8) Type	Correlation Sig. (2-tailed)	-,032 ,654	,119 ,093	-,062 ,380	,040 ,578	-,022 ,756	-,090 ,203	,111 ,118	1

** Correlation is significant at the 0,01 level
* Correlation is significant at the 0,05 level

Table 10: Correlations for technical elaboration and independent variables

The independent variables included in the multiple linear regression to explore effects on *technical elaboration* are identical with the set of explaining variables for *creativity*. Correlations among independent variables have previously been investigated in Section 7.2.2. Consequently, those findings also apply to the correlation analysis displayed in Table 10.

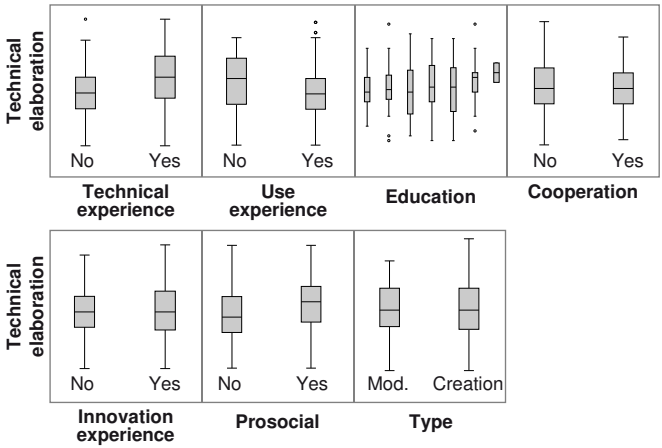


Figure 25: Boxplots for independent variables with technical elaboration[54]

In order to analyze their relationship with *technical elaboration*, all four independent variables with hypothesized relationships, the three variables without hypothesized associations and the two control variables, *age* and *gender*, are included in the regression analysis. The overall model proves to be valid predicting a statistically significant share of the dependent variable's variance with $p<0,01$. Hence, the multiple linear regression model explains 7% of the variance of *technical elaboration* ($R^2=0,109$; adjusted $R^2=0,066$; $F_{(9;190)}=2,572$; $p=0,008$).[55]

[54] Boxplots are a graphical method to examine the relationship between a metrical and a dichotomous or ordinal variable. The boxplots above display the distribution of the metrical variable *technical elaboration* for each value of the dichotomous variables: the lower and upper end of the box represent the 25th and 75th quartile respectively (hence the box contains 50% of the values with the median represented by the line within the box); the two lines extending from the box are called whiskers connecting the lower and larger values outside the box respectively (with a maximum distance from the box of 1,5 times the box length); finally the dots below or above the whiskers are outliers or extreme values with a distance of >1,5 times the box length (Hair et al. 2010).

[55] Creation of a more parsimonious model, including only the two independent variables with significant results, provides a significant model explaining 7,3% in the variance of *technical elaboration* ($R^2=0,082$; adjusted $R^2=0,073$; $p<0,001$).

		B	SE	β	t	p value
Intercept		2,385	,181		13,205	,000
Technical exp.	Technical experience (vs. none)	**,261**	**,072**	**,273**	**3,611**	**,000 ****
Education		**,043**	**,025**	**,127**	**1,762**	**,080 †**
Cooperation	Cooperation (vs. solitary effort)	,073	,107	,051	,683	,496
Innovation exp.	Serial innovator (vs. one-time effort)	-,071	,072	-,071	-,989	,324
Use exp.	User (vs. no user)	-,038	,094	-,033	-,400	,689
Prosocial	Prosocial motivation (vs. egoistic motives)	,076	,085	,075	,895	,372
Type	Creation (vs. modification)	-,078	,077	-,071	-1,017	,310
Age	Technical experience (vs. none)	,010	,023	,033	,417	,677
Gender	Female (vs. male)	-,210	,201	-,076	-1,045	,297

N= 200; R^2= 10,9%; Adjusted R^2= 6,6%; † = p < 0,10 ** = p < 0,01

Table 11: Multiple linear regression model explaining technical elaboration

The relationships on the individual variables' level with *technical elaboration* are assessed with regard to strength and direction of their association. Table 11 gives an overview of the regression coefficients by independent variable. Controlling for the effects of all other independent variables, two variables show significant associations with *technical elaboration*. An innovator who possesses *technical experience* concerning the corresponding innovation achieves about 0,261 points higher technical elaboration scores than an innovator who does not (B=0,261; p=0,000). The previous correlation analysis already provided highly significant results for the two variables. Now the regression findings support Hypothesis 1b on the predictive impact of *technical experience* on *technical elaboration*. A prior correlation analysis does not show any signs for the potential of *education* to explain the dependent variable. However, raising regression model's significance threshold to a significance level of p<0,10, *education* also shows a significant positive association with *technical elaboration*. Thus, an increase in the innovator's highest completed *education* level raises the innovation's *technical elaboration* results (B=0,043; p=0,080), which suggests confirmation of Hypothesis 3b. The regression results provide no evidence to support Hypothesis 4b and Hypothesis 5b.

A comparison of their beta coefficients allows one to derive the relative importance of these two independent variables. The standardized beta weight highlights the importance of *technical experience* (β=0,273) in contrast to *education* (β=0,127) (cf. Backhaus 2008).

7.2.3.1 Statistical assumptions

This section addresses the verification of statistical assumptions underlying the multiple linear regression for *technical elaboration*. The assumptions are assessed and verified analogue to Section 7.2.2.1, where I conduct the same assumptions and quality inspections to the analysis of *creativity*. In conformity with the previous inspection of statistical assumptions, an analysis of residuals is applied.

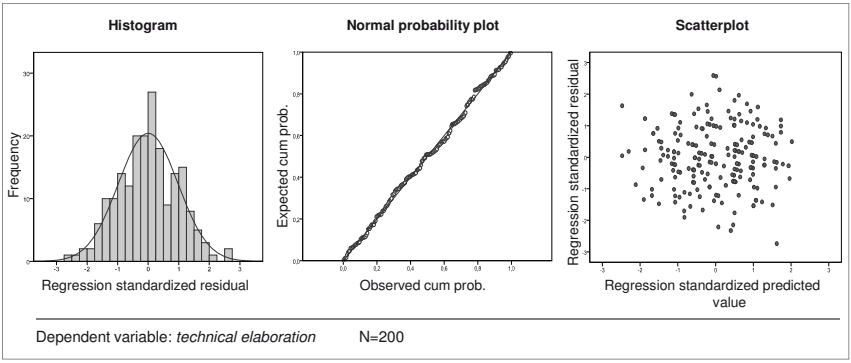


Figure 26: Analysis of standardized residuals for technical elaboration

Linearity and homoscedasticity

Linearity of the relationship between the combination of independent variables and *technical elaboration* as well as the relationship of individual independent variables and *technical elaboration* needs to be verified. A visual inspection of the scatterplot of predicted values against residual values (see Figure 26, graph on the right) confirms a linear relationship between the variate and the dependent variable due to its regular and bulky shape. Moreover, boxplots of individual variables and *technical elaboration* that are illustrated in Figure 25 do not exhibit any issues with non-linearity. Therefore one can assume linearity of relationships for the regression model (cf. Hair et al. 2010).

A uniform variance of the error terms is once more verified via inspection of the scatterplot of predicted values against residual values (see Figure 26, graph on the right). The scatterplot shows a typical pattern of constant variance and the assumption of homoscedasticity for the regression model in question can, therefore, be confirmed (cf. Backhaus 2008).

Normality and independence of error terms

The histogram of error terms in Figure 26 (graph on the left) shows a shape that approximately follows that of a normal distribution. An analysis of the normal probability plot supports this finding (see Figure 26, graph in the center). The residuals of the regression model closely follow the diagonal line of normal distribution, which ultimately confirms the normal distribution of error terms (cf. Hair et al. 2010).

The scatterplot of predicted values against residual values shows an absence of any regular and consistent pattern (see Figure 26, graph on the right). This is a clear sign for the non-existence of another hidden or underlying variable influencing the distribution of error terms of *technical elaboration*. Furthermore, the Durbin-Watson test presents arithmetical support to conclude the independence of error terms.[56] (cf. Backhaus 2008; Hair et al. 2010; Bühl 2006)

Multicollinearity and absence of influential outliers

The binary correlation coefficients in Table 10 are screened for high correlations to detect early evidence for multicollinearity problems. Similarly to the previous multiple linear regression, no alarmingly high correlations[57] can be identified among the independent variables. Additionally, inspection of VIF values finally confirms the absence of multicollinearity effects. The VIF values with a maximum of 1,490[58] are by far below the suggested cut-off threshold of 10,0 (cf. Hair et al. 2010).

Finally the regression model is examined for influential outliers. In this context the cook's distance analysis does not identify any influential cases. A maximum value of 0,074 falls considerably below the critical threshold of 0,5 (cf. Pardoe 2006; Cook 1977). Therefore, one can assume absence of overly influential outliers in the regression model.

The compliance with all relevant assumptions validates the results of the multiple linear regression for *technical elaboration*. The following section can therefore proceed to discussing the findings of both multiple linear models.

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[56] The Durbin-Watson test generates output values between 0 and 4. Values close to 2 indicate no autocorrelation thus independence of error terms. This regression model has a Durbin-Watson value of 1,779, which is close to 2 (cf. Bühl 2006).

[57] Hair et al. (2010) define correlations of 0,90 and higher as substantial. Given that the highest correlation of -0,55 between *use experience* and *prosocial motivation* falls considerably below the threshold of 0,90, I conclude absence of high correlations.

[58] All VIF values vary between 1,043 and 1,490.

7.2.4 Discussion of findings

The objective of this study is to investigate antecedents of consumer innovation at the BoP. Therefore several hypotheses regarding the influence of innovation-related resources on innovation quality have been tested in the course of comprehensive multiple linear regression models. For this purpose the study splits into two analyses for each of the two dependent variables that represent innovation quality.

Creativity

The first analysis addresses the creativity of BoP consumer innovations. Relations are established between the *technical experience* with the underlying technology, *cooperation* and *innovation experience* with *creativity*. The study provides evidence that BoP innovators apply their technical knowledge and experience to the development of their innovation. A wider repertoire of technical know-how and experience seems to provide BoP consumers with more options to apply and combine this knowledge to more creative responses. This positive association of *technical experience* on *creativity* corresponds with findings of other studies (e.g. Burroughs et al. 2008; Amabile 1983) proposing that larger stocks of concepts, knowledge and familiar domains enable individuals to augment the likelihood of creative responses.

Furthermore, I find that *cooperation* during the development of the innovation produces more creative consumer innovations at the BoP than innovations developed by a single consumer. This finding is in line with previous research predicting higher innovation quality from two or more people than from single innovators (e.g. Wuchty et al. 2007; Schettino et al. 2008). Additional individuals may contribute with their own know-how to the collective innovation-related knowledge pool that, similar to technical experience, triggers more creative responses. Also, these additional innovators allow for creativity-enhancing techniques such as brainstorming, feedback and joint problem-solving.

The last established relation is between *innovation experience* and *creativity*. While existence or augmentation of the other two innovation-relevant resources appear to increase novelty and originality of an innovation, *innovation experience* shows a decreasing effect on *creativity*. Repeated innovation activity seems to exhaust the creative combinations of the innovator's existing knowledge and idea pool (cf. Kalogerakis et al. 2010; Baldwin et al. 2006). The innovating consumer may experience a fixation on their first innovation, which prevents him to generate fresh, creative ideas (cf. Bayus 2012; Burroughs et al. 2008).

However, no evidence was found to support that the possession of direct *use experience* relates positively to the degree of *creativity*. This finding is contrary to

user innovation research suggesting that users possess superior information on consumption patterns, needs and solutions requirements putting him in the distinct position to generate, test and evaluate unique and novel solutions (e.g. Faullant et al. 2012; Lüthje 2004; Magnusson 2009; Schreier, Prügl 2008). A plausible rationale may be the poor's embedding into strong social networks at the BoP (Nakata, Weidner 2012; Viswanathan et al. 2010). This proximity allows them to derive very detailed and in-depth information on needs and use situations which substitutes for the advantage of direct information and personal experience. Furthermore, the first study shows (see Section 6.1) that BoP consumer innovations primarily satisfy basic needs. These banal, daily needs may involve more intuitive and generic use information opposed to idiosyncratic needs from e.g. kite surfing, canyoning or sailplaning (e.g. Franke, Shah 2003; Lüthje 2004).

Also, *education* does not seem to influence the level of creativity. However, research credits formal education with a fundamental role in creative performance (e.g. Amabile 1983). Other drivers such as innate abilities, training and work experience (cf. Amabile 1983; Shane 2000) could possibly be more important drivers for the cognitive skills required to recognize, structure and solve problems at the BoP.

Technical elaboration

The second analysis of this study addresses the technical elaboration of BoP consumer innovations. Based on the findings, I establish relations between the *technical experience* with the underlying technology and *education* with *technical elaboration*. The results suggest that *technical experience* not only increases *creativity* but also the *technical elaboration* of a consumer innovation at the BoP. The consumer innovator seems to apply his domain-related know-how and technical skills to the generation and realization of his innovation. Thereby the existence and applicability of technical knowledge with the underlying domain appears to be an important resource that increases the technical quality of an innovation. Similarly, user innovation research finds that available skills and knowledge regarding the respective technology domain are prerequisites for user innovations. They discriminate between innovating and passive users and increase innovation quality (e.g. von Hippel 2010; Lettl et al. 2006; Lüthje 2004; Lüthje et al. 2005; Morrison et al. 2000; Magnusson 2009).

The results provide weak evidence for the relation between *education* and *technical elaboration*. A higher level of educational attainment seems to allow consumer innovators at the BoP to develop technically superior innovations. Formal education may improve the cognitive skills and awareness of universally valid facts, paradigms and principles that can serve an individual for the technical realization of an innovation (cf. Amabile 1983). However, research in wealthy market suggests a high

relevance of education for user innovation (e.g. von Hippel et al. 2010). A possible reason for the surprisingly weak support of the relation between *education* and *technical elaboration* could be the qualitatively poor formal education at the BoP (cf. Banerjee, Duflo 2007). The poor may not necessarily learn much more through the completion of a higher education level so that an increase in formal educational has almost no impact. Also, technical training, experiences and trial-and-error efforts may overcome the shortage of familiarity with universally valid facts, paradigms and concepts.

No evidence was found to support a relation between the remaining innovation-relevant resources and *technical elaboration* respectively. While *cooperation* appears to increase an innovation's novelty and originality, it does not seem to increase its technical quality. Researchers propose that cooperation provides the innovation with additional knowledge and increases innovation quality (e.g. Schettino et al. 2008; Franke, Shah 2003). In opposition, BoP consumer innovators appear to either not use these additional resources or these additional resources may not provide any additional benefit to the technical realization.

The results also suggest that *innovation experience* is not associated with the degree of *technical elaboration*. Repeated innovation activity and its related technical experience do not seem to improve the individual's technical skills and abilities. Possibly BoP consumer innovators apply their existing technical skills in a domain they already know. They may also experience a technical fixation based on their first innovation (cf. Bayus 2012; Burroughs et al. 2008). Hence, *innovation experience* would not expand and amplify any relevant technical know-how yielding technically more elaborated innovations.

Expectedly the results do not suggest any relation between *use experience* and consumer innovations' degree of *technical elaboration*.

7.3 Study 4: The influence of innovation quality and context on market recognition

An important objective of this dissertation project lies in the investigation of the antecedent of attractive consumer innovations at the BoP. In this context the preceding Study 3 focuses on innovation relevant resources and their positive and negative effects on the quality of consumer innovations at the BoP. However, to generate insight into the attractiveness of consumer innovations the interest is not limited to quality but also includes to acceptance of consumer innovations in subsistence markets. Therefore, Study four contributes to the investigation of aspects that impact market acceptance and success of consumer innovation at the BoP. Study 4 employs a multiple ordinal logistical regression to assess the predictability of *market recognition* through the innovation quality attributes *creativity* and *technical elaboration* as well as contextual factors such as *prosocial motivation* and *innovation type*. Beyond *age* and *gender* as control variables, the analysis also controls for *use experience*. *Use experience* is the only innovation-relevant resource that is not accounted for given that no relation can be established with either *creativity* or *technical elaboration* (see Section 7.2). Hence, the variable is included in the analysis to generate a more comprehensive model consistent with the research framework.

Study 4 starts with some fundamentals on ordinal logistical regressions to explain the employed statistical technique. After the subsequent testing of hypothesized relationships between independent variables and *market recognition* a verification of underlying statistical assumptions follows. Finally, the findings are discussed.

7.3.1 Foundations of the ordinal logistical regression

The dependent variable *market recognition* is measured on an ordinal scale ranging from 0 as lowest to 4 as highest value and does not follow a normal distribution (cf. Figure 19 in Section 6.1.2). Given these limitations of the single dependent variable *market recognition,* an ordinal logistical regression to measure the impact of *creativity*, *technical elaboration*, *prosocial motivation* and *innovation type* on market recognition was conducted. The analysis requires that the independent variable be organized according to a meaningful sequence. However, distances between values are irrelevant and can vary from value to value (Gerpott, Mahmudova 2006). Due to the ordinal character and non-normal distribution of the dependent variable, no multiple linear regression can be applied (Hair et al. 2010). An important advantage of the ordinal logistical regression over the multi-nominal logistical regression consists in its ability to maintain information in order and sequence of categories

(Gerpott, Mahmudova 2006). The technique permits statements regarding direction and strength of the influence exercised by metrical, ordinal or categorical variables on a single ordinal dependent variable (Janssen, Laatz 2010).

The ordinal logistical regression assumes an underlying and latent continuous distribution that defines thresholds or points of division separating the different categories of the variable to be explained (McCullagh 1980). The probability *p* of a category is modeled as a function of the independent variables and can assume values between 0 and 1. Probabilities transformed into odds *p/(1-p)* can take any positive value. The logarithm of the odds called logit *ln[p/(1-p)]* allows it to reach values from negative to positive infinity and is symmetrical around zero for complementary events. Hence the logits possess an assumed linear relationship with a combination of independent variables. In the context of the ordinal logistic regression, alpha terms represent intercept equivalents for each category threshold. Furthermore, Beta coefficients indicate the logit increase or decrease for changes in the respective independent variable keeping all other explaining factors constant. Table 12 provides an overview of the described transformation of probabilities into the ordinal logistical regression model (cf. Bender, Grouven 1997; Gerpott, Mahmudova 2006; Norušis 2012).

Basics			
p	=	$P(Y=1)$	Probability (p) of an event Y (Y can take only two possible values 1 or 0) ranging between 0 and 1
Odds	=	$\frac{p}{(1-p)}$	Odds can reach any positive value
Logit	=	$\ln\left[\frac{p}{(1-p)}\right]$	Logits range from negative to positive infinity
Ordinal logistical regression model			
Logit (Y ≤ i)	=	$\ln\left(\frac{P(Y \le i)}{1-P(Y \le i)}\right) = \alpha_i + \beta_1 X_1 + \ldots \beta_m X_m$, i = 1,…,k	For k+1 categories of the dependent variable and m independent variables

Table 12: Foundations of the ordinal logistical regression model (cf. Bender, Grouven 1997)

The exponent of the Beta coefficient gives the odds ratio. Interpretation of the odds ratio is the best way to assess strength and direction of the influence exerted by a variable. Alpha terms, on the contrary, serve primarily to make predictions. One could use these intercepts in combination with a certain set of independent variables to predict chances of achieving a respective category (cf. Norušis 2012; Gerpott, Mahmudova 2006). The purpose of this work, however, consists in investigating the

effects of innovation quality and contextual factors on the *market recognition* of an innovation and not in accurate predictions.[59] Contrary to alpha terms that change according to the category threshold in question, an independent variable's effect on the dependent variable is consistent across all categories (cf. Bender, Grouven 1997; Allison 2009). Thus, the odds are proportional and McCullagh (1980), therefore, refers to the logistical regression model as the proportional odds model.

7.3.2 Analysis of market recognition

Prior to the ordinal logistical regression, one has to review all independent variables for meaningful reference values or categories. In the course of an ordinal logistical regression, the statistics software automatically selects the highest value of a nominal or ordinal variable as baseline. Therefore, the effect coding for some dichotomous variables was reversed in order to define their base category. Furthermore, metrical variables were transformed into standardized distributions before being entered into the analysis, which consequently allowed for setting their mean as base value (cf. Bühl 2006; Hair et al. 2010).

Before the actual analysis, I first verified separately if any of the variables could explain group differences between the five *market recognition* categories, and secondly whether they correlated with each other or the dependent variable. Correlations and prediction of group differences may be an early sign for an independent variable's potential to explain the dependent variable. Correlations between independent variables are primarily consulted to verify underlying assumptions.

1) An analysis of group differences treats all *market recognition* categories as equal groups irrespective of their order. Kruskal-Wallis tests are performed for the metrical independent variables *creativity* and *technical elaboration*. Kruskal-Wallis (1952) is a non-parametric test that investigates whether groups can be considered as parts of the same population or not. The test permits comparison of more than two groups with non-normally distributed samples and different sample sizes. Furthermore, a chi-square test was conducted for the dichotomous independent variables *use experience*, *prosocial motivation* and *type*. A chi-square test investigates if relative frequencies[60] by variable vary across groups (cf. Bortz 1999). Taken together Table 13 shows significant outcomes for four out of the five variables. Test results for

[59] I expect that other factors such as situation, infrastructure, or personality related factors may explain *market recognition* too. The analysis does not and cannot account for all potentially explaining factors. Therefore, accurate predictions do not make any sense.

[60] Indication of frequencies applies to the following categories: availability of *use experience*, occurrence of *prosocial motivation*, and modification as *innovation type*.

creativity as well as *technical elaboration* were highly significant. The results indicated that at least one of the groups must differ considerably from the remaining four *market recognition* groups by explaining variable. Moreover, analysis of relative frequencies of *use experience* and *prosocial motivation* found highly significant disparities between the *market recognition* groups.

	Market recognition (mean ranks)					Kruskal-Wallis test	
	0 (N=23)	1 (N=78)	2 (N=39)	3 (N=19)	4 (N=41)	χ^2 (4)	p value
Creativity	62,67	95,35	122,69	85,34	117,44	**21,08**	**,000 ****
Technical elaboration	63,52	95,96	118,92	89,87	117,28	**17,98**	**,001 ****
	Market recognition (frequencies in %)					Pearson χ^2 test	
	0 (N=23)	1 (N=78)	2 (N=39)	3 (N=19)	4 (N=41)	χ^2 (4)	p value
Prosocial motivation	17,4	20,5	30,8	26,3	63,4	**26,09**	**,000 ****
No use experience	17,4	10,3	20,5	21,1	53,7	**29,50**	**,000 ****
Type (modification)	21,7	23,1	33,3	26,3	19,5	2,41	,661

* = p < 0,05 ** = p < 0,01

Table 13: Group differences explained by independent variables

2) While the analysis of group differences ignores the order of *market recognition* categories, an analysis of correlations focuses on its sequences disregarding the ordinal group character of the dependent variable. Table 14 displays highly significant but moderate correlations with *market recognition* for the same four independent variables. *Creativity*, *technical elaboration* and *prosocial motivation* show a positive correlation with *market recognition*. *Use experience*, however, correlates negatively with the dependent variable. Furthermore, there are two pairs of independent variables with strong correlations. *Creativity* correlates positively with *technical elaboration,* whereas *prosocial motivation* and *use experience* show a negative correlation. Furthermore, the analysis reveals a weak correlation between *technical elaboration* and *prosocial motivation*.[61]

[61] See Vaus (2002) for interpreting the strength of correlation coefficients.

		N=200	1	2	3	4	5	6
Ordinal	**1) Market recognition**	Correlation Sig. (2-tailed)	1					
Metrical	**2) Creativity**	Correlation Sig. (2-tailed)	,236 ** ,001	1				
Metrical	**3) Technical elaboration**	Correlation Sig. (2-tailed)	,232 ** ,001	,628 ** ,000	1			
Dichotomous	**4) Use exp.**	Correlation Sig. (2-tailed)	-,311 ** ,000	-,037 ,599	-,126 ,075	1		
Dichotomous	**5) Prosocial**	Correlation Sig. (2-tailed)	,310 ** ,000	,103 ,147	,152 * ,031	-,550 ** ,000	1	
Dichotomous	**6) Type**	Correlation Sig. (2-tailed)	-,005 ,945	-,004 ,953	-,032 ,654	-,090 ,203	,111 ,118	1

** Correlation is significant at the 0,01 level
* Correlation is significant at the 0,05 level

All correlations with *market recognition*: Spearman's rank correlation
Among all other variables : Pearson product momentum correlation

Table 14: Correlations for market recognition and independent variables

Having considered group differences and correlations, I move forward to the analysis of the ordinal logistical regression model. One can appraise the quality of the overall model and its goodness-of-fit with the data in two ways. First, the likelihood method assesses whether the model predicts the level of *market recognition* better than a baseline model. The baseline model consists of predictions that are simply derived from intercepts or marginal probabilities. Table 15 shows that the overall model improves prediction ability significantly over the baseline model. The null hypothesis that both models predict equally well can be rejected on a significance level of p<0,001 (cf. Norušis 2012; Backhaus 2008). Second, Pearson and deviance statistics test how well observed values correspond with expected values. Both tests are very sensitive to large numbers of especially continuous independent variables (cf. Hair et al. 2010). The present model includes seven independent variables, three with a metrical scale. Still, neither test results reject the null hypothesis that the model fit is good (p>0,01), thus suggesting model validity and quality (cf. Norušis 2012).

Likelihood ratio test		Pearson statistics		Deviance statistics		Pseudo-R^2 statistics	
χ^2 value	39,083	χ^2 value	840,002	χ^2 value	545,888	Cox and Snell	,178
p value	,000	p value	,019	p value	1,000	Nagelkerke	,187
						McFadden	,066

Table 15: Goodness of fit criteria for ordinal logistical regression model

Pseudo-R^2 statistics determine the amount of variance that is explained by the set of independent variables. The Nagelkerke coefficient of determination indicates a variance explanation of approximately 19% (cf. Gerpott, Mahmudova 2006).

		B	SE	OR	Wald	p value
Threshold	Market recognition = 0	-1,79	,82	-	-	-
	Market recognition = 1	,51	,81	-	-	-
	Market recognition = 2	1,45	,81	-	-	-
	Market recognition = 3	2,03	,82	-	-	-
Creativity	Creativity score (standardized)	**,37**	**,17**	**1,44**	**4,64**	**,03 ***
Technical	Technical elaboration score (standardized)	,11	,17	1,11	,40	,53
Use exp.	No user (vs. user)	**1,11**	**,38**	**3,03**	**8,71**	**,00 ****
Prosocial motivation	Prosocial motivation (vs. egoistic motives)	**,76**	**,34**	**2,14**	**5,12**	**,02 ***
Type	Modification (vs. creation)	,20	,31	1,22	,43	,51
Age	Age (standardized)	,00	,14	1,00	,00	1,00
Gender	Male (vs. female)	-,02	,81	0,98	,00	,98

N= 200; Nagelkerke pseudo R^2 = 18,7%; * = p < 0,05 ** = p < 0,01

Table 16: Parameter estimates for ordinal logistical regression

The model overview in Table 16 shows parameter estimates for thresholds and factors of the ordinal logistical regression. Threshold estimates represent boundaries or cut-off points between k categories of the dependent variable. Therefore, there are always k-1 thresholds in a model. Thus, in the case of the present dissertation there are four boundaries for five *market recognition* categories. Threshold values themselves have only limited explanatory relevance and will not be analyzed individually. They are useful to predict category probabilities of a dependent variable for a given combination of explanatory factors (cf. Gerpott, Mahmudova 2006; Bühl 2006). Beta coefficients and their transformation into odds ratios by independent variable, however, are the appropriate measures to interpret the effects on the predicted variable. A positive Beta coefficient is hereby associated with an effect toward a higher category of the dependent variable. A negative coefficient, however, is associated with an effect toward a lower category. The odds ratio enables one to interpret effect size in terms of direction and strength. *Creativity* (B=0,37; odds ratio=1,44), *prosocial motivation* (B=0,76; odds ratio=2,14) and *use experience*

(B=1,11; odds ratio=3,03) all show a positive and significant association with *market recognition*. An increase by one *creativity* unit raises the odds to achieve a higher category of *market recognition* by approximately 1,5. Prior analyses of group differences and correlations already hint at the potential of *creativity* as a predictor for *market recognition*. While controlling for all other independent variables, the ordinal logistical model now suggests confirmation of Hypothesis 8. Odds ratios for dichotomous variables are interpreted against their base category. The odds for *prosocial motivation* to achieve a higher level of *market recognition* are more than twice the odds for egoistic motives. Conversely the odds of attaining a higher *market recognition* category for an egoistically motivated innovation are approximately half (odds ratio=0,47[62]) the odds for a prosocially motivated innovation. In line with previous findings on correlation and group differences, this result supports Hypothesis 6. Furthermore, the odds of achieving higher *market recognition* are more than three times more for innovating non-users than for innovations generated by consumers with *use experience*. Conversely the odds for a user to attain a higher *market recognition* category with his innovation are one-third (odds ratio=0,33) the odds for a non-user. While analyses on group differences and correlation already indicate a potential relation between these two variables, no hypothesis was developed prior to conducting the study.

The regression results provide no evidence to support Hypothesis 7 and Hypothesis 9. The odds ratios of *technical elaboration*, *innovation type* as well as the control variables *gender* and *age* are close to 1 and suggest no association with *market recognition* (cf. O'Connell 2006; Gerpott, Mahmudova 2006).

7.3.2.1 Statistical assumptions

The proportional odds model assumes the same Beta coefficients for every logit function. Thus independent variables have the same effect on the odds on every threshold. A test of parallel lines is applied to investigate this proportionality of odds. The test result exhibits significance at the 0,001 level leading us to reject the null hypothesis of proportional odds. However, Peterson and Harrell (1990) criticize the test for its anti-conservative nature as well as its lack of power. O'Connell (2006) criticizes the test of parallel lines stating that it almost always fails to accept the assumption of proportional odds. The likelihood of rejection increases if one or more

[62] As explained earlier in Section 7.3.1 logits are symmetrically around zero. The logits for two complementary events are the same logit values with a positive and negative prefix respectively, consequently the odds ratio for one event is calculated exp(logit) and exp(-logit) for a corresponding complementary event. Alternatively a complementary odds ratio can also be determined via the reciprocal odds ratio value (1/odds ratio).

of the following three conditions are met: a large number of independent variables (Brant 1990), explaining variables with metrical scales or a large sample size (Allison 2009). All three conditions apply to my analysis: 1) It includes seven independent variables; 2) Three out of the seven variables have metric scales; and 3) The sample size is 200. Considering the weaknesses of the test in general and the conditions met above, rejection of the proportional odds assumption is not surprising.

O'Connell (2006) proposes an alternative way to test for proportionality. She suggests conducting tests of parallel lines for each independent variable separately without controlling for the remaining explaining variables. Furthermore, she recommends investigating binary logistical regressions for each threshold of the ordinal model and comparing effects across models. Table 17 gives an overview of both separate tests as well as four binary logistic regression models. Three explaining variables that show significant results in Section 7.3.2. are included in the two tests respectively. Separate tests of parallel lines were performed and confirm the assumption of proportional odds for each independent variable ($p>0,01$). All binary logistical regression models show a good fit with the data indicated by statistically significant χ^2 and non-significant Hosmer and Lemeshow tests.[63] Estimated B coefficients and odds ratios for all four thresholds demonstrate stable and homogeneous values across binary logistical regressions. All coefficients show the same direction and minor variations across odds ratios. The only exception is *use experience* for the *market recognition* threshold "greater than or equal to one."

I, therefore, conclude that the overall model shows rather similar patterns across thresholds. Also the individual tests of parallel lines support proportionality of odds. Moreover, one should not be excessively severe if the objective of the ordinal logistical regression is to explain effects, and not to make exact predictions (cf. O'Connell 2006). Based on the supporting results, the assumption of proportional odds is accepted.

[63] The Hosmer and Lemeshow test investigates how well the model predicts probabilities; the null hypothesis states the difference between predicted and observed values equals zero (Backhaus 2008).

	B coefficients				Odds ratios				Test of parallel lines
N=200	= 4	≥ 3	≥ 2	≥ 1	= 4	≥ 3	≥ 2	≥ 1	p value
Intercept	-2,27	-1,41	-,44	2,10	-	-	-	-	-
Prosocial	1,08*	,73†	,62	,76	2,94	2,07	1,86	2,13	,223
User	1,30**	1,10**	1,02*	-,14	3,66	3,01	2,77	,87	,151
Creativity	,35†	,12	,43**	,75**	1,42	1,13	1,54	2,12	,063
R^2 (Nagelkerke)	24,1	15,3	16,3	13,1					
Model x^2	33,32**	22,87**	26,13**	13,86**					
Hosmer & Lemenshow test	3,22ns	6,01ns	5,17ns	10,33ns					

** Correlation is significant at the 0,01 level
* Correlation is significant at the 0,05 level
† Correlation is significant at the 0,10 level

Table 17: Results of binary regressions for each threshold

The data is dichotomized for all four thresholds of the underlying ordinal logistical regression. Four binary logistical regressions are conducted: for market recognition values of 4 vs. 3, 2, 1, 0 (=4); 4, 3 vs. 2, 1, 0 (≥3); 4, 3, 2 vs. 1, 0 (≥2) and finally 4, 3, 2, 1, vs. 0 (≥1).

There are further assumptions to consider in addition to the assumption of proportionality of odds. Linearity of logits with the combination of independent variables is assumed and multicollinearity of variables has to be investigated. O'Connell (2006) proposes to analyze linearity of logits on the basis of separate binary logistical regressions underlying the ordinal regression. The model fit analysis helps to detect nonlinearity. Given the significant χ^2 statistics and non-significant Hosmer and Lemeshow test, linearity of logits is assumed (cf. (Statistical Regression Methods in Educational research (SRME))). Absence of very strong correlations among variables in Section 7.3.2 and analysis of VIF values suggests no problems with multicollinearity[64] (cf. Section 7.2).

7.3.3 Discussion of findings

Having investigated antecedents of innovation quality in the previous study, the objective of this study is to explore what influences the degree of market acceptance or success of consumer innovations at the BoP. Therefore, several hypotheses were tested regarding the influence of innovation quality and contextual factors on *market recognition*. For this purpose a comprehensive ordinal logistical regression analysis

[64] All VIF values vary between 1,111 and 1,703 and are below the critical cutoff threshold of 10 (cf. Hair et al. 2010).

was conducted.

Based on the regression results relations were established between *prosocial motivation, creativity* and *use experience* with *market recognition*. The regression model implies that an underlying *prosocial motivation* for the generation of a consumer innovation achieves higher *market recognition* at the BoP. Consumers who develop solutions to help someone else or comply with someone's innovation request seem to create innovations that are more appealing to other consumers. *Prosocial motivation* may enable the innovator to put himself in the situation of other consumers. The innovator appears to better understand their perspectives on needs and requirements and generates innovations that are more useful to other consumers (cf. Grant, Berry 2011). Social welfare and community preferences play an important role for the poor. Hence, the prosocial context, more specifically meeting collective and social needs, is essential to achieve diffusion and adoption of innovations in subsistence markets (cf. Nakata, Weidner 2012).

The regression model assesses the impact of both innovation quality dimensions on *market recognition*. With regard to *creativity* the results suggest that more creative consumer innovations are more successful and achieve higher market acceptance. Characteristics of creative innovations are their novelty and relevance with regard to addressing unmet needs and offering new benefits (e.g. Kock et al. 2011). Above all BoP consumers appear to seek and value solutions that help them to satisfy their urgent needs. This finding is supported by previous research. According to Im et al. (2004), creative solutions are most likely to evoke positive reactions by other consumers. Kock et al. (2011) propose that new benefits increase customer value, which in turn triggers larger commercial success. New product attributes are of particular importance for the product adoption and diffusion in subsistence markets (Nakata, Weidner 2012).

However, I find that *technical elaboration* as second dimension of innovation quality is not associated with *market recognition*. The ability of an innovation to satisfy unmet and relevant needs seems to be the decisive factor even if the new product is technically imperfect. There may be minimum requirements for the technical quality of an innovation, such as basic functioning of the product, but beyond that BoP consumers do not seem to attach great importance to *technical elaboration*.

Surprisingly, a strong negative relation was found between an innovating consumer's *use experience* and the *market recognition* of the resultant innovation. An innovator who does not possess any *use experience* seems to achieve significantly higher market success with his innovations. This finding contradicts many user innovation studies suggesting that being a user is positively related to the attractiveness of an user innovation (e.g. Schreier, Prügl 2008; Franke et al. 2006). Possibly innovating

consumer users experience a fixedness regarding their habitual consumption and usage patterns.[65] This fixation may hinder users from refraining from existing usage patterns and generate solutions that are more original and better for other consumers (cf. Faullant et al. 2012; Kristensson et al. 2002). Another plausible rationale for this finding is that direct use information does not represent any innovation-related advantage at the BoP. Perhaps the focus of BoP consumer innovations on basic everyday needs and problems does not involve any specific and valuable use information. Moreover, the poor live in such close communities sharing their lives that it may be easy for them to acquire any relevant use information via observation. Considering the oppositional effects of *use experience* and *prosocial motivation* on *market recognition*, it seems that prosocially motivated innovators are able to objectively analyze needs and use information from the perspectives of other people while addressing collective needs. In contrast users appear fixed on habitual usage patterns and potential one-time problems. Therefore innovations of prosocially motivated BoP consumers may enjoy higher market recognition opposed to innovators with *use experience*.

Finally the study results provide no evidence for any predictive effect of *innovation type* on *market recognition*. The success of BoP consumer innovations does not seem to depend on whether consumers modified or created them from scratch. In contrast Prügl and Schreier (2006) imply that other consumers value innovations created from scratch more than modified products. However, BoP consumers appear to ignore *innovation type* and focus on creative solutions for their needs.

[65] A similar fixation is discussed regarding the established relation between innovation experience and creativity in Section 7.2.4.

8 Summany of findings and conclusions

In the beginning of this dissertation, questions were raised on patterns of consumer innovations at the BoP. I argue that the phenomenon adapts to the distinct living conditions at the BoP while still maintaining certain similarities with consumer innovation by wealthier consumer populations. Innovation-relevant resources as well as contextual factors influence the attractiveness of BoP consumer innovations. Before deriving final conclusions and implications, the major findings will be summarized. Finally, limitations will be discussed. The thesis closes with further research suggestions.

8.1 Summary of findings

The overarching research questions split into three different topics. Proceeding from the corresponding initial research question, major findings are presented and interpreted in the following.

Research Questions 1a/b: Characteristics of consumer innovation at the BoP

The first study starts with a call for the characterization of consumer innovations and consumer innovators at the BoP. The sample from India shows that poor mostly male consumers innovate across all occupations, education levels and age groups. Their innovations are predominantly manufactured goods such as machinery and electrics that satisfy basic needs to ensure daily survival.

Overall BoP consumers seem to apply their locally available resources to the development of innovations. According to the findings the innovator tends to be a user of his solution and, therefore, applies consumption information to the development. While an average consumer innovator equally innovates in fields where he has or does not have technical experience, craftsmen not only show a higher propensity to innovate than other occupations, but they also appear to almost always employ their existent technical skills and knowledge to the development. Most likely due to resource scarcity, BoP consumer innovations are rather created from scratch through creative recombination of existing resources.

The study suggests that the poor carry out innovation activities alone and are rarely prosocially motivated despite a high social cohesion at the BoP. However, a considerable share of consumer innovations diffuses in the market. This finding indicates that consumers are an important source of innovations for subsistence markets.

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Research Question 2: Comparison with innovating consumers of the developed, wealthy world

The second research question investigates similarities and differences between innovating consumers in developed countries and subsistence markets. In response, a comprehensive study on consumer innovation in the UK (von Hippel et al. 2010) was consulted to compare consumer innovation characteristics with the Indian BoP.

Study 2 indicates that the consumer innovator populations share certain preferences and demographic dispositions toward innovation activities. Both are predominantly male and middle-aged despite different age structures. They prefer innovating by themselves and are mainly driven by egoistic motives.

Major differences, on the contrary, seem explicable through the discrepancy of living standards and availability of resources between the two populations. The poor are far more concerned with basic needs and serious day-to-day problems such as food production and preparation or water and energy supply. UK consumers, however, mostly innovate with reference to leisure activities. In contrast to the far better educated UK innovators, a higher educational attainment does not seem to translate into a higher likelihood of innovation at the BoP. Another indication is that BoP consumers have to create innovations from scratch possibly due to the restricted availability of products to be modified. In the developed country, innovators focus on incremental innovation by modifying products to better meet their needs.

Finally the comparison suggests that consumer innovations are more widely shared in subsistence markets than in the developed, wealthy world. An insufficient supply of solutions and people's urgent need for products to improve and ensure their survival (cf. Nakata, Weidner 2012; Viswanathan, Sridharan 2012) may create a more welcoming environment and higher demand for consumer-generated innovations at the BoP. This finding highlights the relative importance of consumers as a source of innovations for subsistence markets.

Research Questions 3 and 4: Antecedents of BoP consumer innovation

The objective of Research Questions 3 and 4 is to examine antecedents of attractive consumer innovations at the BoP. Innovation-relevant resources and contextual factors are considered as influential antecedents. In order to investigate their hypothesized effects, attractiveness of BoP consumer innovations is conceptualized via 1) an innovation's creative and technical quality as well as 2) its market recognition. For this purpose, two separate but interconnected studies were conducted based on a subsample of technical consumer innovations.

Study 3 indicates that innovation-relevant resources relate to an innovation's technical elaboration and creativity. Consumers' experience with the underlying

domain and technology not only increases the innovation's level of technical elaboration, but also its degree of novelty and originality to address relevant needs. While there is no indication that education increases creativity, a higher education attainment positively relates to technical quality. Nevertheless, creativity of consumer innovation appears to be higher if innovators cooperate during the development. In contrast innovation experience gained through repeated innovation activities hinders innovators to generate creative solutions. Neither cooperation nor innovation experience affects the technical elaboration of innovations. Despite strong evidence from numerous user research projects (e.g. Faullant et al. 2012; Magnusson 2009; Schreier, Prügl 2008), the findings do not confirm a significant positive influence of use information on the quality of consumer innovations. Being a user does not relate to innovation quality.

Study 4 establishes relationships between innovation motives, creativity and use experience with market recognition. While a more creative innovation achieves higher acceptance by other consumers, its technical elaboration appears not to influence an innovation's success in the market. BoP consumers seem to demand and value creative solutions catering to their unmet needs regardless of the idea's technical realization. Furthermore, there is indication that the market prefers innovations resulting from an altruistic intention over egoistically motivated solutions. Prosocially motivated innovations seem to better address needs that are shared by other consumers as well. In this context innovation type does not seem to matter. Creations and modified products are equally well received by the market. However, use experience, which is the only innovation-related resource without impact on innovation quality, relates negatively to market recognition. The possession one's own use information does not appear to be an advantage for consumer innovation at the BoP. It rather prevents innovators from developing solutions that are useful and appealing to other consumers too.

Figure 27 provides an overview of the relationships between variables established in the course of Studies 3 and 4.

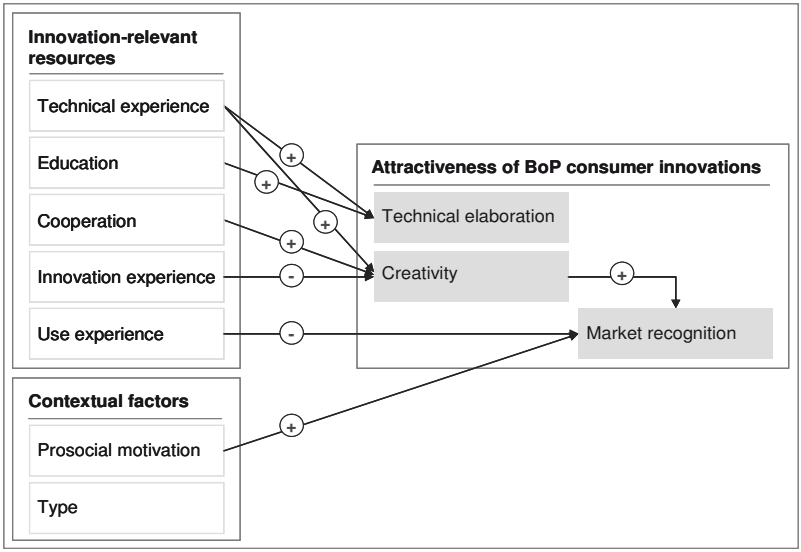

Figure 27: Research framework including established relationships

8.2 Theoretical contributions

This thesis provides insight into the consumer innovation phenomenon in subsistence, poor markets. It expands user and consumer innovation research from developed markets into a poor, subsistence context with considerably different preconditions to innovation. While the few studies that do exist are mostly anecdotal case studies (cf. Viswanathan, Sridharan 2012), the present thesis offers an empirical, quantitative approach to generate produce generalizable findings. Prior research found very similar patterns of consumer innovation across different countries (cf. von Hippel et al. 2011; Shah 2000), whereas others proposed that consumer behavior is influenced by cultural contexts (cf. Malhotra, McCort 2001). In this context a differentiated picture emerges from the findings. Accordingly, wealthier and poor consumers seem to share certain stable demographic predispositions and preferences towards consumer innovation while at the same time the phenomenon adapts to the particular living conditions including respective needs and availability of resources.

Another contribution consists in the identification of antecedents of attractive consumer innovations at the BoP. This thesis applies and adapts the componential conceptualization of creativity (Amabile 1983) to user or consumer innovations. Other researchers have previously employed an adaptation of this framework to the investigation of antecedents of lead userness (cf. Faullant et al. 2012). However, its

development and application to antecedents of quality and attractiveness of consumer innovations has not yet been undertaken. Furthermore, in this context an operationalization for attractiveness of innovations has been developed.

While the majority of similar research projects focus on either antecedents of lead userness, users' propensity to innovate or the impact on lead userness on innovation quality and attractiveness (e.g. Lilien et al. 2002), I have aimed to respond to the call for a combination of both approaches to directly identify promising consumers and preconditions (cf. Schreier, Prügl 2008). The thesis therefore specifies and identifies antecedents of innovation quality and attractiveness. Based on the suggestion that the lead user method does not fit consumer mass markets (cf. Faullant et al. 2012) especially in subsistence contexts (cf. Soukhoroukova et al. 2010), it thereby proposes an alternative approach to identify promising consumer innovators.

In respect to the social cognitive theory (Bandura 1986), this thesis depicts how both environmental as well as personal factors interact with innovative behavior. By combining it with the componential concept of creativity, I specify innovation-relevant resources and contextual factors that influence innovative behavior and how this innovation experience interacts in turn with innovation-relevant resources. Interactions and behavioral antecedents as suggested by the social cognitive theory are sharpened and adapted to fit the consumer innovation context.

The dissertation contributes to the understanding of relationships between innovation-relevant resources with the quality of BoP consumer innovations. Resources such as technical experience and education have a positive impact on the technical quality of a solution while technical experience and cooperation exert a positive influence on its creative quality. Repeated innovation activities, however, appear detrimental to creativity.

Furthermore the interplay between the quality of an innovation and its acceptance or success in the market has been explored. I have shown that subsistence consumers seek creative solutions for their predominantly basic needs while the innovation's technical elaboration does not relate to its market success.

The findings indicate that an underlying prosocial motivation to innovate has a positive impact on the market success of a BoP consumer innovation. It suggests that it causes innovators to take perspective of other consumers (cf. Grant, Berry 2011) and to develop solutions that are more useful and attractive to the entire consumer population.

Another contribution to consumer innovation research consists in the finding that being a user and thus in possession of direct use information does not alter innovation quality at the BoP in contrast to the innovator's resource endowments; in fact, it deteriorates a consumer innovation's success in the market. In a subsistence

context the needs are very basic and unlike needs typically analyzed by user innovation research in developed markets. It may not matter whether an innovator possesses direct or indirect use information, because they are less specific, more obvious and easily accessible through close social ties. However, being a user may prevent an innovator from taking perspective and catering to the needs of the general consumer population.

8.3 Managerial implications

This dissertation started with describing the need for participative innovation in order to do business at the BoP. Favorable conditions for consumer innovation in subsistence markets were identified. This innovation activity represents an opportunity of BoP consumer integration into companies' BoP business efforts. I, therefore, aimed at concluding managerial implications from the findings on consumer innovation patterns. I believe that these implications are useful for companies in several BoP business-related challenges.

Market research

Analysis of consumer innovations in subsistence markets offers highly valuable information on consumer needs, preferences and market conditions at the BoP. Organizations require in-depth knowledge on their potential customers in order to successfully serve them and satisfy their needs (cf. Homburg et al. 2009). The current research and companies' extreme knowledge paucity regarding subsistence markets and their consumers prevents them from addressing and serving the BoP (Nakata, Weidner 2012). Major reasons are that information on the BoP is very sticky (cf. von Hippel 1994), and that companies do not possess the adequate capacity to absorb, process and exploit this information. By actively reaching out to innovating consumers and their solutions, companies can immerse into consumers' lives and behavior. Consumer innovations reveal underlying needs, specific requirements, living conditions and current solutions. It makes information of the BoP more tangible and specific; thus it unsticks it.

Furthermore, a company's and its employees' absorptive capacity (Cohen, Levinthal 1990) depends on the existing stock of knowledge and experiences. The more familiarization with consumer innovations and associated market information, the greater the ability to recognize and exploit additional opportunities to conduct business at the BoP. This also holds true for research and development activities (cf. Nelson 1982). Hence, BoP consumer innovations not only provide detailed market knowledge, but familiarization with consumer innovations may be considered as a valuable approach to immerse into the BoP and to increase capabilities to gather further knowledge, to sharpen innovation focus and to cease business opportunities.

Subsistence markets only offer an unsatisfying supply of appropriate products and services to the poor. Given these imperfect market conditions, consumers step in to help themselves and thereby fill the gap in supply with their own innovations (cf. Hienerth et al. 2011). Research conducted in developed markets shows that innovating users can start entirely new industries (cf. Shah 2000). Therefore, observation and analysis of consumer innovation at the BoP may allow companies to identify underserved industries that are attractive and promising for future business activities.

New product development

Beyond general consumer knowledge, these BoP innovations also provide concrete product specifications and even new ideas. There is only limited theoretical and practical knowledge to guide product development efforts for the poor (e.g. George et al. 2012). This immersion into consumer needs, preferences and product adoption at the BoP represents a starting point for new product development for subsistence markets. The findings indicate that companies should focus on products that help the poor to fulfill basic needs. BoP consumers are demanding and willing to pay for products that help them to effectively produce and process food, especially in the agricultural sector. The poor search for solutions to secure water and power, and they need transportation-related products. Hence, companies willing to serve the BoP market should develop and offer products such as agricultural and household machinery and electronics, improved seeds, water pumps and irrigation system solutions as well as vehicle-related equipment. The consumer innovation sample also highlights the importance of taking into account common constraints such as power outages and current fluctuation that damage engines or compatibility with existing equipment, e.g. rickshaws. Moreover, research emphasizes that foreign innovations and technology have to consider and build on indigenous innovation to be successful in emerging markets (cf. Fu et al. 2010).

The findings suggest that companies' product developers should focus on creative products to address relevant needs instead of technical superiority. BoP consumers do not seem to value higher technical elaboration. By keeping solutions technically simple, the poor may more easily repair products themselves, potentially even adapting them to better meet specific conditions; local craftsmen could take over the repair business.

This thesis indicates that consumers are a valuable source of innovation in subsistence markets. Companies who are seeking opportunities to locally embed their innovation processes and business models should consider involving innovating BoP consumers. Leveraging these promising consumers and integrating them into the new product development process could be helpful in gaining knowledge and

solution requirements as well as co-creating innovations. Various possible applications allow leveraging the strengths of consumer innovators from sourcing, generation and selection ideas to testing solutions (cf. Soukhoroukova et al. 2010; Viswanathan, Sridharan 2012).

User innovation research suggests the application of the lead user method to identify the most promising consumer innovators (cf. (von Hippel 1986). Consumer mass markets (cf. Faullant et al. 2012), especially in combination with the remote and unfamiliar nature of subsistence markets, do not allow for the identification of lead users. In this context, the research results of this dissertation contribute to identifying BoP consumer innovator profiles for the purpose of co-creation. These profiles can be applied to the search of promising consumer innovators to study their solutions or to integrate them into BoP innovation activities. Companies should ideally target male, middle-aged, mostly craftsmen and farmers with some basic education who possess direct use information regarding a certain need or product category. These BoP customers seem to have a higher propensity to innovate than others and can be leveraged in order to source a large volume of ideas and innovations. For higher quality regarding the innovation attractiveness to the general consumer population, however, the focus should be different. BoP consumers with experience regarding the underlying technology, without direct use information, not carrying out innovation activities on a regular basis and willing to help others, are most likely to generate commercially attractive solutions for subsistence markets. The findings further suggest that companies should foster cooperation during innovation efforts and not be afraid to involve poorly educated BoP consumers.

Product adoption

The sample shows that consumer innovations at the BoP diffuse relatively well. Despite considerable infrastructural hurdles in subsistence markets, almost half of the innovations have diffused and approximately one-third of them have been adopted by other consumers. Given the immense problems to access BoP markets, these consumer innovators may represent a promising opportunity to distribute and promote products. Companies can study and learn from the diffusion of consumer innovations in subsistence markets or establish innovator networks that may serve as embedded ambassadors of products and services.

Corporate social responsibility

Leveraging innovating BoP consumers can be valuable regarding a company's corporate social responsibility efforts. Not only does research suggest that businesses employing social capital in subsistence markets are more successful (cf. Ansari et al. 2012; London, Hart 2004), but leveraging social capital also brings

benefits to the BoP. The poor are integrated into the formal economy; entrepreneurial behavior and innovation activities are stimulated and additional income is generated. Therefore, investments into promising innovators can be at the same time advantageous for the business and supportive to the poor. This can prove to be beneficial for a company's reputation and market positioning assuming of course respectful and fair treatment of the innovators. In most cases companies collaborate with local bases of support composed of non-governmental organizations or local governments in order to understand, relate to and address the BoP. By highlighting the value of BoP consumer innovations, these company-driven collaborations may entail policy developments or further efforts to sustainably support entrepreneurial and innovation activities among the poor.

The results suggest that companies should target the basic needs of the poor in order to do business at the BoP. Serving the BoP with affordable solutions to basic needs instead of e.g. alcohol and tobacco, can offer the BoP at the same time opportunities to increase social and economic wellbeing (cf. George et al. 2012).

8.4 Limitations and future research

This dissertation concludes with consideration of the limitations and suggestions for future research. Limitations apply primarily to the sample and the associated operationalization of variables. The sample is based on a secondary source of data (cf. Sekaran, Bougie 2010). Despite its exceptional richness of detail, the database composed out of the NIF award competitions (National Innovation Foundation) may be subject to bias. The collection of consumer innovations throughout India is influenced by the course of the exploratory journeys that cannot simultaneously and equally cover the country. Moreover the sample consists in awarded innovations and additional ones of the same innovator that were included in the award profiles. Therefore, the process underlying the choice of awardees also may exert a selection bias. Choice and operationalization of variables are subject to the richness of detail of this secondary data source. Therefore, future research should further analyze consumer innovations at the BoP by means of a direct source of data allowing for the inclusion of additional explanation variables and constructs such as personality traits.

Another limitation consists in the evaluation of the BoP consumer innovations. CAT is a valid technique for assessing creativity and technical elaboration. It yielded adequate inter-judge reliability in the course of this study. However, the judges were from different continents but no one was part of the BoP. The jury mutually agreed upon what was creative and technically elaborated to the poor. Research suggests that all people recognize creativity when they see it and refer to the same characteristics as being creative (cf. Amabile 1983); however, future research should

also consider BoP consumers themselves as raters of innovation quality.

The comparison of consumer innovations in the UK with the Indian BoP could be expanded to include more countries or population groups of different development stages. Thereby a higher number of comparable variables can be collected in a consistent manner, such as experience with underlying technology.

Suggestions for future research include the implementation of identifying promising consumer innovators at the BoP and integrating them into the new product development process. This involves the appropriate business models to effectively acquire, incentivize, retain and communicate with these consumer innovators. An additional dimension to be considered consists in the realization of co-creation activities. Possible approaches are idea generation workshops, idea competitions, joint development sessions together with engineers from developed backgrounds or provisions of funds and resources to the consumer innovators at their disposition. The success of co-created products and services in subsistence markets and their benefits for the poor should be measured in comparison to solutions that are not co-created.

The lead user method seems inappropriate for mass consumer markets in general (cf. Faullant et al. 2012), not only in a poor, resource-constraint context. I suggest applying and adapting the framework of this dissertation to account for antecedents of consumer innovation in the developed world.

Finally the findings of the present study suggest that the value of direct use information differs in function according to the distinctiveness and specificity of the associated need. Moreover, being a user seems to hinder consumer innovators from taking perspectives and developing solutions of greater societal interest. I, therefore, suggest further investigation into the relationship between specificity of the underlying need, value of direct use information, perspective taking and its impact on innovation attractiveness.

Overall this thesis contributes to the perception of the poor as an important source of innovations in subsistence markets. However, there are still many unanswered questions regarding their integration into new product development processes. Findings on patterns of consumer innovation at the BoP and its antecedents show that user and consumer-innovation research from developed markets is not entirely transferable to subsistence markets and needs to consider differences in living conditions and resource endowments.

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Appendix

Calculation of BoP population

The calculation of the world's total and relative BoP population is based on the World Bank (2012).

		Own calculations	
	World bank data	Total	Share
Total world population	6.737.384.474	6.737.384.474	100%
▪ Population above $2 a day		4.317.492.855	64,1%
▪ Population at $2 (above $1,25 a day)		1.158.195.454	17,2%
▪ Population at $1,25 a day		1.261.696.165	18,7%
Population low and middle income (LMY)	5.625.038.631		
▪ LMY Population at $1,25 a day	22,43%	1.261.696.165	
▪ LMY Population at $2 a day	43,02%	2.419.891.619	

In local purchasing power at 2005 international prices, includes 216 countries, population data from 2008

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Coding categories for profession

Based on the systematic classification of occupations codes and descriptions by the Bundesagentur für Arbeit (2010) supplemented by International Labour Organization (2008).

Codes	Translated descriptions	BoP examples	Coding category
11	Farmers and livestock farmers	Farmers (crops, cattle, bees, horses)	Farmers
21	Raw material extraction, glass and ceramic processing	Diamond processing, clay craftsman	Craftsmen
22	Plastics and wood production, processing	Rubber production, carpenter, lathe, furniture producer, painter	
23	Paper, print, technical media professions	Printer	
24	Metal production, processing, working	Jeweler, watch repair, welding, metalworker	
25	Mechanical and automotive engineering	Repair/production of agricultural implements, motors, pumps, vehicles	
26	Mechatronics, energy and electronics	Repair/sale of electronics & electrics	
28	Textile and leather related occupations	Weaver	
52[1]	Vehicle drivers (incl. transportation)	Rickshaw driver	Simple workers & unemployed
62[1]	Sales	Sales person	
N/a[1]	Elementary occupations	Day laborer	
N/a[1]	Unemployed	Unemployed, housewife	
71	Business management, organization	Local manager	Administration
73	Law and administration	Public service (government, district)	
81/2	Health professions	Alternative medicine	Education & Health
83	Education, home economy, theology	Social workers, clergy men	
84	Teachers	Teachers, scientists	
N/a	Students	Students	Students

1 Defined as elementary occupations (code 9) by the International Labour Organization's classification 2008

Coding categories for industry of origin

The industrial classification system by the United Nations (United Nations Statistics Division 2012) serves as basis for the derived industry codes. First and second order coding categories were derived depending on their occurrence in the sample.

ISIC classification		Coding categories (first & second order)	
A	**Agriculture, forestry and fishing**	**Agriculture**	
01	Crop and animal production, hunting, related service activities		
	• Growing of non-perennial, perennial crops	Crop growth	
	• Plant propagation	Plant propagation	
	• Support activities to agriculture and post-harvest crop activities	Support activities	
C	**Manufacturing**	**Manufacturing**	
16	Wood, products of wood and cork, except furniture; articles of straw, plaiting materials	Wood	
20	Chemicals and chemical products	Chemicals	
21	Basic pharmaceutical products, pharmaceutical preparations	Pharmaceuticals	
22	Rubber and plastics products	Plastics	
25	Fabricated metal products, except machinery and equipment	Metal	
26	Computer, electronic and optical products	Electronics	
27	Electrical equipment	Electrics	
28	Machinery and equipment	Machinery	
29	Motor vehicles, trailers and semi-trailers	Motor vehicles	
30	Other transport equipment	Other transportation	
32	Other manufacturing	Other manufacturing	
E	**Water supply; sewerage, waste management and remediation activities**	**Water & sewerage**	
36	Water collection, treatment and supply	Water supply	
37/38	Sewerage, waste collection, treatments, disposal activities; materials recovery	Waste management	
F	**Construction**	**Construction**	
42	Civil engineering	Civil engineering	
43	Specialized construction activities	Construction activities	
J	**Information and communication**	*Information*	**Other**
43	Computer programming, consultancy and related activities	Computer programming	
R	**Arts, entertainment and recreation**	*Arts*	
42	Creative, arts and entertainment activities	Arts	

Instruction page for CAT evaluation

Instruction page that was given and explained to the judges before carrying out the evaluation task.

Instructions for idea evaluation

Evaluation step-by-step

1) Read through the entire paper list of ideas given to you in order to get an overview of the ideas
2) Open the Excel containing the same list of ideas that you have on paper but with a web link that directs you to a detailed online idea description and picture
3) Now start analyzing each idea one by one using the online description and rate the idea:
   - on the 2 dimensions by marking the appropriate score on each of the 2 scales
   - using your own, subjective definition of "creativity" and "technical elaboration" (including further clarifications on the right)
   - relative to the other ideas, make use of the full scale for the entire set of ideas
4) In case you feel really unsecure about your rating and also about your understanding of the idea, please additionally cross the "P" (Problem)
5) All ideas separated via a dotted line (on paper) or sharing the same "Print ID" number (Excel) are described on the same webpage[1]

Information on the two dimensions

Please try to keep the two dimensions as separate from each other as possible:

1) **Creativity**
   - The degree to which the idea is creative
   - Creativity corresponds to the level of *novelty* (uniqueness and originality) and *relevance* (meaningfulness and appropriateness for the application) of a given product
2) **Technical Elaboration**
   - The degree to which the work is good technically (quality or fit of the technical solution)

Scales

- Ranging from **1 "Very low"** to **4 "Very high"**

1 In case of internet connection problems, you can find a PDF print of the idea websites labeled with the "Print ID" number in the folder I will provide you with

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Evaluation sheets for CAT

Evaluation sheets version A; the judges received these evaluation sheets in varying sequences.

	#	Idea	Short description	Creativity 1	Creativity 2	Creativity 3	Creativity 4	Techn. elaboration 1	Techn. elaboration 2	Techn. elaboration 3	Techn. elaboration 4	P
1	5	Bullet Driven Santi	New farming machine, smaller than the tillers and tractors but stronger than the bullocks, can perform all bullock agricultural activities + transportation + motorcycle, no need to feed bullock	☐	☐	☐	☐	☐	☐	☐	☐	■
2	19	Development of an environment friendly oil engine	Improved existing oil engine, less pollution (white smoke instead of black smoke) and less smell	☐	☐	☐	☐	☐	☐	☐	☐	■
3	26	Arrowroot grinding machine	Invented a low cost, easy to use, hand operated processing machine to grind (mahlen) arrowroot (Pfeilwurz, a plant)	☐	☐	☐	☐	☐	☐	☐	☐	■
4	59	Relay Switch	Integrated a relay coil (switch) in a motor that automatically stops a motor pump when too high/low electricity load appears (coil can burn) or there is no water in well/tank for water pump (pump would run without stopping, shortens life time of pump)	☐	☐	☐	☐	☐	☐	☐	☐	■
5	60	Simple coffee Pulper	Developed a Coffee berry pulper to extract coffee bean more efficiently without damaging the bean; simple and compact hand operated device, can easily be dismantled into small units, transported and reassembled in a anpother place	☐	☐	☐	☐	☐	☐	☐	☐	■
6	61	Spathe cutting instrument	Invention of low cost instrument with electric motor for cutting spathe (blütenscheide) from which black sugar is made; can be easily installed, without maintenance need. Moreover, more juice is collected in less time	☐	☐	☐	☐	☐	☐	☐	☐	■
7	67	Water Level Indicator	It can measure the depth of water level in wells, a probe (sensor) gives electrical sound when touching the water surface - wire has to be measured	☐	☐	☐	☐	☐	☐	☐	☐	■
8	68	Egg Boiler	Eggs boiler boild in steam instead of water saving both time and energy, boiler is made of plastic and has perforated bottom	☐	☐	☐	☐	☐	☐	☐	☐	■
9	75	Indigenous Gas kit for moped	Developed an indigenous gas kit icl. valve resisting potential sparks (Funken) caused by moped engine	☐	☐	☐	☐	☐	☐	☐	☐	■
10	79	Electronic circuit to prevent burning of electric pumps	Due to fluctuations in electric supply caused frequent motor burn outs and solutions in the market were not sufficient; the invented circuit provides motor protection at low cost and is specifically targeted at the motors for powering water pumps for agricultural applications. The circuit switches motor off when any of the functional parameters indicate the possibility of coil burn out	☐	☐	☐	☐	☐	☐	☐	☐	■
11	80	Electronic Robot	Build robot with 40 integrated circuits, camera, light sensors etc. guided by modified TV remote control it automatically recognises obstacles; useful as fire alarm, humidity indicator, search for mine workers etc.	☐	☐	☐	☐	☐	☐	☐	☐	■
12	81	Handy Auto Air Kick Pump for Scooter	Inexpensive device developed for inflating tyres of two-wheelers, uses the built-in kick-start mechanism of the vehicle. The compression of air obtained while cranking the cylinder of the engine is transferred to the tube with the help of this device	☐	☐	☐	☐	☐	☐	☐	☐	■
13	82	Bicycle with transmission system	The bicycle doesn't slow down after bumps as normally, it would accelerate after every bump because of its ability to convert vertical movement due to bumps into horizontal propulsion	☐	☐	☐	☐	☐	☐	☐	☐	■
14	84	Cotton Stripper Machine	Big machine that took over the formerly hard, manual task of stripping the cotton lint (Flocke) from partially opened bolls (samenkapsel)	☐	☐	☐	☐	☐	☐	☐	☐	■
15	86	Machine for threshing Coconut husk for coir industry	Cheaper and more productive machine to defiber (entfasern) coconut husk (schale) - manual work was cumbersome, damaging the fibres and giving little output; machine is run by a motor	☐	☐	☐	☐	☐	☐	☐	☐	■
16	87	Palm and Coconut Leaf Mat Weaving Machine	New machine for speedy weaving of mats from palm leaves (different designs) and can be operated by pedal or handle; increased productivity, efficiency - make more money	☐	☐	☐	☐	☐	☐	☐	☐	■
17	95	Hydro electricity Turbine	Developed small and low cost hydro power turbine (electricity through water power) to generate power to run domestic electrical appliances; in the beginning he tried power generation by supplying water from a stream to a moving turbo, then build his own turbo on a trial and error basis (problem: electricity shortage and uncertainty in Karnataka)	☐	☐	☐	☐	☐	☐	☐	☐	■
18	96	Filling filter "kittanal"	Developed a filling filter/funnel which helps to fill in plastic bags, e.g. where seedlings are raised at nureries, small polyethylene/polypropylene bags need to be filled with soil, a tedious job and the mouth of the plastic bags often closed down while these were being manually filled and the soil fell outside	☐	☐	☐	☐	☐	☐	☐	☐	■
19	96	Gum scrapper	Developed a small apparatus to scrap gum from Prosopis tree more efficiently, simpler and safer. A saucer shaped plate along with sharp blade on the top of bamboo stick or a plastic pipe, is used which prevents the gum from falling on the ground	☐	☐	☐	☐	☐	☐	☐	☐	■
20	96	Water lifting/carrying aid	Simple apparatus to ease burden of rural women carrying load on their head through two extended rods (Gestänge) supporting the circular disk that is put on the head to keep the vessel. There is no need for help from a third person for the transition. The load rests on shoulder instead of head, if needed	☐	☐	☐	☐	☐	☐	☐	☐	■

	#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
21	100	Post-Box Alarm	Simple, low cost device alarm s.o. as soon as something is dropped in a letterbox placed far away (main gate of a large farm or housing premises); a flap (ligh-spring-loaded flap at the bottom of the letter box) is deflected by the letter, this is made to send a pulse-alarm which may be a short-duration hoot (sound) or light flash, emptying the letterbox automatically resets the device; NIF found that there are already a lot of similar solutions but this one is a very simple, low cost one	☐	☐	☐	☐	☐	☐	☐	☐	■
22	101	Seed scatterer	Agricultural implement: a tinned cylindrical container is cut from the center and a rotor with metal blades is fitted to it, the rotor is attached to a motor (driven by torch battery or tape recorder). A regulator is attached to a fan and a scattering machine which controls the quantity of seed or fertilizer scattered	☐	☐	☐	☐	☐	☐	☐	☐	■
23	102	Battery operated pollution free Motor Cycle	Developed motor cycle powered by battery (due to pollution level in the city) and with increased efficiency: more aerodynamic (redesigned front, aerodynamic fiber sheet etc.), increased front wheel size etc.; in addition to normal control functions of the motorcycle a display indicating the battery consumption is attached to the motor cycle	☐	☐	☐	☐	☐	☐	☐	☐	■
24	103	Battery operated sprayer and duster	Multi purpose, light weight, low cost and flexible battery driven sprayer or duster for spraying liquids or suspension in gardens, for fumigation or for spraying on tall trees (attached to a stick); 2 types: six and twelve volt batteries	☐	☐	☐	☐	☐	☐	☐	☐	■
25	104	Bicycle weeder, tiller and harrow	Easy to operate, inexpensive multi-purpose implement,ideally suited to the needs of marginal farmers who cannot afford to maintain bullocks; the main part of the implement consists of the front portion of a bicycle, namely handlebar, front axle and the wheel, asteel fork is connected to the axle and the other end carries different kinds of attachments. Separate attachments for weeding and tilling or a harrow can be attached through bolts and nuts and adjusted to specific needs. Safety provisions are incorporated so that the blade doesn't hurt the farmer	☐	☐	☐	☐	☐	☐	☐	☐	■
26	109	Gas based water pump	Water pump to lift water through moped engine power by LPG (low cost, alternative electricity shortage/power failure)	☐	☐	☐	☐	☐	☐	☐	☐	■
27	109	Gas lamp	The gas lamp is a very simple attachment of a lamp with the gas stove during power failure it can be used simultaneously with the gas stove	☐	☐	☐	☐	☐	☐	☐	☐	■
28	109	LPG driven three-wheeler	LPG driven three-wheeler, a hybrid of a motor cycle and three wheeler; the front portion comprises the motorcycle, a chain attached to the motor cycle engine drives the two rear wheels (LPG is lower cost)	☐	☐	☐	☐	☐	☐	☐	☐	■
29	112	Mini tractor drawn ridger, weeder and sugarcane leaf mulcher	The ridger-weeder attached to a minitractor does both weeding (jäten) and earthing-up (Pflügen) in a single operation in sugarcane crop. This saves time and costs (more than 60 per cent)	☐	☐	☐	☐	☐	☐	☐	☐	■
30	119	Seed cum fertilizer drill machine	Tractor pulled seed cum fertilizer drill machine with higher capacity which drills fertilizer and seeds seperately at different depths but at the same time; comprises three main parts - box, cultivator and arm wheel; if seed and fertilizer are drilled together it is less efficient (seeds party destroyed, they need different depths) and if they are drilled seperately 2 machines and two drives are needed	☐	☐	☐	☐	☐	☐	☐	☐	■
31	120	Self-propelled weeder	Easy to handle, adjustable weeder (jäten) powered by motorbike engine (fuel), made up of used iron angle, gears, chain sprocket, clutch, tines, lever; faster and less expensive than hiring manual workers, a small sprayer pump can also be operated with this instrument	☐	☐	☐	☐	☐	☐	☐	☐	■
32	122	Boiled Tea Making Machine for Customised Taste	Tea making machine the Indian way (separately pumping in water, adding tea-leaves and sugar, heating all an then adding milk, boiling and filtering), dispensing the tea automatically into max 4 cups at the same time in pre-assigned, adjustable proportions (according to user's taste), cups are automatically pushed out on a sliding tray once the tea is ready; machine can also be run with the help of an inverter during power black-outs. This machine is easy to build and operate, and requires minimal maintenance. Before it was difficult to make tea because lighting up the stove was necessary and conventional electric heaters consume too much energy; no other tea maker offers tea the "Indian way" and offers changes of proportions according to one's taste	☐	☐	☐	☐	☐	☐	☐	☐	■
33	124	Grading Machine for Raisins	The machine for dried grapes saves time and simplifies the process by blowing away the dust, removing the twigs and grading the raisins by size. Traditionally, grading required a lot of time and energy and was done manually, there are other imported machines on the market but they are way more expensive	☐	☐	☐	☐	☐	☐	☐	☐	■
34	125	Ground Nut Digging cum Seprating Machine and Trench Digger	Unique machine that meeting the needs of the farmers and saving money, time and effort, (powered by the coupler from the tractor unit, elaborate system of crankshafts, flywheel, connecting linkages, rotating vanes on a shaft and a sieve is provided with a vibrating mechanism to filter the groundnut from the soil); Rajasthan has sandy soil and normal groundnut diggers fail on this ground - many pods remain in the ground, have to manually extracted (hard work and expensive), groundnut digging involves digging up the ground and separating the groundnut from the soil; there are others groundnut diggers but this one works with a sieve	☐	☐	☐	☐	☐	☐	☐	☐	■
35	128	Garlic Peeling Machine	Improvement of exisiting garlic peeling machine - low cost, easy to operate and maintain, lower energy requirements, higher efficiency, more automatization (less labour needed), uniform sizes	☐	☐	☐	☐	☐	☐	☐	☐	■
36	128	Lemon Cutting Machine	Improvement of exisiting lemon cutting peeling machine - low cost, easy to operate and maintain, lower energy requirements, higher efficiency (less lemon wastage), more automatization (less labour needed), uniform sizes, better hygiene (steel housing)	☐	☐	☐	☐	☐	☐	☐	☐	■
37	129	Manual Wood-Cutting Machine	Low cost and energy saving (no electricity at all) manual wood cutting machine works on the principle of inertia of motion, can be used to cut big logs as well as wood for furniture; machine out of wood, partly out of steel and RCC (two wooden columns on which steel channels are fitted, a Bed, two Fly wheels,two connecting rods made of wood, cutting blade, flexible clamp made of iron and eight Ball bearings);the inventor was unable to pay the cost of getting his wood needed for furniture done in the nearby saw-mills, also there are limited number of expensive saw mills and electrical saws are expensive	☐	☐	☐	☐	☐	☐	☐	☐	■

	#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
38	130	Matchsticks of Natural Fibre	Making matches (Streichhölzer) using some natural fibres: natural fibres bound by natural starch (Speisestärke), then coated by some natural oils, cut to required length/size and dipped into the phosphorus solution to coat the tips with the igniting material. These matches burn longer, alre cheaper and easier to produce and even waste from fiber processing industry can be used	☐	☐	☐	☐	☐	☐	☐	☐	■
39	131	Modified Fan Design Made of Bamboo	Developed a multi-bladed, double-layer fan (unique design, several blade lengths) made out of bamboo to blow air in order to separate rice and husk when the mixture falls from the rice de-husking and winnowing machine; comparative study of the performance of different fan designs indicated that the multi-bladed, twin layered bamboo fan has several advantages over conventional designs as (i) higher value of air flow rate per unit sweep area, (ii) higher value of air flow rate at comparatively lower speeds and (iii) less noise. Further, it is environment friendly and saves energy (more efficient and smaller than the others)	☐	☐	☐	☐	☐	☐	☐	☐	■
40	133	Novel Wood Screw	New screw design for wood: screw with grooves and the "working" wood can occupy this space thereby reducing the opposite force and rendering a locking mechanism at the place of the grooves; less effort to drive screw in, wood doesn't not crack while driving in, better locking mechanism or grip; L.D. College of Engineering, Ahmedabad and the results show that there is an improvement in this screw in terms of holding capacity	☐	☐	☐	☐	☐	☐	☐	☐	■
41	133	Smokeless oven	Smokeless oven through narrow neck device with inlet holes for air flow and subsequent cleaning of soot and deposits are located at the bottom and the heat is captured effectively in the belly shaped pot interior; works with locally available clay and would increase health and comfort (decrease smoke entering the eyes, pollution)	☐	☐	☐	☐	☐	☐	☐	☐	■
42	135	Scooter for the Physically Challenged	Build scooter for himself/physically handicapped person; converted two-wheeler into a four-wheeler with two old auto rickshaw wheels, picked up a fairly strong steel pipe and customizing so that he could drive the vehicle himself (dwarf, can only use 1 hand)	☐	☐	☐	☐	☐	☐	☐	☐	■
43	137	The Amphibious Bicycle	Developed a bicycle that can float on water as well as move on land (air floats and blades at the wheel) - less expensive and saves time, people in rural areas nno longer depend on the few overcrowded boats for crossing the rivers or overflooded areas	☐	☐	☐	☐	☐	☐	☐	☐	■
44	137	Mini tractor	Improved tractor: Low cost and easy to handle, dynamometer instead of battery for light, hydraulic lifting mechanism for propelling farm implements, air pressure horn - can also be used for transportation	☐	☐	☐	☐	☐	☐	☐	☐	■
45	137	Hand operated fan	Developed a manually operated fan (Ventilator) that can be used during summer heat in rural areas where power blackouts occur: rotating the hand crank-key for half a minute, fan stores energy and uses it to rotate for one hour	☐	☐	☐	☐	☐	☐	☐	☐	■
46	137	Water pump	Manually operated pump with additional flywheel which is larger than the impeller - easier to pump water (Prinzip Servolenkung, Kraftübertragung beim Getriebe) and low cost because no electricity or gas is needed	☐	☐	☐	☐	☐	☐	☐	☐	■
47	137	Spring loaded (shock absorber) bicycle	Spring-loaded bicycle is a modified bicycle with a number of springs attached to it to absorb the shocks on an uneven road - more comfortable	☐	☐	☐	☐	☐	☐	☐	☐	■
48	137	Conserved energy by pedal operation	Conventional bicycle modified: two chain drives are used instead of one; a coiled spring is tightened and stores energy in it when pedalling; after ten times of pedalling the stored energy in the coiled spring helps the cycle to move forward for about one kilometre with a speed of 20 km/hr - higher speed and less effort to drive the bicycle	☐	☐	☐	☐	☐	☐	☐	☐	■
49	137	Mini turbine	Easy to handle and low cost mini turbine to generate electricity through water current via a generator to light up to 2 light bulbs	☐	☐	☐	☐	☐	☐	☐	☐	■
50	141	Dual purpose Rotary Huller	Easy to handle rotary huller can be used to hull (schälen) small quantities of different items simultaneously, uses the principle of the inherent gravitational force of falling bodies (plunger/Kolben in cylinders) to do the hulling, and can be operated manually or with electricity (small motor), contrary to other hilling machines no almost no heat occurs so that plant, herbs etc. don't loose their falvor and form; device costs one third of the cost of the nearest comparable mechanical huller available in the market	☐	☐	☐	☐	☐	☐	☐	☐	■
51	141	Improved LPG Gas Conversion kit for automobiles	Safe, simple, and inexpensive LPG conversion kit for automobiles providing multistage pressurized fuel flow and rich, lean fuel air mixture to the carburetor with a single LPG cylinder. Result: improved fuel efficiency, mileage (Benzinverbrauch), many cities are now switching to LPG powered vehicles	☐	☐	☐	☐	☐	☐	☐	☐	■
52	141	Cell phone charger	Charger for cell phones that uses the dynamo/ battery of the two-wheeler while the vehicle is running	☐	☐	☐	☐	☐	☐	☐	☐	■
53	141	Coconut dehusker - drive mechanism	Redesign of coconut dehusking machine with an improved a drive mechanism (Antriebsmechanismus) that facilitates uniform peeling speed without stopping the motor, he also introduced single feeding of coconuts from the top of the machine which makes the dehusking job easy	☐	☐	☐	☐	☐	☐	☐	☐	■
54	141	Coconut dehusker - knife	Redesign of coconut dehusking machine with improved knife: with the old knife the same operation was carried out by hand thus disturbing the production speed, by adding this knife, a totally automated mode of production is possible	☐	☐	☐	☐	☐	☐	☐	☐	■
55	143	Wood Based Low Cost Environment Friendly Crematorium	New crematorium concept/technique: formerly the open wooden crematorium is expensive, requires a lot of resources (wood) and takes long - the new hybrid crematiroium (open and electric) generates higher temperatures and burns faster, uses less wood and is less polluting	☐	☐	☐	☐	☐	☐	☐	☐	■
56	144	Zero Head Hydro Turbine	Very low cost (5 times less) water turbine that is portable and doesn't need a dam - efficiency higher than 50%, for rural india where electricity is scarce	☐	☐	☐	☐	☐	☐	☐	☐	■
57	146	Innovative Technique to Transmit Music in Buildings	Developed a technique to transmit audio signals from one room (with a tape recorder) to another (with a speaker) via an adopter through which the neutral line and earth line of a general electrical system are used to transmit audio signals within the house; new low cost solution to related issues in communication technology	☐	☐	☐	☐	☐	☐	☐	☐	■
58	147	Kerosene and Steam Heated Stove	Hybrid stove especially the poor who are the major consumers of kerosene; the stove is powered by kerosene and steam, two conventional stoves are joined with two tanks (one kerosene and one water tank) both connected to one burner and three regulators; it is low cost stove and lower kerosene consumption, less smoke (less kerosene is burnt)	☐	☐	☐	☐	☐	☐	☐	☐	■

	#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
59	148	Modified stick for the visually challenged	Developed a blindman's stick with new functionalities based on sensors and reflectors: signals on obstacles in different directions around him through the headphone, moisture sensing electrodes sense the moist soil or stagnant water, micro-switches, to detect manholes, an anti-theft alarm	☐	☐	☐	☐	☐	☐	☐	☐	■
60	149	Washing Cum Exercise Machine	Washing machine - powered by man power through pedalling (like a bicycle or exercycle), very low cost and portable machine especially for the poor rural people who can't afford an electric machine and don't have constant power supply, it is faster and more efficient than manual washing	☐	☐	☐	☐	☐	☐	☐	☐	■
61	151	Auto Compression Sprayer	An new auto sprayer for spraying pesticides which eliminates the tiresome, repetitive manual pumping action by using normal body movement of walking as energy input to move dead weight, which in turn drives a piston that generates enough pressure for spraying, sprayer is mounted on the back of the user, when the user walks jerks (movements) are transmitted to a dead weight, which rests on the spring	☐	☐	☐	☐	☐	☐	☐	☐	■
62	151	Solar water heater	Developed a solar powered water heater in different capacities (50, 100, 200 and 500 litres)	☐	☐	☐	☐	☐	☐	☐	☐	■
63	152	Automatic engine stopper for Two Wheelers	Auto-engine stopper for 2 and 4 wheelers which stops the vehicle engine automatically within 25 to 30 seconds as the ignition is cut-off, e.g. at traffic lights; it consists of an electronics timer, a relay and a neutral indicator switch, attachment of this element in two wheelers saves fuel and reduces pollution	☐	☐	☐	☐	☐	☐	☐	☐	■
64	153	Automatic Motor Winding Machine	Cost- effective multi-purpose and precise electronic motor coil (Draht- Magnetspule) winding machine (other machines are far more expensive and it is hard manual work) that can be used for a wide range of winding applications (ransformers, fans, coolers, pumps, grinders etc.); burning-out of the coil is very common in rural India and semi-urban areas due to erratic power supply and fluctuating voltage, Coil making is an arduous and time taking process, the machine has potential to free thousands of child labourers who do this work in almost every motor winding workshop	☐	☐	☐	☐	☐	☐	☐	☐	■
65	154	Bamboo Splints Making Device for Incense Sticks	Inexpensive, portable, easy to operate machine to cut bamboo for incense sticks (Räucherstäbchen), for remote areas (manually operated, no electricity needed), varying thickness can be obtained, four times faster and higher quality manually with a knife; other machines are either too big and expensive or are not working propperly and need precut bamboo	☐	☐	☐	☐	☐	☐	☐	☐	■
66	155	Bicycle Mounted Sprayer	Portable spraying system for pesticides is an assembly of a modified sprocket-pump assembly, tank and the adjustable, flexible sprayer boom can be mounted on any bicycle available in the market; energy from pulling the bike is transfered to the spraying pump - saves energy, painful process of spraying manually (very tiresome work, pumping by hand), saves time and is less expensive than other machines ir devices that are mounted on jeeps	☐	☐	☐	☐	☐	☐	☐	☐	■
67	155	A seed-cum fertiliser dibbler	Device enabling more efficient, faster and cheaper sowing, helpful in both sowing the seeds and fertilisation of the crops which require fertilisers to be impregnated in the ground, near their roots, Wastage of seeds and fertilisers is prevented. Due to uniform sowing the germination percentage is also increased	☐	☐	☐	☐	☐	☐	☐	☐	■
68	156	Black Pepper thresher	Low cost, easy to handle machine to thresh pepper (either through little use of electricity or manually operated), more efficient (less pepper destroyed) and faster than with conventional thresher, by changing the blade it can also be used for paddy, less expensive than other machines in the market	☐	☐	☐	☐	☐	☐	☐	☐	■
69	160	Cycle Operated Horse Shaver	Bicycle -powered horse shaver (detachable, portable) in which the power of the bicycle rotary drive is transferred via speed cable to the clippers to cut the hair on horses, camels, dogs and with some modifications on sheep; efficient device (half of the time needed for manual cutting), better quality than manual cutting, less expensive than other electric/motor powered shear units and doesn't need electricity	☐	☐	☐	☐	☐	☐	☐	☐	■
70	161	Cycle operated water-lifting pump	Bicycle-powered water pump, low cost and relying on human power	☐	☐	☐	☐	☐	☐	☐	☐	■
71	161	Flour mill	Manual flour mill operated through cycle pedal rotation, efficient and grinds one kilogram of grains into powder in approximately five-six minutes	☐	☐	☐	☐	☐	☐	☐	☐	■
72	162	Double Acting Reciprocating Pump	Unlike the single acting reciprocating pump, both strokes of this pump are effective in this pump and no idle strokes (leerhub) occurs. It gives continuous water supply with no fluctuation in discharge and is run by electricity or diesel engine	☐	☐	☐	☐	☐	☐	☐	☐	■
73	163	Dual purpose Sickles	Developed 3 multi-purpose, specialized sickles (Sichel) (perform different functions of harvesting, interculturing and weeding),they provide ease of handling and maintenance to the farmer and labourer, less quickly battered (old, overused) than conventional ones	☐	☐	☐	☐	☐	☐	☐	☐	■
74	164	Eco-friendly Non-return valve for Two-Wheeler Engines	Developed the non return valve which is fitted between the air filter and the carburetor (petrol engine)/intake manifold (diesel engine) ensuring fuller combustion of the air-fuel mixture and reduces the release of un-burnt fuel (less fuel consumption, less pollution and less "bumpy" driving)	☐	☐	☐	☐	☐	☐	☐	☐	■
75	165	Foot Operated Roof Tile Making Machine	Manual/pedal operated tile (dachziegel) making machine based on the principle of mechanical vibrations, Tiles are for building roofs and made out of mixture of cement and river sand/stone sand. A vibrating platform with polythene sheet is moved with the help of a cycle wheel, powered by pedaling; the mixture is spread over the sheet and stirred over the vibrating platform till air bubbles booze out. Benefits; faster, better quality of tile, different designs possible - other machines available on the market are way to expensive for normal people	☐	☐	☐	☐	☐	☐	☐	☐	■
76	166	Fuel efficient two-in-one stove	Modified oven design to save fuel/wood and prevent wastage of heat: the wood fired stove cooks and heats water at the same time - energy efficient utilization of burnt wooden fuel-stock	☐	☐	☐	☐	☐	☐	☐	☐	■
77	167	Hand driven sprayer	Sprayer for pesticides: Two-wheeled wagon made out of 2 bicycle wheels etc. is pulled and through the motion of the wheels, a small wheel at the middle is rotated. This rotation transfers energy to the pump piston and generates pressure, then liquid is sprayed through the nozzles fitted on the spray boom (adjustable) - no electricity/fuel is needed and makes spraying work easier	☐	☐	☐	☐	☐	☐	☐	☐	■

	#	Idea	Short description	Creativity				Techn. elaboration				P
				1	2	3	4	1	2	3	4	
78	168	Hand pump with attachment for giving water to animals	Cost-effective modification in the chamber of hand water pumps: whenever one operates the hand pump to take out water, a portion (25%) of water flows to water tanks connected for stray animals - no extra need for monitring water level for animals etc.	☐	☐	☐	☐	☐	☐	☐	☐	■
79	169	Improved Fodder cutter	Improved, more efficient and safer fodder machine (Trockenfutter): in existing machines the blade has to be sharpened after 1 hour and the fodder has to be carefully fed in small bundles,if too much quantity fodder can be ejected or machine stalls - necessary manual correction could injure the hand. In this modified machine bundles are simply placed on the feeding platform (no manual feeding). the blades don't require frequent sharpening	☐	☐	☐	☐	☐	☐	☐	☐	■
80	170	Improved Stove with Kerosene heating	Modified, more efficient, less noisy stove which doesn't require pumping (pumping is work, this is the main advantage and goal of this invention): the kerosene storage tank is placed above the burner-stove stand height to facilitate the flow of fuel without pumping and a bent copper pipe attachment is placed around the burner which is connected to the fuel cylinder - automatic flow of kerosene, a valve helps to regulate it	☐	☐	☐	☐	☐	☐	☐	☐	■
81	172	Magnetic Shock Absorber	Developed new shock absorber type for cars, 2-wheelers etc. (due to an accident caused by a broken shock absorber): works with two repulsing magnets in a rod (straight cylindrical rod which can be used as axle), one magnet is attached at the bottom of the rod and is the base magnet; reduces problems faced in the spring shock absorbers due to friction and other factors	☐	☐	☐	☐	☐	☐	☐	☐	■
82	173	Modified Design for Air Blowers	New design for blowers/fans out of plastic (extrudes ABS plastic and make fins out of it for the blower himself): cheaper, less noise and vibration, more strengths through better aerodynamic profile and longer life because aluminium fins use to react and corrode	☐	☐	☐	☐	☐	☐	☐	☐	■
83	174	Modified Stove with Kerosene Heating	More efficent, improved stove based on the principle of kerosene atomization: pre-heating of kerosene thereby converting it into gas which is burnt and results into a higher kerosene combustion, 25% less kerosene consumption and burns with a blue flame thus eliminating smoke, in addition no soot (Russ) deposits on the bottom of the cooking vessel	☐	☐	☐	☐	☐	☐	☐	☐	■
84	175	Motorcycle sprayer	Sprayer unit that can be mounted on a motorcycle, sprays with adjustable height and width of spraying boom - it is faster than the conventional method with backpack, helps with the labour scarcity and usually the farmer owns a motorcycle	☐	☐	☐	☐	☐	☐	☐	☐	■
85	176	Multi - Purpose Sprayer and Tiller	Multi-purpose mini tractor for small farmers wo can't afford tractor and want to overcome labour shortage & bullock difficulties: engine and gearbox is installed on a self-fabricated chassis having a four-wheel base, it has a spraying system and small farm implements can be attached (plough, cultivator, shallow and blade harrow and seed cum fertilizer drill for normal agricultural operations like shallow ploughing, inter-culturing and sowing)	☐	☐	☐	☐	☐	☐	☐	☐	■
86	177	Multi purpose bicycle	Redesigned bike with assortment of functionalities (mobile workstation on the bike: drilling unit (for wood, metal), a grinder for sharpening tools, a motor winding attachment and a wood sawing unit with a lock and lever) while reducing the weight and improving the basic function	☐	☐	☐	☐	☐	☐	☐	☐	■
87	179	New Valve for modified two stroke engine	New valve for 2-stroke engines that decreases the possibility of petrol mixture leakage. Due to controlled emission of smoke, atmospheric pollution is reduced and the engine has better fuel efficiency as the wastage of petrol is minimised	☐	☐	☐	☐	☐	☐	☐	☐	■
88	182	Pump less stove with Kerosene Heating	Improved stove which burns with a blue flame (less blackening of vessels) - less expensive than LPGs and less kerosene consumption than conventional ones, safer due to constant pressure, less noisy, only one initial pumping here compared to repeated pumping for the conventional ones	☐	☐	☐	☐	☐	☐	☐	☐	■
89	183	Reciprocating hydraulic prime mover for water lifting	Water pump that works according to the principle of gravity, weight of water in stream (even small streams) and doesn't require any engine or electricity	☐	☐	☐	☐	☐	☐	☐	☐	■
90	185	Seed cum fertilizer drill machine	Multi-utility bullock driven agricultural equipment which is flexible, adjustable and can be used as a seed-drill-cum fertilizer dispersant as well as for ploughing, inter-cropping, weeding and leveling the land - more efficient, easier than just manual or bullock work, affordable for rural people (versus expensive tractors)	☐	☐	☐	☐	☐	☐	☐	☐	■
91	186	Silk Worm Rearing Tray	Optimized the size, material, weight and arrangement of silk worm rearing trays - increased cocoon capacity, easier to desinfect, clean	☐	☐	☐	☐	☐	☐	☐	☐	■
92	186	Hand weeder	Hand weeder which is more efficient than the conventional implements used for weeding, can be operated while standing, requires less time and less labour and the physical strain caused is comparatively less	☐	☐	☐	☐	☐	☐	☐	☐	■
93	187	Small diesel engine for motorbike	Developed a small and light weight diesel engine that can be used for 2-wheelers or various other applications such as pumps, mini-flour mills, lawn mowers, motorboats, small elevators, portable power generation sets etc	☐	☐	☐	☐	☐	☐	☐	☐	■
94	189	Tricycle Mounted Sprayer	Tricycle that is used to spray pesticides, operated through pedaling - easier and healthier (less contact with pesticides)	☐	☐	☐	☐	☐	☐	☐	☐	■
95	191	Uzi fly trap	Low cost fly trap killing the flies which menace and destroy silk worms	☐	☐	☐	☐	☐	☐	☐	☐	■
96	192	Walking Stick for the Elderly	Walking stick for elderly people especially enabling them to walk at night: stick made out of of PVC pipe with a switch at the upper end of the stick to turn the light source on and off (illuminating light source, battery driven)	☐	☐	☐	☐	☐	☐	☐	☐	■
97	193	Water lifting vane pump- the 'HYDRO-GEN'	Low cost water pump, it captures kinetic energy/water velocity of a water flow (no electricity, fuel is needed) and transmits it to the main shaft which is coupled to the pump	☐	☐	☐	☐	☐	☐	☐	☐	■

#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
98	194 Pedal Operated Pump	Portable pedal water pump which is particularly useful for pumping water from the canal for irrigation purposes and to draw water from wells, tube wells and reservoirs (high volume pump, 100 liters of continuous flow per minute here compared to 70-80 liters per minute of intermittent, stroke-by-stroke flow with a normal reciprocating hand pump)	☐	☐	☐	☐	☐	☐	☐	☐	■
99	196 Shivraj Multipurpose Equipment	Lightweight multipurpose tool frame drawn by paired bullocks up to six agricultural operations, different accessories can be attached to it for operations like shallow ploughing, interculturing, weeding, sowing, residue collection, groundnut, digging and soyabean harvesting. With modifications, it can also be used for spraying - solves these problems: labour scarcity and hard work operations	☐	☐	☐	☐	☐	☐	☐	☐	■
100	197 Motek Treadle Press: rejuvenating old letter printing press	Low cost, user friendly upgrade for most traditional priniting machines which use treadle (Tretmaschine) press and are unable to deliver today's quality output standards	☐	☐	☐	☐	☐	☐	☐	☐	■
101	198 Phone operated switch	Mobile phone operated switch is an instrument with an attached mobile phone and modified circuit, which can switch a device on and off and can also be used as a conduit to know the status of a remote operating device - useful for farmers who have to walk long distance at night to switch on/off or check their water pumps	☐	☐	☐	☐	☐	☐	☐	☐	■
102	199 Dual Security Alarm	Low cost alarm system for contruction/production sites, new: current product uses transformers and simple electronic devices, ability to control "one to one" and "one to many" emergency communication built in for signaling from substation to main station etc., current product uses transformers and simple electronic devices which makes it simpler and cheaper as other available systems using GSM etc.	☐	☐	☐	☐	☐	☐	☐	☐	■
103	200 Automatic Saree Border Weft Insertion	Developed a loom (Webstuhl) that does a special, complicated "contrast" weaving automatically which was only manually possible before	☐	☐	☐	☐	☐	☐	☐	☐	■
104	201 Conversion of plain power looms into continuous weft feeding looms	Normal low cost looms (Webstühle) can be improved to automotically insert new yarn (no stopping), more colours, more fabrics are possible, saves times, space (otherwise other looms were necessary), better quality (less stopping) - for small weavers with normal looms	☐	☐	☐	☐	☐	☐	☐	☐	■
105	203 Retrofitted car for physically challenged	The innovation is a modification kit that can be fitted to cars for physically handicapped people (lower limbs) With the retrofitting brake, accelerator and clutch controls can be actuated with a single hand. This fitment can be retrofitted in any vehicle with a power brake	☐	☐	☐	☐	☐	☐	☐	☐	■
106	204 Power Tiller Operated Stubble Shaver	Power tiller (little machine with diesel engine) operated sugarcane stubble shaver, unique cutting mechanism enables fine and closer depth of stubble cutting, can also be used for weeding and intercultural separation in sugar cane cultivation. This attachment can be fitted to all kinds of power tillers	☐	☐	☐	☐	☐	☐	☐	☐	■
107	204 Tractor Operated Stubble Shaver	Tractor operated sugarcane stubble shaver (run by diesel engine), unique cutting mechanism enables fine and closer depth of stubble cutting, This attachment can be fitted to a tractor	☐	☐	☐	☐	☐	☐	☐	☐	■
108	204 Sugarcane Trash Grinder	Sugar cane trash grinder with safe feeding chute can handle both dry and fresh sugarcane trash, is useful for compost preparation and to prepare cattle feed as well. It is mounted over a trolley with wheels therefore portable/movable - natural, conventional compostation takes very long, problem with a lot of sugar cane trash	☐	☐	☐	☐	☐	☐	☐	☐	■
109	209 Water Walking Shoes	Large specially designed shoes to walk over water filled with thermocol, fitted to each foot and oars (Ruder) filled with thermocol to walk on water using buoyancy principles. Use of lightweight thermocol gives the desired buoyancy (Auftrieb)	☐	☐	☐	☐	☐	☐	☐	☐	■
110	209 Amphibious cycle	Developed a water cycle with large empty cans on both sides of the bike	☐	☐	☐	☐	☐	☐	☐	☐	■
111	214 Five Wheeled Car	Designed a simple car with a fifth wheel in the centre on the rear axle, power from the engine is directly transferred to the fifth central wheel while other four wheels are free, this reduces power loss and eliminates the differential on driving axle; chassis made out of nickel pipes, scooter wheels, moped engine, simple steering gear	☐	☐	☐	☐	☐	☐	☐	☐	■
112	215 Speed Control device	Developed a low cost speed governor, which restricts the speed of a vehicle to a predefined maximum limit by restricting fuel supply - microprocessor based system, greater precision and reliability than mechanical motor or actuator units fitted in conventional alternatives	☐	☐	☐	☐	☐	☐	☐	☐	■
113	216 Solar laminator	Laminating machine runs on solar energy (box with a mirror system), gives almost the same output as that of an electricity-operated laminator when the sun is shining. Machine can also be used as a conventional electrical lamination machine by switching on the bulbs fitted inside - lamination is used to protect important documents over time	☐	☐	☐	☐	☐	☐	☐	☐	■
114	217 A Multipurpose crutch for physically Challenged people	A crutch (Krücke) for handycaped or physically challenged people that has a foldable seat, a headlight (battery), an alarm and even an umbrella holder-cum-stand	☐	☐	☐	☐	☐	☐	☐	☐	■
115	218 Vermi compost pellet making machine	Manually operated machine to produce compost/fertilizer pellets - vermin-compost is used as organic fertilizer and there are very few machines available in rural areas to manufacture compost in the easy-to-use pellet form	☐	☐	☐	☐	☐	☐	☐	☐	■
116	219 Umbrella that cools in hot summer	Modified an umbrella to cool during intense heat: umbrella is made of different layers, upper made of white cloth, middle of sponge, below a layer of black cloth. A water sprayer is attached to the handle of the umbrella, which also houses a thermometer, when it is hot, water can be sprayed into the sponge and creates cold air due to condensation	☐	☐	☐	☐	☐	☐	☐	☐	■
117	220 Intelligent letterbox	Designed a letterbox with an indicator that lights up when a letter is in the box, "red light" flashes when the letterbox is empty and the "green light" flashes when the letter is dropped inside, actuating the plate and subsequently the whole electronic circuit - for people in a high building, alarm of alternativess would disturb others	☐	☐	☐	☐	☐	☐	☐	☐	■

#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
118	221 An improved system for saving water	Modification in the tradition water pumping system, doesn't require constant monitoring and thus saves time, labour and fuel to operate the pump: a flag shows when the water level is down and the engine is automatically switched off - before someone/children has to constantly monitor the pump, often located far from the house - the engine would break if pump is operated without water	☐	☐	☐	☐	☐	☐	☐	☐	■
119	224 Motorized Thread Winder for Kite Fliers	Battery operated/automatic string winder for kite flying that can be used to roll up thread on to the reel, central chassis made of wood or plastic (electrically nonconductive) housing the gears, spooling unit, electric motor and batteries along with an operating push button switch on one side of the main operating handle - simple, fast device which protects the string and the hands of the person	☐	☐	☐	☐	☐	☐	☐	☐	■
120	225 Side-stand gear lock system	Side-stand gear lock system to prevent accidents when two wheeler sidestands are not pushed back - simple, low cost, retrofitted clamp	☐	☐	☐	☐	☐	☐	☐	☐	■
121	226 Two-wheeler based mobile spray painting device	Painting device that can be easily mounted on a two-wheeler scooter and carried to a customer's place, deriving power from the two-wheeler's engine to run the compressor (used to paint vehicles, compressed air is needed) - flexibility for painter, no need to buy extra, expensive compressor and replaces the missing electricity	☐	☐	☐	☐	☐	☐	☐	☐	■
122	227 Windmill operated tube well	Simple windmill out of bamboo and tin sheets as low-cost alternative to pump water in the fields for the winter crops - environmentally friendly, simple, low cost	☐	☐	☐	☐	☐	☐	☐	☐	■
123	228 Low speed Wind operated Power Generator	Power generator operated through wind energy to overcome electricity shortage and costs, also works on very low wind speeds and gives a constant output despite variable wind speed (thanks to dynamic system with centrifugal action)	☐	☐	☐	☐	☐	☐	☐	☐	■
124	229 "Chalakh" Mango Nipper (greifer)	Efficient, lightweight device to harvest mangoes without damage (Greifer, Stange mit Netz am Ende), Bamboo handle, metal ring with 2 blades to cut fruit from tree - faster harvesting with less damage to the fruit, also other fruits such as sapota, lemon, guava and orange	☐	☐	☐	☐	☐	☐	☐	☐	■
125	230 Modified Wood Stove	Multipurpose, modified wood stove with two burners at different elevations that can efficiently run using both, wood and coal as fuel - better efficiency/use of heat, less smoke, faster, saves fuel etc.	☐	☐	☐	☐	☐	☐	☐	☐	■
126	230 Innovative windmill	Windmill, which included weight balancing gearbox system, designed to pump water out of the well at a rate of 2000-2200 litres/hour	☐	☐	☐	☐	☐	☐	☐	☐	■
127	231 Multi-purpose sugarcane based farm machinery	Implement that can be attached to a tractor and can perform multiple tasks related to sugarcane cultivation (like bund forming, seed sowing, manure application and harvesting) - saves time, labour and money	☐	☐	☐	☐	☐	☐	☐	☐	■
128	231 Electricity from sea waves	Machine to generate electricity from sea waves based on the principle of air compression, the force of sea wavesis used to move a turbine and to generate electricity to light up four bulbs of 100 watts each	☐	☐	☐	☐	☐	☐	☐	☐	■
129	231 Water clock	Clock working via drops of water, the second's hand moves forward when a drop of water from a timed dispenser falls down	☐	☐	☐	☐	☐	☐	☐	☐	■
130	231 Milking machine	A foot-operated milking machine using a suction pump	☐	☐	☐	☐	☐	☐	☐	☐	■
131	232 Hand operated water lifting device	Simple, portable hand operated water-lifting device for marginal farmers, which is capable of giving high discharge, low cost compared to conventional hand pumps, manual bucket pump, and bicycle operated pumps	☐	☐	☐	☐	☐	☐	☐	☐	■
132	232 Self-opening irrigation device	Self-operating irrigation pipe device to open and close canal pathways in the field according to the water level	☐	☐	☐	☐	☐	☐	☐	☐	■
133	233 Low cost Centrifugal Sprayer	Centrifugal sprayer where liquid from a tank falls on a fast rotating fan resulting in a misty spray: user operates handle up and down, reciprocating motion of lever is converted into rotary motion of the fan, chemicals flow from the tank to the top portion of the fan with the help of stopper valve, the fan breaks the droplets into fine mist due to its centrifugal force - no battery needed (caused problems), low cost alternative	☐	☐	☐	☐	☐	☐	☐	☐	■
134	234 Herbal Bulletproof Jacket	Bulletproof jacket out of herbs, which is much lighter when compared to the conventional available materials	☐	☐	☐	☐	☐	☐	☐	☐	■
135	240 'Chandrike' cocoon stand	Simple, environment friendly cocoon stand (for silk worms) using mulberry sticks, is a cheap and useful alternative to conventional plastic cocoon stands (more expensive, can transmit desease to next season)	☐	☐	☐	☐	☐	☐	☐	☐	■
136	243 Suraksha Tong	New tong (Zange, Halter) design to lift heavy, hot vessels of various vessel types and diameters comfortably (in the kitchen and elsewhere) - consists in 1 steel shaft with 2 steel grips (plastic sleeve attached to springloaded steel shaft combinations)	☐	☐	☐	☐	☐	☐	☐	☐	■
137	244 Vatsal tong	New tong design enabling secure gripping action by 2 spring loaded wire clamps on either side of the vessel, grips are insulated - easy and safe way to lift hot vessels	☐	☐	☐	☐	☐	☐	☐	☐	■
138	247 Onion Transplanter	The onion transplanter is a tractor drawn semi-automatic unit, it can perform three functions at a time: transplanting the onion, applying the fertilizer and making the irrigation channels	☐	☐	☐	☐	☐	☐	☐	☐	■
139	247 Drill	Improved, lighter bullock operated seed drill, it is an automatic model with a dedicated orifice type metering system and 4 furrow openers	☐	☐	☐	☐	☐	☐	☐	☐	■
140	247 Water pump controller	Automatic, very simple water pump controller based on the principle of float which can automatically switch on/off a pump	☐	☐	☐	☐	☐	☐	☐	☐	■
141	247 Biogas stove	Improved biogas stove, having a new nozzle design fabricated in copper instead of CI and fitted with a modified burner, manages to separate hydrogen sulphide and moisture from the gas. It is claimed to have increased efficiency by over 50 per cent	☐	☐	☐	☐	☐	☐	☐	☐	■

#		Idea	Short description	Creativity				Techn. elaboration				P
				1	2	3	4	1	2	3	4	
142	248	Pomegranate de-seeder	Pomegranate (Granatapfel) De-seeder: separates the outer cover and thin inner membrane without damaging the seeds	☐	☐	☐	☐	☐	☐	☐	☐	■
143	248	Arecanut peeler	Annoyed by the injuries caused while peeling the areca nuts manually, he developed an areca nut peeling machine with a capacity of peeling 100-120 nuts per minute	☐	☐	☐	☐	☐	☐	☐	☐	■
144	248	Cassava peeler	Portable electric machine that can peel/process up to five kg of cassava (Maniok) per minute	☐	☐	☐	☐	☐	☐	☐	☐	■
145	248	Bamboo splitting machine	Bamboo processing by hand is a time consuming and difficult process.This assembly of machines that can perform operations like splitting long lengths of bamboo, sizing, surface finishing, polishing etc.	☐	☐	☐	☐	☐	☐	☐	☐	■
146	249	A farm implement without a steering wheel and others	Low cost, lever operated farm machine capable of doing most agricultural operations, 360 degree rotating technology. One problem associated with conventional tractors is soil compaction due to their heavy weight, this machine prevents soil compaction due to its light weight	☐	☐	☐	☐	☐	☐	☐	☐	■
147	249	Four-in-one machine	Four-in-one machine: contains a generator, water lifting pump, a flour mill and an iron cutting machine	☐	☐	☐	☐	☐	☐	☐	☐	■
148	249	Simple seed sowing rolling device	Cylindrical PVC tube with perforations at equal distance, seeds are put inside the tube, an iron spike wheel is put on both sides of the cylinder sealed from both ends; using a U shaped rod, the device is rolled on the field and seeds fall on the ground through the perforations	☐	☐	☐	☐	☐	☐	☐	☐	■
149	249	Long lasting bulbs	Modified bulb via a small inteserted circuit which lengthens the bulb lifetime, not for inhouse use due to light quivering (flackern)	☐	☐	☐	☐	☐	☐	☐	☐	■
150	249	Motorcycle Plough	Multipurpose tool bar for agricultural operations using a Suzuki with two smaller wheels were put besides the motorcycle to balance the vehicle in the field	☐	☐	☐	☐	☐	☐	☐	☐	■
151	249	Electricity Tester	Detecting electricity, the tester shows light and also gives a mild alarm, very useful for detecting breakage of concealed wires	☐	☐	☐	☐	☐	☐	☐	☐	■
152	251	Gravity operated cycle	Bicycle that uses the repeated downward movement of the rider on a spring-loaded seat. This would charge a spring that would release the energy and make the cycle move without much pedaling. The rider on the cycle appears like galloping on a horse	☐	☐	☐	☐	☐	☐	☐	☐	■
153	251	TRYGO X, a three wheeler	Developed a small vehicle that could smartly zip in and weave through the city traffic. TRYGO X can sharply turn and park perpendicular to the curb and can travel at 60 km/hr	☐	☐	☐	☐	☐	☐	☐	☐	■
154	251	Hybrid car	New concept hybrid car without gears that runs on solar power as well as on fuel, engine is powered by a battery; The battery charger is hybrid, during daytime the battery can be charged through solar power and at night/emergencies by fuel	☐	☐	☐	☐	☐	☐	☐	☐	■
155	251	Compressed air car	Car with integrated motorcycles and Maruti car engines, runs with compressed air, maximum speed of 120 km/h	☐	☐	☐	☐	☐	☐	☐	☐	■
156	252	Biomass based gasifier	Developed an efficient biomass gasifier where he has changed the conventional design (filters, cooling unit) to get clean gas, ensuring smooth operation of engine at low operational cost - pump sets in remote fields, lift water in homes, operate basic machines such as saw mills, flour mills and generate electricity by charging the alternator	☐	☐	☐	☐	☐	☐	☐	☐	■
157	253	Generator accessory for cleaner exhaust	Low cost pollution/noise control device for engine generators: precipitates the particles of the gases, lowers their temperature and also reduces (dämpfen) the noise considerably - it is a cylindrical drum placed between generator and exhaust pipe, exhaust gases strike against the array of protruding fins and perforated tubes continuously, the vortex (Wirbel) results in the dissociation of CO and CO2 into carbon particulates and oxygen; silencer by internally canceling out sound waves as they pass through a series of concentric channels	☐	☐	☐	☐	☐	☐	☐	☐	■
158	254	Earthen kitchen products - fridge	Small refrigerator made of clay (Ton) for storing vegetables, fruits, milk and water, does not need any external source of energy for the cooling effect, natural cooling process inside the refrigerator can keep vegetables and fruits fresh for around six to seven days, while milk can be preserved for three days	☐	☐	☐	☐	☐	☐	☐	☐	■
159	254	Earthen kitchen products - non-stick clay tava	Low cost alternative for teflon coated tava (Pfanne): earthen griddle with a non-stick coating, preserves natural taste of food cooked, lon lasting coating, better energy efficiency - also developed other earthen products for daily use in the kitchen (hot plates, cooker, etc.)	☐	☐	☐	☐	☐	☐	☐	☐	■
160	255	Laxmi Asu Making Machine	Device to mechanize the process of hand winding of yarn which is required in the traditional silk saree production and relieve women, who generally do this task, from the drudgery involved; time to finish one sari has reduced from 4 hours to 1,5 hour	☐	☐	☐	☐	☐	☐	☐	☐	■
161	257	Multipurpose twin chambered cooking vessel	Improved, safer cylindircal cooking vessel (out of stainless steel, with two compartments and a lid fitted with two pressure valves) that facilitates quick and effective cooking of various items simultaneously, provides filtering the residual water safely while keeping it separately for consumption/resuse - especially for low income families with only 1 single vessel	☐	☐	☐	☐	☐	☐	☐	☐	■
162	257	Revolving ceiling fan	Ceiling fan mounted on a circular ceiling rail so that it can be manually moved to obtain proper air flow in different parts of the room	☐	☐	☐	☐	☐	☐	☐	☐	■
163	257	Dual face table fan	Improvement of existing table fan: extended shaft to the other side and fitted another set of fan blades (air in both directions)	☐	☐	☐	☐	☐	☐	☐	☐	■
164	257	Letter box alarm	Alarm to alert the presence of letter in the box (an electronic circuit, a letter receiving plate, which senses the letter inside and triggers the circuit to produce an alarm) also has a locking system and twin LED	☐	☐	☐	☐	☐	☐	☐	☐	■

#	Idea	Short description	Creativity				Techn. elaboration				P
			1	2	3	4	1	2	3	4	
165	258 Automatic pump operator	System for automatic control of the water pumps for domestic and industrial use, the pump switches on automatically as soon as the overhead tank goes below the threshold level and switches off when full, prevents engine damages because pump is only working if there is water in reservoir as well	☐	☐	☐	☐	☐	☐	☐	☐	■
166	258 Innovative dryer	Simple dehydrator for fruits and vegetables with an efficient mechanism - advantages: machine is run by a single-phase power and therefore any domestic line can be used, consumes less energy, faster and more uniform drying process	☐	☐	☐	☐	☐	☐	☐	☐	■
167	258 Incense Sticks Making Machine	Manual incense stick making machine. device with two blade arrangements, one for making small bamboo splints and for making small sticks - contrary to manual or other machines it can use both green and dry bamboo, superior quality of dhoop, bamboo wastage is very minimal	☐	☐	☐	☐	☐	☐	☐	☐	■
168	259 Electric shock proof converter	Innovative device, which converts all electrical lines to shock-free power lines - if accidentally someone touches these lines, electricity circuit becomes open through the relay - then also the person does not feel any shock	☐	☐	☐	☐	☐	☐	☐	☐	■
169	260 Pressure cooker coffee maker	Modified ordinary cooker to a low cost espresso/cappuccino coffee making machine: it boils water and generate steam, through a long delivery pipe with regulator, high pressure steam is used to make frothy, tasty coffee - normal coffee machine is too expensive, especially interesting for little tea stall and stands	☐	☐	☐	☐	☐	☐	☐	☐	■
170	265 Bamboo processing machine (Arulepsa)	One bamboo processing machinery that facilitates seamless removal of knots, planing, polishing and carving of bamboo instead of several machines as usually. Precision in work is achieved by deploying the dedicated control center and a user friendly four way joystick - the bamboo dust is used for other materials, e.g. mixed with resins to build a turbine	☐	☐	☐	☐	☐	☐	☐	☐	■
171	268 Picture tube charger	Simple, low cost device, which can charge the picture tube of a black and white television, when the display becomes unclear and snow	☐	☐	☐	☐	☐	☐	☐	☐	■
172	268 Rat trap	Machine to capture rats: bread is kept between a plate and the flap, when the rat pulls the bread, the metallic flap falls on the plate, the circuit is completed resulting in an alarm and closing the trap	☐	☐	☐	☐	☐	☐	☐	☐	■
173	268 Magnetic balance	Magnetic balance working according to the principle of repulsion of the like magnetic poles: two concentric cylindrical pipes of different diameters, inner pipe with bowl is inserted inside the outer pipe, due to the repulsion of the like poles the inner pipe doesn't go down. When a weight is kept in the bowl, it moves until equilibrium between the weight and the force of repulsion is achieved	☐	☐	☐	☐	☐	☐	☐	☐	■
174	268 Charging kit	Charging kit for mobile phones which works with both AC (220 V) and DC (12 V) power at the cost of a normal charger, converts both tensions to 4-5 V necessary for mobile	☐	☐	☐	☐	☐	☐	☐	☐	■
175	269 Auto Stopper for LPG gas stove	Battery powered attachment to stop gas supply for stoves: timer controller to stop the gas flow according to a preset time, digital display, cooking time for different varieties of rice or different dishes can be preset with the clock, gives an alarm when the gas stove is switched off - saves gas, prevents food from being over-cooked, increases security	☐	☐	☐	☐	☐	☐	☐	☐	■
176	270 Modified silencer	Modification in silencer of two wheelers where exhaust gas is partly used to pre-heat the air and pressure, leading to increased combustion efficiency of the engine - decrease of consumption by 25 to 30 per cent	☐	☐	☐	☐	☐	☐	☐	☐	■
177	270 Electricity control board	Electric circuit that disconnects power supply in case of voltage fluctuation for more than a preset time, system can also switche off power supply whenever the load is less than a preset value (to be inserted into machines, household appliances etc.)	☐	☐	☐	☐	☐	☐	☐	☐	■
178	271 Automatic watering system in flower pots	Automatic watering system in flower pot: when the soil moisture is below a preset value, sensor gets activated and switches on a water pump and off if moisture is sufficient	☐	☐	☐	☐	☐	☐	☐	☐	■
179	271 Short-circuit alarm	Device that alerts the user if he had inserted a faulty device into a power plug or if there is some internal short-circuit - to prevent common injuries and deaths due to short-circuits	☐	☐	☐	☐	☐	☐	☐	☐	■
180	271 GSM based burglar informer	System to inform about attempted break: when the main door is forced open, a relay switch is triggered and activates the circuit, the system dials a preset mobile number, continues the dialing until either the system is switched off or the call is accepted - system can be switched on and off, useful for houses, offices, shops and vehicles	☐	☐	☐	☐	☐	☐	☐	☐	■
181	271 Ceramic pot with heating filament	Electrical heating filament in a ceramic pot, which can be used to burn slowly, small mosquito coil fragments/tablets - very clean process	☐	☐	☐	☐	☐	☐	☐	☐	■
182	271 Automatic water pump controller	Water pump operating system for filling of overhead tanks in houses and buildings, device can start on its own and switches off the pump when the tank is full	☐	☐	☐	☐	☐	☐	☐	☐	■
183	272 Motorised cob web	Motorized cob web cleaner (Spinnennetz): device that cleans cob webs through winding up the threads - easy to use and convenient	☐	☐	☐	☐	☐	☐	☐	☐	■
184	272 Pocket police	Pick pocket alarm is activated when someone touches the pocket, a red LED bulb is fitted to a spectacle through wire and a sensor is kept inside the purse; also used for system to protect juwelry box	☐	☐	☐	☐	☐	☐	☐	☐	■
185	275 Modification in Jacquard loom for extra weft insertion	Low cost design making attachment for Jacquard looms, three components: a base frame as a shaft holder, magnet bearing shaft and the specially designed bobbin for efficiency; facilitates automatic selection and lifting of warp threads for design making through magnets - faster, more efficient and facilites hard manual work	☐	☐	☐	☐	☐	☐	☐	☐	■

#	Idea	Short description	Creativity 1	2	3	4	Techn. elaboration 1	2	3	4	P
186	276 Hand pump with modified plunger	Redesigned pressure hand pump, made of mild steel and fitted with a modified plunger system - higher efficiency by minimizing the pressure leakage, lighter, longer durability, lower cost than conventional ones	☐	☐	☐	☐	☐	☐	☐	☐	■
187	276 Battery operated bicycle	Battery operated bicycle using a car battery, which could run at an average speed of 20 kilometers per hour	☐	☐	☐	☐	☐	☐	☐	☐	■
188	305 Ribbed energy efficient griddle	Ribbed griddle: change in material (alu) and configuration leads to significant energy savings compared to the flat iron griddle - presence of the ribs increases the area of contact between the flames and the surface, which leads to better heat utilization	☐	☐	☐	☐	☐	☐	☐	☐	■
189	305 Butter Milk Churning Machine	Electrical machine to produce buttermilk - reduced the time and hard, long work of churning buttermilk manually (rural women got relatively free using this machine)	☐	☐	☐	☐	☐	☐	☐	☐	■
190	305 Electrical Furnace Type Wood Based Crematorium	Improved crematorium furnice design with sufficient air flow for better aeration from all three sides (bottom and two side walls) - less wood needs to be burnt	☐	☐	☐	☐	☐	☐	☐	☐	■
191	305 Agate Grinding Mill	Mill with a vacuum pump that pulls the dust in the opposite direction of workers polishing the gem stones- before they used to inhale the dust causing silicosis, which proved fatal in many cases	☐	☐	☐	☐	☐	☐	☐	☐	■
192	308 The motorcycle driven ambulance	Motor cycle driven ambulance: Quick and cost effective way of providing emergency response and transport at up to 40 km/hour for rural India: motor cycle pulled ambulance trailer with doors at the rear, facility to keep oxygen cylinder, first aid box, saline solution dispensing station, up to 3 people	☐	☐	☐	☐	☐	☐	☐	☐	■
193	308 The manual ambulance	Manual ambulance: Quick and cost effective manual ambulance unit for emergency response and transport in rural India - for shorter distances (< 30 km), even tighter budget, at a speed of 10 km/hour, powered through a bicycle based mechanism	☐	☐	☐	☐	☐	☐	☐	☐	■
194	308 The amphibious three-wheeler	Boat on three wheels (one in the front): pair of long cylindrical floats on either side for stabilization, parked inside when traveling on road, equipped with a steering system, two people sitting in the front seats run it by pedaling rotating a set of blades that work as propeller to move the vehicle in water, two people can sit in the rear as well - low cost solution for flood situation when many people have to flee the water and there aren't enough boat options	☐	☐	☐	☐	☐	☐	☐	☐	■
195	308 Five gear bicycle pedaled by two people	Bicycle for 2 people with steel frame body provided with five gears (different slopes and terrains) and a braking system for downhill driving, Two gears were designed for use on level roads while other two gears were used for running on inclined slopes, no automatic gear shift was provided, and the driver had to get down and manually change the drive (Invented in the 50ies)	☐	☐	☐	☐	☐	☐	☐	☐	■

CAT results: Kolmogorov-Smirnov-tests

	Creativity	Technical elaboration
N	200	200
Kolmogorov-Smirnov-Z	,848	,825
Asymptotical significance (2-tailed)	,469	,504

The distribution to be tested is a normal distribution

CAT results: Linear regression model creativity and technical elaboration

Model summary

Dependent variable: creativity	R	R^2	Adjusted R^2
Independent variable: technical elaboration	,628	,395	,392

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	15,118	1	15,118	129,138	,000
Residuals	23,179	198	,117		
Total	38,296	199			

Coefficients

	Unstandardized coefficients		Standardized coefficients		
	B	Standard error	Beta	t	Sig.
(Constant)	1,200	,132		9,060	,000
Technical elaboration	,581	,051	,628	11,364	,000

Preconditions of multiple linear regressions – Kolmogorov-Smirnov-tests

	Age	Education
N	200	200
Kolmogorov-Smirnov-Z	2,879	2,928
Asymptotical significance (2-tailed)	,000	,000

The distribution to be tested is a normal distribution

Additional information on multiple linear regression for creativity

Model summary

			Change statistics					
R	R^2	Adjusted R^2	R^2 Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,337	,113	,071	,113	2,702	9	190	,006	1,779

Dependent variable: creativity; Independent variables: technical experience, use experience, education, cooperation, innovation experience, prosocial motivation, innovation type, age, gender

Additional coefficients

	95,0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	2,356	3,012		
Technical experience	,012	,275	,823	1,214
Use experience	-,162	,180	,671	1,490
Education	-,046	,043	,900	1,111
Cooperation	,038	,425	,847	1,180
Innovation experience	-,342	-,081	,909	1,100
Prosocial motivation	-,088	,222	,672	1,488
Innovation type	-,180	,100	,959	1,043
Age	-,025	,059	,742	1,348
Gender	-,531	,201	,892	1,121

Dependent variable: creativity

Multiple linear regression for technical elaboration

Model summary

			Change statistics					
R	R^2	Adjusted R^2	R^2 Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,330	,109	,066	,109	2,572	9	190	,008	1,710

Dependent variable: technical elaboration; Independent variables: technical experience, use experience, education, cooperation, innovation experience, prosocial motivation, innovation type, age, gender

Additional coefficients

	95,0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	2,029	2,741		
Technical experience	,118	,403	,823	1,214
Use experience	-,223	,148	,671	1,490
Education	-,005	,092	,900	1,111
Cooperation	-,137	,283	,847	1,180
Innovation experience	-,212	,070	,909	1,100
Prosocial motivation	-,092	,244	,672	1,488
Innovation type	-,230	,074	,959	1,043
Age	-,036	,055	,742	1,348
Gender	-,607	,187	,892	1,121

Dependent variable: technical elaboration

Parsimonious multiple linear regression model for technical elaboration

The model only includes the three explaining variables with significant results in the comprehensive regression model.

Model summary

			Change statistics					
R	R^2	Adjusted R^2	R^2 Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
,287	,082	,073	,082	8,830	2	197	,000	1,601

Dependent variable: technical elaboration; Independent variables: technical experience, education

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	3,690	2	1,845	8,830	,000
Residuals	41,159	197	,209		
Total	44,849	199			

Coefficients

	Unstandardized coefficients		Standardized coefficients		
	B	Standard error	Beta	t	Sig.
(Constant)	2,300	,089		25,917	,000
Technical experience	,276	,067	,288	4,105	,006
Education	,044	,024	,129	1,841	,067

Additional coefficients

	95,0% Confidence Interval for B		Collinearity Statistics	
	Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	2,125	2,474		
Technical experience	,143	,408	,945	1,059
Education	-,003	,091	,945	1,059

Multicollinearity analysis for ordinal logistical regression

A multiple linear regression was conducted to derive the collinearity statistics.

Collinearity Statistics

	Tolerance	VIF
Creativity	,601	1,664
Technical elaboration	,587	1,703
Use experience	,684	1,462
Prosocial motivation	,683	1,465
Innovation type	,972	1,028
Age	,900	1,111
Gender	,899	1,112

Dependent variable: market recognition