

JUGAAD SMARTNESS

Developing frugal, sustainable and inclusive solutions for cities

Saiba Gupta

Graduation thesis report

MSc Thesis Report

December 2018

Jugaad Smartness

Developing frugal, sustainable and inclusive solutions for cities

Keywords

Frugal Innovation | Jugaad | Smart City | Transition | Sustainable

Supervisor

Grazia Concilio

Politecnico di Milano | AUIC

MSc Urban Planning and Policy Design

Author

Saiba Gupta

870352

saibagupta@gmail.com

saiba.gupta@mail.polimi.it

ACKNOWLEDGEMENTS

Writing this thesis was a well-rounded and fascinating experience for me and I would like to thank everyone who was part of this process. This journey was made possible with the constant support and guidance of my thesis supervisor, Grazia Concilio. I would like to express my gratitude towards her for constantly bettering my work throughout this period of almost one academic year. She is not only extremely knowledgeable, but also has a wonderful attitude. I look forward to continuing working with her. I would also like to thank my family and friends for just being there for me at all times. The product of this research would not have been possible without them.

I am not just happy to complete this thesis successfully but also to have gained knowledge in this field. I hope to do good research and practical work in the future with these learnings. Overall this master's thesis journey was a challenging one, but it sparked my interest in research and so I once again thank everyone for their support and contribution towards its completion. Please feel free to contact me for any interest in this graduation project.

Saiba Gupta
Politecnico di Milano
December 2018

ABSTRACT

Innovation is proven to be an absolute requirement for growth and development, but the type and motivation of innovations may differ depending on the context (socio-economic and cultural characteristics, geography, infrastructure, mindset and income levels of customers). At a time when the entire world seems to be merely paying lip service to the term 'smart city', it is important to understand that for a city to be considered smart, the urban system needs to be adaptable and innovative.

This research talks about a specific approach to innovation - Jugaad. 'Jugaad Smartness' refers to a way of developing flexible, frugal, sustainable and inclusive solutions for cities. I believe this dimension is essential for cities in the face of the various contemporary challenges. 'Jugaad' (/dʒuːˈɡɑːd/, Hindi: जुगाड़) is a Hindi word that in everyday language refers to an innovative hack or a quick fix that fulfils the immediate need by making things work (finding solutions) from whatever resources are at hand. This 'good enough' or 'will do' attitude can lead people to view jugaad as only a temporary solution.

India, which is also a focus of this thesis, has become a breeding ground for frugal and social global innovations. This research aims to illustrate that jugaad innovation can be a driver of transitional change and lead to long-term, durable impact. The thesis analyzes various cases of jugaad solutions, especially those of Indian origin; discussing the various approaches adopted by local firms and multi-national companies and the diffusion of social innovations. Furthermore, the research also looks at the dynamics between the existing regime and niches, in reference to jugaad innovation.

Jugaad is a frugal, simple, sustainable and inclusive approach to innovation. It aims to create solutions (products/services/processes) that are accessible to those who are generally un(der)served or excluded and does so with minimum possible wastage. It takes advantage of existing material resources and human capital to deliver context-appropriate alternatives. Hence, the question arises: Are jugaad solutions more than 'just good enough'? Could they in fact be better?

TABLE OF CONTENTS

Acknowledgements	
Abstract	
Table of Contents	
List of Figures	
List of Tables	
1. Introduction	9
2. Understanding ‘Smartness’ of Cities	12
2.1 Relation between Smartness & Innovation	12
2.2 Relation between Smartness & Frugality	14
2.2.1 BoP - Bottom of Pyramid	15
2.2.2 Constraints	18
2.2.3 Technology	20
3. India’s Indigenous Genius: Jugaad	25
3.1 The Jugaad Mindset	25
3.2 Main conceptual components of Jugaad	27
3.2.1 Frugality	27
3.2.2 Context: Place and People	30
3.2.3 Simplicity	36
3.2.4 Low environmental impact: Green	40
3.3 Transitional change and its relation to Jugaad	43
3.3.1 Theory of transitional change	43
3.3.2 Relation to Jugaad	46
4. Jugaad solutions for Sustainable Transition	48
4.1 Regime - Niches Dynamics	48
4.2 Mapping Jugaad Solutions	51
4.3 Examples of Transition Dynamics	72
4.3.1 The Water Market	72
4.3.2 The Energy Market	76
5. Conclusion	79
List of References	84

LIST OF FIGURES

Chapter 1

Figure 1: Six dimensions of a smart city & related aspects	10
Figure 2: Research Objectives of thesis	11
Figure 3: Structure of thesis	11

Chapter 2

Figure 4: Innovation - Smartness – Frugality	14
Figure 5: The World Economic Pyramid	15
Figure 6: Strategies for Innovation for BoP	16
Figure 7: Fundamental dimensions of constraint-based innovations	19
Figure 8: Inverse-U shaped relationship between slack resources and innovation	20

Chapter 3

Figure 9: Jugaad vehicle powered by an agricultural water pump engine	25
Figure 10: Jugaad vehicle powered by an agricultural water pump engine	25
Figure 11: Jugaad Philosophy	26
Figure 12: Aravind Eye Care System	28
Figure 13: Public Service Innovation: Co-creation	32
Figure 14: Evolution of the Customer	35
Figure 15: Nokia 1100 was advertised as a phone ‘Made for India’	37
Figure 16: One of the many popular jokes about how sturdy the phone was	37
Figure 17: Dr. Jeganathan’s Baby Incubator	38
Figure 18: Motorcycle ambulance, India	39
Figure 19: E-Ranger, Malawi	39
Figure 20: Green Constraint-based Innovation	40
Figure 21: Grassroots Innovation: intersection of three dimensions	41

Chapter 4

Figure 22: Regime Niche	48
Figure 23: Possible diffusion of Jugaad Innovation	51
Figure 24: Cases: Jugaad Innovation	51
Figure 25: Water market in India	72
Figure 26: Energy market in India	76

Chapter 5

Figure 27: Innovation ‘sandbox’ for healthcare in India (Pralhad)	79
--	----

LIST OF TABLES

Chapter 4

Table 1: Case Jaipur Foot, India	52
Table 2: Case Aravind eye care system, India	53
Table 3: Case Low cost incubator, India	54
Table 4: Case Mobile diabetes clinic, India	55
Table 5: Case GE's Mac 400 ECG machine, India	56
Table 6: Case Isang Litrong Liwanag (a liter of light), Philippines	57
Table 7: Case Vortex Gramateller, India	58
Table 8: Case SELCO (Solar Electrical Light Company), India	59
Table 9: Case Husk Power Systems, India	60
Table 10: Case C-Dot, Department of Telecommunications, India	61
Table 11: Case Sakshat tablet, India	62
Table 12: Case Banking on phones, Philippines	63
Table 13: Case Sarvajal, India	64
Table 14: Case Tata Swach water filter, India	65
Table 15: Case Cooking chulhas and cooking fuels, India	66
Table 16: Case Lifesaving dot, India	67
Table 17: Case Motorcycle ambulances, India /e-rangers, Africa	68
Table 18: Case Revol, India	69
Table 19: Case Low cost hygienic sanitary pads, India	70
Table 20: Case MittiCool - clay refrigerator, India	71

Chapter 1

Introduction

The Indian Government has proposed to set up 100 ‘smart cities’ across the country. ‘The smart cities should be able to provide good infrastructure such as water, sanitation, reliable utility services, health care; attract investments; transparent processes that make it easy to run commercial activities; simple and online processes for obtaining approvals, and various citizen centric services to make citizens feel safe and happy’- Ministry of Housing and Urban Affairs, Government of India [1]. An amount of INR 7060 crore (approximately 1 billion USD) was announced by Indian Prime Minister Narendra Modi, in September 2014 to fund the Smart City Mission.

“Let us consider urbanization as an opportunity. Gone are the days when it was seen as a challenge or obstacle.”

- Prime Minister Narendra Modi

The objective of this mission is to promote cities that not only provide core infrastructure, but also a decent quality of life and a clean and sustainable environment to its citizens, along with introducing ‘smart’ solutions. Yet the project proposals for the individual cities are not entirely following these objectives. There is more emphasis on pan city development, instead of focusing first on small scale interventions. The engagement of citizens is limited to feedback. Instead citizens can have deeper involvement in the process as innovators and co-creators. Also, the project requires a diverse group of stakeholders who can co-produce.

The 6 dimensions of a smart city (Fig.1) as per the ranking of European medium-sized cities [2], have been widely discussed and researched. The basis of this thesis was to go beyond the confines of these six characteristics and ask the below mentioned questions.

[1] Ministry of Housing and Urban Affairs, Government of India. Available online: <http://smartcities.gov.in/content/innerpage/what-is-smart-city.php> (accessed on 18 June 2018).

[2] smart-cities.eu. Report: Smart cities Ranking of European medium-sized cities (Final Report, October 2007). Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf (accessed on 18 June 2018).

What does ‘smartness’ really mean? How can this concept be implemented, especially in the context of an emerging economy like India? What is the existing strength of this context and how can its potential be harnessed?

Dimension of smart city	Related aspect of urban life
Smart People	Education
Smart Governance	E-democracy
Smart Mobility	Logistics & Infrastructure
Smart Environment	Efficiency & Sustainability
Smart Living	Security & Quality
Smart Economy	Industry

Fig.1 Six dimensions of a smart city & related aspects

Source: drawn by author

Adapted from Ranking of European medium-sized cities

‘Jugaad Smartness’: The concept of Jugaad is indigenous to India. This research aims to explore the concept of Jugaad innovation and how it can contribute to improving lives of people by making services available to them, meeting their needs and solving their problems. In other words, how it can contribute to the notion of smart. Frugality is the key ingredient of the Jugaad phenomenon. Hence, before understanding jugaad, it is essential to study the concept of frugal innovation.

Chapter 2 talks about the link between smartness and frugal innovation. The three concepts: smart, frugal and innovation are interconnected. This relation is established by focusing on three elements:

- BoP (Bottom of Pyramid): what is the bottom of the economic pyramid and what are the type of innovative solutions this population requires.
- Constraints: the characteristics of constraint-based innovations.
- Technology: the enabling role of information technology (IT) in overcoming the constraints of a frugal ecosystem and the importance of indigenous technologies.

Chapter 3 discusses the origin of the term jugaad and its use in everyday life/language. It also discusses the negative connotations attached with the jugaad mindset. This research explains the phenomenon of jugaad innovation in terms of four main conceptual components, citing examples/cases for each of the following:

- Frugality
- Context – Place & People
- Simplicity
- Low environmental impact – Green

These four conceptual components are used to establish the relation between jugaad and transitional (long-term, durable) change.

Taking off from where the previous chapter ended, chapter 4 explains the dynamics between the regime and the niches, in the case of jugaad innovation. Twenty cases of jugaad solutions are cited, divided into different categories – healthcare, energy, Information & Communication Technology (ICT), water, food & nutrition, transport and miscellaneous. The chapter goes deeper into the water and energy markets in order to explain the transition dynamics. This last section examines how Jugaad has made a sustainable/long-term impact, specifically in these two markets.

Chapter 5 concludes this research thesis. It discusses the implications of jugaad innovation for governments, markets, social entrepreneurs and users. It also talks about jugaad for the west. Finally, the need for a system to harness the Jugaad Innovation approach to be a catalyst in transitional change and some policy guidelines.

	Research Objective (RO)	Methodologies used
RO1	To establish a relationship between smartness and frugal innovation	Case analysis Literature review
RO2	To establish if and how jugaad can be a driver of long-term transitional change	
RO3	To establish transition dynamics in the case of jugaad solutions	

Fig.2 Research Objectives of thesis

Source: drawn by author

Chapter	Research Focus	Research Objective
2	Innovation – Smart - Frugal	RO1
3	Jugaad	RO2
4	Transition dynamics	RO3

Fig.3 Structure of thesis

Source: drawn by author

Chapter 2

Understanding 'Smartness' of Cities

2.1| Relation between Smartness & Innovation

A smart city is not merely a city with smart buildings, smart parking and free Wi-Fi. 'Smart' represents a breakthrough in how to understand and improve cities. A useful test of 'smartness' is the degree to which any given innovation facilitates equitable access and benefit. The creative development of ICT to enhance the quality of urban life is full of possibilities. But the central question around the smart city debate is: 'Smart for whom?'

Innovation refers to a significant positive change aimed at carrying out a certain function and/or solving a certain problem. There is a tangible outcome. In innovation studies, innovation has traditionally been defined as the successful introduction of a new or improved product, process, or service to the world or marketplace (Dorfman,1987). It is described as the best-known indicator of organizational competitive advantage (Drazin and Schoonhoven, 1996; Christensen, 1997). There are various definitions of innovation in literature and urban research.

"Innovation is a process of turning opportunity into new ideas and of putting these into widely used practice". (Tidd et al., 2005, p.66)

"Innovation is the successful creation and delivery of a new or improved product or service in the market ... innovation is the process that turns an idea into value for the customer and results in sustainable profit for the enterprise." (Carlson & Wilmot, 2006, p.3-4)

Each of the definitions above notes that an action or process that introduces something new is required to innovate. The constituent elements of innovation can be identified as the new thing to be introduced, the act of introducing it, and some type of arena where the introduction occurs. These new things can take on a variety of forms such as a product, behaviour, system, process, organization, or business model. At the heart of all these 'new things' is a novel idea. There is emphasis on putting this novel idea into practice - the application of a new idea to create value. To describe an idea as innovative suggests that it should be acted upon (Wylant, 2008). A key factor in the approach to innovation is the importance of users – the people for whom the innovation is developed. The end users' ideas, experiences, needs and requirements should form the basis for innovation. As

mentioned above, innovation is the process of turning knowledge and ideas into value. Hence, this knowledge ought to be derived from daily experiences and interactions with the environment/social setting.

The kind of innovation required to make a city smart is one that aims at improving citizens' daily life by facilitating citizens' access to services while giving them the opportunity to become key players in the development of their city. In emerging countries, the Smart city concept implementation is even more relevant and challenging than in developed countries. Research also acknowledges that due to different environmental conditions such as socio-cultural attributes, geography, infrastructure, political environment and income levels (Rauch et al., 2013), innovation systems and strategies are distinct for developing and developed countries. Large market sizes, growing demands and plentiful workforces generate more challenges as well as opportunities.

In emerging markets, the fundamental objective of innovation is not just about delighting customers but rather about meeting customers' fundamental needs (Petrick, 2011). The unique conditions and basic unmet customer needs of the developing world are driving newer low-cost and problem centric innovations. The frugal approach refers to optimization of existing resources, investment in human capital and promotion of local innovation. This approach is a way to get the maximum out of the financial and human resources available locally.

Although the overall innovation processes and systems in the developed and developing parts of the world are driven by a distinct set of motivations, yet they follow the same basic rule – 'innovation drives innovation'. The more a city has successfully experienced innovation, the more capable it is of driving and hosting it. Moreover, a city's ability to deal with changing circumstances and to re-invent itself, is one of the key factors determining its success (Simmie, 2003). Hence, both the urban system and the innovation process need to be adaptive, flexible and robust.

Technological innovations, like those in ICT can boost the performance of public services if managed properly. But does everyone have access to these technologies or are they just benefitting an exclusive group? Innovation is what drives smartness. A city can be considered smart only if the urban society has learned to be adaptable and innovative (Hambleton, 2015). If innovation can link the technical and the social aspects, inclusive solutions can be designed for cities.

2.2| Relation between Smartness & Frugality

Frugality refers to the quality of being economical or prudent in saving. It entails the requirement of few resources and the lack of wastefulness. This section will be looking at the following three aspects to relate SMART (solutions for cities) and FRUGAL (innovation):

- 2.2.1 **BoP** or the Bottom of the economic pyramid refers to the population that is living on less than USD 2/day per capita. This is the largest and poorest socio-economic segment of the world population which is expected to grow for the next three decades as per World Bank reports (Population reference Bureau, World Bank, 2011).
- 2.2.2 **Constraints** that these BoP markets are under – in terms of resources, consumer purchasing power, R&D etc.
- 2.2.3 **Technology** is considered a key element of the ‘smart’ concept yet is often not designed for a large section of users and neglects critical institutional and social aspects.

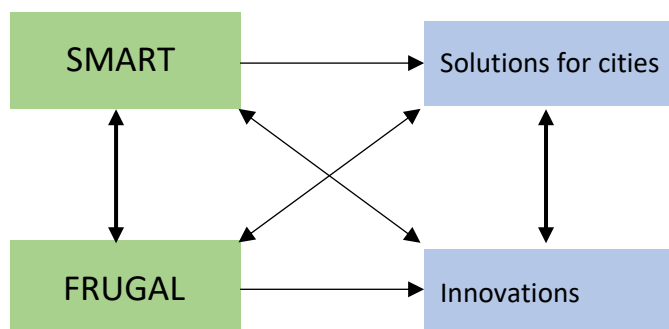


Fig.4 Innovation - Smartness - Frugality

Source: drawn by author

2.2.1 | BoP – Bottom of Pyramid

Tier 4 of the World Economic Pyramid represents the BoP or the bottom of the pyramid. More than 4 billion people live at the BoP on less than USD 2 per day (Prahalad, 2005). Given its vast size, tier 4 represents a multitrillion-dollar market. Yet the basic needs of this large section, that constitutes majority of the population are un(der)served.

The tier 4 contributes to the informal economy which constitutes a large percentage of the total economic activities of developing nations. It is estimated by the NSSO (National Sample Survey Office) that 84.7% of jobs in the Indian economy are in the informal or unorganized sector. Most tier 4 or BoP people live in rural areas or urban slums and informal settlements/unauthorized spaces. These spaces might be invisible on official plans, but their economic impact is observable. Jobs in the informal economy refer to the self-employed and self-sufficient – such as street vendors, petty producers, laborers, small service providers and domestic help.

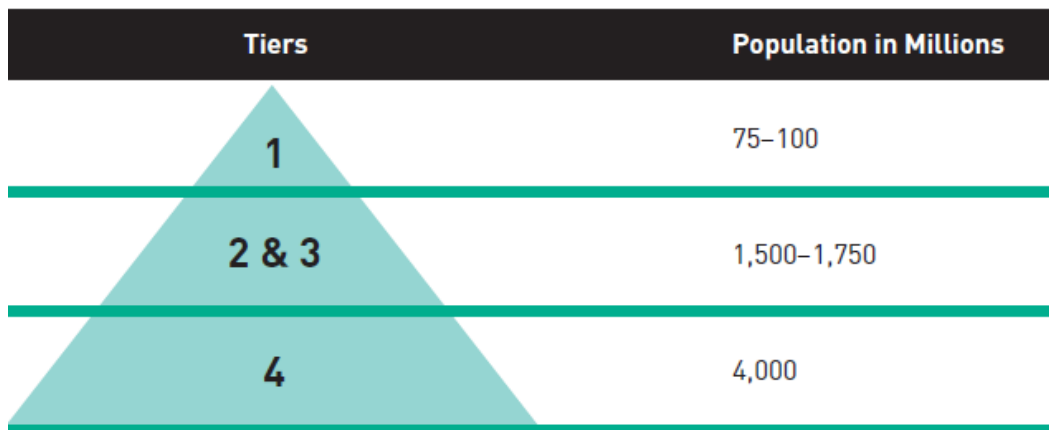


Fig.5 The World Economic Pyramid

Source: C. K. Prahalad and Stuart Hart, 2002

The Fortune at the Bottom of the Pyramid, Strategy+ Business, Issue 26, 2002

People employed in such activities continue to provide goods and services without getting any welfare rights, labor protection or the license to trade. Since it is an informal process, self-help relies on social networks to get work, borrow money or land, get protection etc. Squatters and slums even though may have existed for a long time are temporary and do not have the legal security of permanence. They have no property rights or right to access to services and infrastructure. Hence, given its nature, the BoP is difficult to reach through conventional systems of distribution, credit and communication. It is an un(der)tapped market that is an

opportunity for profitable growth. No single organization can undertake the task of serving BoP markets on its own. To cater to the needs of this large economically viable audience, multiplayer are required – local governments, communities, NGOs, financial institutions and companies. Hence, even though the government is the primary custodian and provider, it is the collaboration between different types and scales of organizations – government, corporations and social ventures; that is key to provide for everyone including the BoP.

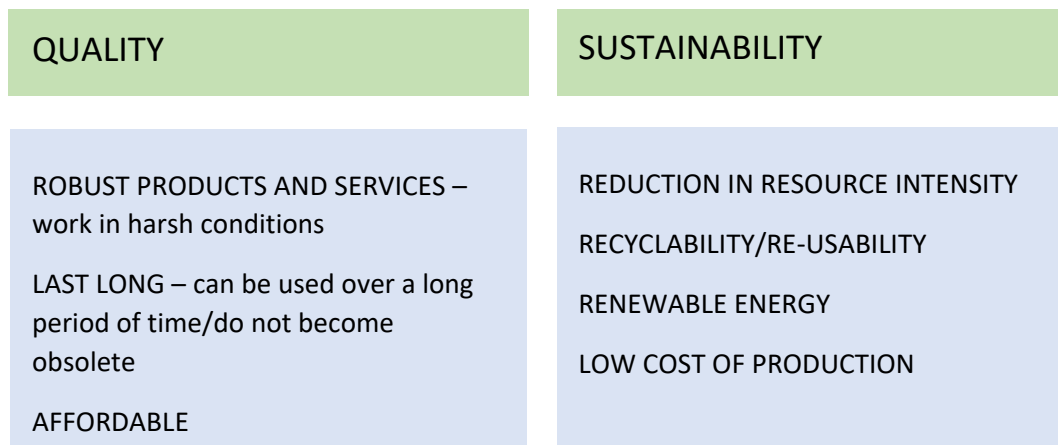


Fig.6 Strategies for Innovation for BoP

Source: drawn by author

As mentioned above, conventional methods of production and provision of goods and services will not work in case of the BoP. What is required are new strategies and a different approach altogether. Following are certain **principles for innovation** for BoP markets:

- Reducing resource intensity: all innovations must focus on conserving resources - eliminate, reduce, and recycle.
- Robustness: products and services must be able to function in hostile environments (heat, dust, low quality of infrastructure).
- The heterogeneity of the consumer base in terms of language, culture, skill level, and prior familiarity with the function or feature is a challenge to the innovation team (Prahalad, 2005). Therefore, it's important to involve the local communities and organizations, local social ventures and grassroots level initiatives; to make the most of their knowledge and skill.
- In addition to affordability, the price-performance relationship is also key in serving the BoP. The consumer should be able to derive the maximum

possible value from the purchase, in addition to paying less. Hence, the product must last long and not be designed to become obsolete in anticipation of the revamped version of the same thing.

- Re-usability/recyclability: in order to extract maximum possible value, constant reinvention is required – things need to be re-used in different ways, passed down, shared and recycled.
- To be economically viable and to reach maximum population, innovations need to be commercially scalable. This can be done by breaking the barriers between systems and organizations. Hence, it's a give and take process: MNCs will benefit from learning how to engage with NGOs and local community-based organizations to co-create new products, services, and business. NGOs will benefit from partnerships with MNCs, through which they can leverage MNC know-how and systems to scale innovations broadly (Prahalad, 2005).

Lastly, the only way to reach everyone (including the BoP) is to partner with people and innovate to provide them with solutions.

Innovation for inclusive growth refers to innovations that create or enhance opportunities to improve the wellbeing of the generally excluded group at the BoP. Here, innovation is considered as the development and implementation of new ideas and strategies. This includes innovations related to products, services, processes, institutions, business models and supply chains. One main aspect that is crucial for inclusive innovation and hence inclusive growth, is affordability. And often these models of extreme affordability come from the poor. As the proverbial saying goes, 'Necessity is the mother of invention' – when the need for something becomes essential, people will find ways of getting or achieving it (generally through unconventional/alternative means in the case of the BoP). These can be called innovations for the poor by the poor, where the poor become the providers.

There are also many innovators who did not suffer from a particular problem themselves but felt strongly about the suffering of others. These can be called empathetic innovations (Gupta, 2010). Many grassroots innovations and social ventures are triggered by such empathetic interactions. But this does not necessarily mean that these ventures do not have monetary gains or incentives. The BoP is a 4 billion strong market. This means that the solutions we develop must be sustainable and ecologically friendly. Sustainability-driven innovation (Pansera et al. 2016) refers to solutions designed to minimize the impact on the environment. This combined with frugal use of resources leads to efficient and truly sustainable solutions. What is required are new 're-combinations' and creative improvisations that make the most of what is already available, rather

than creating technologies and infrastructure from scratch. Enlarging the scope of existing technologies to new applications can meet the needs of the economically poor and disadvantaged groups.

2.2.2 | Constraints

“Scarcity, the quality of something that is unavailable, insufficient, or not plentiful, is a central concept in the social sciences due to its visibility in many facets of human life” (Pina e Cunha et al., 2014, p.202).

BoP markets are under constraint in terms of:

- Resources:
 - business/financial resources
 - infrastructure
 - material resources
 - environmental resources
- Research and Development
- Consumer Purchasing Power

Majority of the BoP population lives in emerging economies. There are various innovation approaches to develop specific solutions for BoP customers residing in resource-constrained areas of the world. The constraints/conditions of scarcity are the common factor, hence let's refer to this approach collectively as 'Constraint-based Innovations' (Agarwal, 2017). We can define constraint-based innovations as the process of developing new products and services that use minimal resources and are affordable to a broader market. Following are the characteristics of **Constraint-based Innovations/Solutions**:

- Optimize and use existing resources to maximum potential by combining and recombining existing resources and technologies in new ways to generate solutions.
- Yield relatively cheaper/affordable products and services that are good enough to meet the needs of the otherwise underserved consumer. “Cost discipline is an intrinsic part of the process, but rather than simply cutting costs, frugal engineering seeks to avoid needless costs in the first place” (Sehgal, Dehoff, and Panneer, 2010, p.20).
- Are simple and easy-to-use technologies that are inviting to use. Apart from being easy to use, simple objects are easier and less expensive to produce as well and these savings in production can benefit the consumer by lowering prices.

- Are improvised solutions:
 - Innovators respond to product innovation opportunities in the face of limited windows of opportunity and with less than adequate resources.
 - They must act deliberately and unexpectedly (Moorman and Miner, 1998) and resort to whatever materials they have, because there might be no time to search for or access the otherwise preferred resources.
- Are scalable i.e. can be produced in large quantities at low costs. Another prerequisite of cost-efficient solutions is that they should be scalable to reach maximum audience and be flexible/adaptable enough to suit their needs.
- Are environmentally sustainable: Intended benefits of using limited amount of resources include lower prices and higher market penetration of new products. But there are certain unintended benefits as well - frugal use of resources means conservation of scarce resources, which in turn means low impact on the environment. This also reduces the burden on the supply chain, making the process ecofriendly.

Hence, constraint-based is a flexible, frugal and improvised approach to innovation that sees the challenges (constraints) as opportunities.

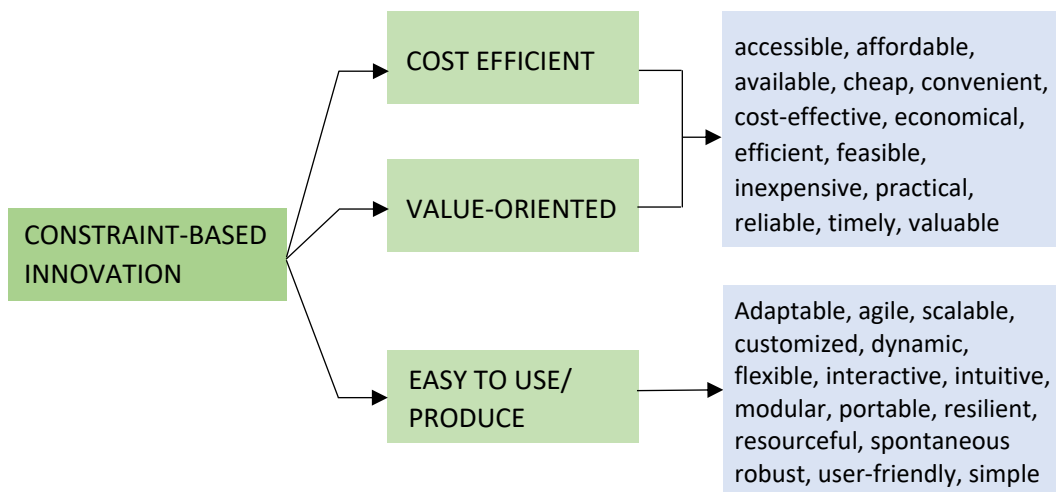


Fig.7 Fundamental dimensions of constraint-based innovations

Source: drawn by author

Cities especially in emerging nations are facing resource scarcity because of growing demands and populations. These constraints can trigger innovations in

adverse contexts. These innovations will inadvertently be sustainable, in addition to being cost-efficient out of necessity. Plus, for a city to grow and be able to sustain itself/provide for everyone now and in future, resources need to be used judiciously irrespective of being currently scarce or not. So, constraint-based innovations are required irrespective – even in situations where currently resources may be ample.

If approached in a proactive and socially responsible way, scarcity may help to improve the living conditions of billions of people. Engaging scarcity rather than avoiding it, is the precondition for innovation (Pina e Cunha et al., 2014).

2.2.3| Technology

“If necessity is the mother of invention, constraint is the mother of frugal innovation.”

- Terri Bresenham, President and CEO, GE Healthcare India

This part of the chapter looks at the enabling role of Information Technology in a resource constraint environment and the dynamics between indigenous and foreign technologies.

A frugal ecosystem is one that is characterized by market constraints, resource scarcity and institutional complexities, but where the collective relational connections of the ecosystem participants are channeled towards developing affordable and sustainable solutions to fill institutional voids and overcome constraints (Costello, Donnellan, and Curley 2013).

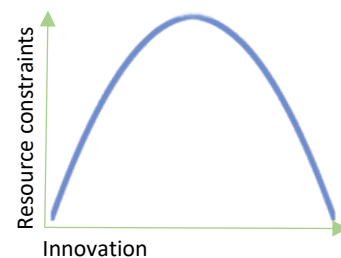


Fig.8 Inverse-U shaped relationship between slack resources and innovation

Source: Nohria and Gulati 1996

As per a study conducted by MIT’s Center for Information Systems Research (CISR), companies in emerging economies are spending a larger percentage of revenue on digitization, are faster to market with new offerings, and perform better than peers in developed economies (Weill and Woerner, 2013). The report also emphasizes that firms in emerging economies are faster to adopt newer technologies and leverage them better, resulting in faster innovation and better performance. These firms also have lower legacy costs to consider and have

learned from the experience of firms in developed economies in terms of their process of IT adoption. Nonetheless, the argument can still be made that in the frugal context, the cost of IT adoption is high and thus can be counter-productive. However, this argument can be addressed with findings from MIT's study and similar studies, which show that firms in developing economies are differentiating themselves by maintaining flexible and highly adaptable IT systems and processes which enable them to remain light on IT assets and can lead to increased innovation and firm performance (Pavlou and El Sawy, 2010; Tanriverdi et al., 2010; Tallon, 2011).

The traditional paradigm for innovation is "fail fast, fix fast, learn fast", while frugal innovation is based on "fail cheap, fail fast, fail often" (Radjou et al., 2012). This distinction in the approach and implementation of innovation practices in resource-constrained environments can potentially lead to the emergence of new cost-effective innovation programs in various organizations.

Coming to the relation between IT and frugality: **Frugal IT Innovation** is a special case of frugal innovation where IT plays a pivotal role in enabling capabilities to overcome challenges of resource constraint environments. It is centered on development of products/services with a sharp focus on affordability, simplicity, and sustainability. An example of this type of innovation can be observed in the *M-PESA* mobile payment service that was developed in Kenya (launched in 2007) to overcome the lack of physical banking branches. Using a simple SMS-based transaction system, people use their mobile phones to send and receive digital currency. The affordability, scalability, and simplicity of M-PESA has made it so successful that 75% of the Kenyan population uses it today and over 30% of Kenyan GDP flows through this system (Orlikowski and Barrett 2014).

Various firms have moved towards the adoption of **digital platforms** as augmentation mechanisms to facilitate the ease of doing business. Digital platforms may provide certain inherent features and IT capabilities that enable firms to innovate despite operating in difficult environments. They may provide low-cost, easy to access and easy-to-deploy solutions to firms that are unable to acquire expensive digital infrastructures and other resources (Ahuja and Chan, 2016). This makes them a natural fit for resource constraint environments. One such example is *JobMatch* - a for-profit platform for matching jobs that is operating in India. It is specifically tailored towards the informal sector and entry-level formal sector jobs that pay less than USD 250/month and makes jobs easily accessible to everyone (Ahuja and Chan, 2014). With the use of digital platforms, the consumers can be reached directly (without the need of any middle man) and

thus organizations can access and respond to their needs and demands. Hence, technology is a means to create a digital network of many people.

A **disruptive technology** is one that displaces an established technology and shakes up the industry or a ground-breaking product/service that creates a completely new industry. Christensen (2003, p.221) states that “disruptive technologies are simpler, cheaper, more reliable, and convenient than existing ones.” It is within this framework that most of the frugal technology innovations take place. Ordinarily businesses improve their profitability by undertaking various cost cutting measures. Traditionally these post design measures are directed at minimizing the cost of a given product by streamlining the various processes that go into its realization. In contrast, cost cutting is built into the initial design process of a frugal-innovation, thereby producing products that are cheaper than the cheapest ordinary products. Hence, frugal innovations are in a good position to disrupt their counterparts.

An example of this type of frugal technology innovation can be found in Nokia’s basic cell phone, the *Nokia 1100*. It is arguably the world’s best-selling phone and is a classic example of closing the gap between IT design and resource-constraints. In order to make it highly affordable, Nokia reduced its elements to the basic features required for low-income consumers and included a much-valued flashlight component (Heeks, 2012).

It is important to note that not all frugal innovations are disruptive and not all disruptive innovations are frugal (Wierenga 2015). Also, frugal technology innovations are generally not about creating the next radical technology product or service, but instead about finding the right fit between the needs of the market and the technical specifications of the product (Heeks 2012). This powerful combination of low-cost, quality and simplicity make mass consumption of frugal products a sustainable solution for a better tomorrow. Therefore, frugal innovations are a significant disruptive force.

Frugal engineering (FE) is an overarching philosophy that enables a true “clean sheet” approach to product development. Cost discipline is an intrinsic part of the process, but rather than simply cutting existing costs, frugal engineering seeks to avoid needless costs in the first place (Tiwari and Herstatt, 2012).

Even though consumerism is growing with the new emerging middle class, there are still many families who just want proper basic amenities. Frugal engineering addresses these billions of consumers at the bottom of the pyramid who are shopping for the basics, not for fancy features (Sehgal et al., 2010). FE uses cutting edge technology to create low-cost and no-frills products. The adoption of frugality entails design principles that advocate minimal use of resources for

realizing efficient functioning of products. The no frills nature of these products helps maintain lower costs with a positive impact on sustainability because of lesser resource consumption (Rao and Drazin 2002).

The term (FE) was coined in 2006 by Renault Chief Executive Carlos Ghosn to describe the competency of Indian engineers in developing products like Tata Motors' Nano, the pint-sized, low-cost automobile. *The Nano*, launched in India in 2009 was termed the 'worlds cheapest car' at about USD 2500.

Another good example of FE is refrigerators. Customers at the bottom of the pyramid can't afford traditional energy-sucking, compressor-driven refrigerators. Rather than cut costs out of a bigger refrigerator, India's Godrej Appliances produced a fridge with the capacity of only 6 litres called the *ChotuKool*, which literally translates into 'little cool'. The company realized that most Indians do not buy grocery in bulk and hence, a small fridge will meet their needs. The appliance has no compressor, instead using a cooling chip and fan similar to those that keep computers from overheating. It can run on a battery during the power outages that are inevitable in rural areas. By keeping the number of parts down to around 20 instead of the 200-plus used in conventional refrigerators, Godrej keeps the price low too, at about USD 55 (Sehgal et al., 2010). Thus, the key is to recognize the unique needs of the BoP and the fact that merely removing features from existing technologies from the west to sell them at cheaper rates in emerging markets is not the answer.

If technologies were costless to diffuse and if the effectiveness of a technology was the same in different local contexts, developing countries could rely on foreign technology transfer and easily catch up with the world technology frontier without **indigenous innovation** (Fu and Gong, 2011). Nevertheless, foreign technologies developed in industrialized countries may not be appropriate for the socio-economic conditions of developing economies. For a particular country, appropriate technology is a technology tailored to fit the psychosocial and biophysical context prevailing in a particular location and period (Stewart, 1983; Willoughby, 1990). Therefore, these products/services, when imported or transferred are inappropriate to the local conditions, and hence less productive (Acemoglu, 2002; Acemoglu & Zilibotti, 1999).

For example, *Home Depot* - a large American company that specialises in delivering home supplies to Do It Yourself (DIY) opened 12 stores across China in 2006. What they realized later was that in China, just like in various other developing countries, labour is cheap and what would have been the target audience does not really believe in doing handyman house jobs themselves. Another example from China is that of *eBay* - an e-commerce giant that copied its

American model to China and got destroyed by local competitor Taobao. Reason being, while Taobao allowed buyers and sellers to chat over instant-messaging, giving them a chance to establish a personal connection, eBay did not realize that personal relationships are of utmost importance in the Chinese context. An example of product failure is that of *P&G's Gillette* that launched a razor called Vector for India in 2002. Gillette spent 3000 hours and employed MIT graduates to design this product, but what they didn't realize was the fact that Indian men use a cup of water instead of running water to clean the razor, which was clogged after a single use.

Another important factor to be considered is that the benefits from international knowledge transfer are subject to the existence of adequate absorptive capacity of the local firms and organizations - the ability of an organization to identify, assimilate, and exploit knowledge from its surrounding environment (Cohen & Levinthal, 1989; Girma, 2005). Domestic technologies are much easier to be absorbed by domestic firms – higher absorptive capacity.

Furthermore, benefits of foreign technologies cannot be delivered without parallel indigenous innovation efforts – local innovation capacity. For example, China excels at absorbing western technologies by integrating them into indigenous innovation strategies and reinterpreting them in the Chinese context. China has made indigenous innovation as its national strategy in its Eleventh Five Year Plan. This has indicated that indigenous innovation has become the key to transform the mode of economic growth from simply relying on natural resources and imitation of foreign technologies to one driven by innovation (Chen et.al, 2006).

In conclusion, the need for foreign technology to be appropriate to the specific socio-economic and technical context of a developing country implies that developing countries cannot rely on foreign technology for technological upgrading and that indigenous innovation is of crucial importance. So, despite relatively fewer resources, emerging markets are reducing the reliance on imported costly technologies by developing their own less expensive technologies, that are: robust, value-oriented, sustainable, scalable and most importantly - **appropriate for the context.**

Chapter 3

India's Indigenous Genius: JUGAAD

3.1| The Jugaad mindset

Jugaad is a colloquial Hindi word that according to the Oxford English dictionary refers to ‘a flexible approach to problem-solving that uses limited resources in an innovative way’. Originally the word was used to describe a low-cost makeshift vehicle (Fig.10) that farmers in North India (specifically in the Punjab region) would scrape up using old automobile parts, wooden planks, water pumps for engines etc. Hence, the origin of the word comes from ‘making do’ with limited resources, yet getting the job done.

The word Jugaad is used loosely by people in daily language to refer to a ‘hack’ or an ‘innovative fix’- making use of resources at hand to find a solution or fulfil the immediate need either by making existing things work or something new from meagre resources. Hence in some contexts, jugaad might have a negative connotation attached to it. The ‘will do’ attitude could imply cutting corners, a temporary solution ‘just good enough’ to satisfy immediate need or an unofficial method of getting something done by alternate means that may or may not be ideal; but either way gets the job done. The individual innovator with Jugaad skills



Fig.9 Jugaad vehicle powered by an agricultural water pump engine

Source: [3]



Fig.10 Jugaad vehicle engine being hand-started

Source: [3]

or a 'Jugaadu' is someone who uses his/her smartness to make things work with whatever resources at hand. Jugaad has come to refer to a mindset, born out of historical scarcity and an environment of uncertainty, which emphasises on flexibility and ad hoc improvisation as a way of getting things done. Jugaad means different things in different contexts, but it's fundamentally the art of "making things work" in the immediate present circumstances, without necessarily being concerned about long-term sustainability or systemic impacts. Jugaad enables people to come up with quick, innovative and low-cost ways of solving problems, and to make something work even when conventional wisdom says it isn't possible. It's a philosophy that is at the heart of Indian entrepreneurial energy and optimism. Hence, this mindset encompasses both – a sense of frugality (careful use/management of resources) as well as a short cut (or sometimes even a lazy) approach to getting things done. On one hand, there are certain ideas associated with this concept: frugality, flexibility, simplicity, innovation and intuitiveness. On the other hand, there are other notions as well: fast, quick, temporary, 'chalega' (Hindi; just good enough to work), 'baad mein dekhenge' (Hindi; will see later).

This poses a dilemma:

Can Jugaad only be applied to short term solutions?

Can Jugaad be a driver of transitional change (long term)?

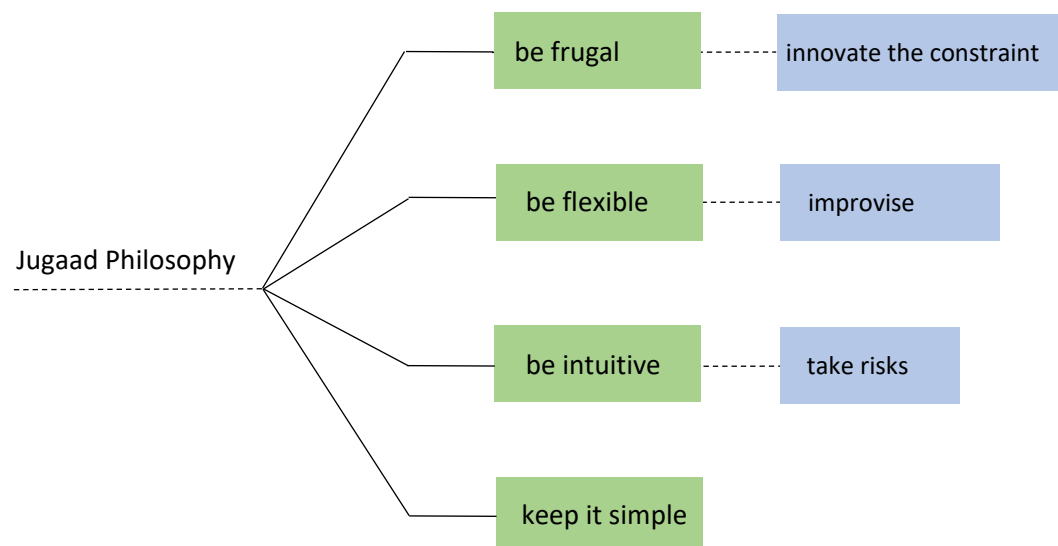


Fig.11 Jugaad Philosophy

Source: drawn by author

3.2| Main conceptual components of Jugaad

To answer these questions, it is important to understand how the Jugaad approach works in the entrepreneurial and innovation context. Following are the characteristics or value systems that drive Jugaad Innovation, divided into 4 broad categories:

- 3.2.1 Frugality
- 3.2.2 Context – Place & People
- 3.2.3 Simplicity
- 3.2.4 Low environmental impact – Green

3.2.1| Frugality

The concept of frugality is ingrained in jugaad, right from finding new uses for everyday objects like the Indian household where empty mineral water or carbonated drink bottles are reused as ad hoc containers, to examples like the makeshift truck cobbled together with an old diesel engine placed onto a wooden platform of a cart (Radjou et al., 2012). Jugaad uses this concept of frugality to make constraints work in its favour or in other words, innovates the constraint. For example: Kanak Das, a jugaad innovator from a village in the North-Eastern state of Assam, like many rides his bicycle to work every day. But the pot holes and bumps on the roads slowed him down. Instead of waiting for the road quality to improve, he retrofitted his bicycle - every time the front wheel hits a bump, a shock absorber compresses and releases energy to the back wheel; making his bicycle run faster on bumpy roads (Rajdou et al., 2012). Hence, Jugaad Smartness is about making these proverbial or in this case, literal bumps work for you. Another important aspect is constant improvisation as and when the environment or situation changes. Trial and error are part of the process – innovation is a never-ending experiment where one needs to adapt and evolve over time. This flexible thinking is what allows jugaad innovators to navigate around any obstacles that come their way or just the adversity of the environment. As mentioned before, frugal innovation reframes constraints and challenges as opportunity for growth and improvement. It is the **ability to do more with less**. As Womack and Jones define it: 'Lean thinking is lean because it provides a way to do more and more with less and less, less human effort, less equipment, less time, less space – while coming closer and closer to providing customers with exactly what they want.' These customers as mentioned before are the disadvantaged or underserved group that usually get left out. **Scale of operations** is a prerequisite for making an economic case for the BoP.

One such example is that of Aravind Eye Care System - the largest eye care facility in the world, headquartered in Madurai, India. Doctors at Aravind perform more than 200,000 state-of-the-art cataract surgeries per year. Frugally innovative methods were employed to improve efficiency and help doctors save valuable time between surgeries like nurses prepare the next patient while the doctor is operating on a different one; the doctor moves directly from one patient to the next. Each doctor at Aravind performs about 2600 surgeries per year. These measures have pushed down the average cost of surgery [4]. Aravind also started an intraocular lens production facility, Aurolab in 1992. In the 1990s, there were no lens manufacturers in India. With lenses costing \$200, they were highly unaffordable for most. Aurolab devised efficient methods for creating lenses as per international standards at the low price of just \$2 each. The cost of the surgery is not more than \$25 for a basic cataract operation with intra-ocular lens (Khan, 2016). With only 40 percent of paying patients at such seemingly low prices, Aravind is nevertheless very profitable. The high level of quality at Aravind attracts patients from all over the world who are willing to pay the market price for their treatment and surgeries. The profit generated from these patients is then used to cross-subsidize and fund free surgeries for poor patients (Govindarajan et al., 2011). Hence, low price does not mean low quality service, but the system of functioning needs to be adapted to the nature of the customer. The idea of a successful jugaad innovation is to provide for a large number of people and get maximum gains from minimum costs.

In this case, large volumes helped to spread fixed costs over a large population. The process is efficient and at the same time is able to meet its social mission to help those in greatest need by innovating as a business.

- The fact that it promotes social inclusion by serving the marginalized groups who normally do not receive quality (or any) healthcare, makes it a socially sustainable business.
- At the same time, it provides large scale employment along with structured training programs to healthcare professionals and associated workers.
- Lastly, it has emerged as a successful and sustainable business model that has now expanded its services to 11 Indian cities.

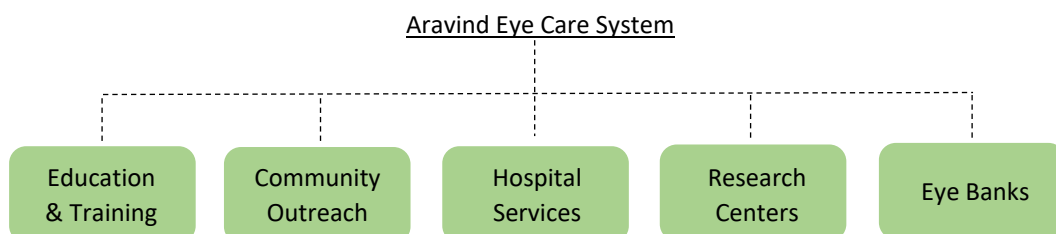


Fig.12 Aravind Eye Care System

Source: drawn by author

Converting the poor into a market requires innovations. The BoP (bottom of pyramid) demands a range of innovations in products and services, business models, and management processes (Prahalad, 2005). Their problems require systemwide reform not partial measures.

One such example of a systematic reform is in the field of agriculture – ITC’s e-Choupal initiative. While 66% of the Indian population earns its livelihood through agriculture, it makes up only 23% to the Indian GDP (World bank, 2017). Most of the agrarian workforce is based in rural India. There is a vast disparity in access to education and opportunities between urban and rural India. This means the farmer rarely knows of nonagricultural opportunities and does not have the resources to pursue opportunities even when he knows about them [5]. The e-Choupals are information centers linked to the Internet. Their role is to connect farmers with large firms, current agricultural research, and global markets. Each center is operated by a local farmer in each community called the sanchalak. The sanchalak undergoes a basic training program in computer usage, business skills, quality inspection and pricing. For the sale of products through the e-Choupal, the sanchalak receives product training directly from the manufacturer, with ITC involving itself only in product design and facilitation (ITC is a large Indian food and agribusiness company). The farmers benefit by realizing better prices for their crops, better yield through better practices, and the advantages of being connected with the rest of the world. The traditional system of agricultural trade is run by markets called mandis. The mandi acts as a delivery point where farmers bring produce for sale to traders. The inefficiencies of this system lie in that fact that the actual price of the produce will be determined only at the auction (at the mandi); the farmer does not have the resources to analyze or exploit price trends beforehand. ITC devised a strategy to systematically deploy IT to change the game in each area – from the field to the trade; to optimize effectiveness, scalability and cost. Today e-Choupal services reach out to more than a million farmers in nearly 11,000 villages through 2,000 centers across four states in India [6]. Apart from better information content and timing in terms of pricing, farmers also get a chance to innovate. They are now coming up with products and services (mutually profitable solutions) that ITC could provide to further improve their operations.

[5] World Bank, 1997, India - The Indian oilseed complex: capturing market opportunities: Main Report (English). World Development Sources, WDS 1997-2. Washington, DC: World Bank. Available online: <http://documents.worldbank.org/curated/en/461811468752374364/Main-Report> (accessed on 17 August 2018).

[6] ITC, e-CHOUPAL. Available online: <https://www.itcportal.com/businesses/agri-business/e-choupal.aspx> (accessed on 17 August 2018).

In both the above-mentioned examples, human well-being, access to services and social sustainability are being promoted. These frugal innovations have positive societal effects and the potential to fulfil some pressing needs. Even the poorest sections of society gain access to essential services through such innovative models. The BoP is an untapped market with a large consumer base and an even larger potential. These innovations put forth a win-win scenario – both for the BoP consumer as well as for the firm/organization. The relationship between the consumer and the firm at the BoP market is symbiotic: they co-create value.

3.2.2 | Context – *Place & People*

As mentioned before, it is important to consider the context/setting to develop solutions (technologies/innovations) that are appropriate for an area. Many policies are emphasizing on the importance of taking into account the local conditions of the respective area. According to the OECD, **place-based innovation** is the “new paradigm of regional policy.” Place-based initiatives inherit a strong bottom-up element in public governance. A fundamental part of the place-based approach is that it allows responses to be tailored to local conditions, according to the specific characteristics of the respective place. Institutions and public bodies such as local governments and local initiatives are central to shaping the success or failure of place-based initiatives.

Hence, a place-based development policy is a long-term development strategy that aims to provide place-tailored public goods and services, designed by aggregating local preferences and knowledge and implemented through participatory political institutions (Stahlecker and Koschatzky 2010). In the Barca-Report it is argued that the approach can be particularly effective since it responds to the need for tailoring interventions and economic institutions to local conditions; a need that has been forcefully stressed by recent advances in the theory of growth and development. The design and implementation of place-based innovation and technology policies are built on collaboration and multi-level governance. One size-fits-all policy delivered from above is not conducive to integrated place-sensitive solutions (Tödting and Trippel 2005). An example of a place-based innovation is Sarvajal.

Sarvajal (Piramal Water Private Limited) is a social enterprise in India that aims to tackle the problem of access to clean drinking water in various rural villages. This organization has set up reverse osmosis plants across 16 Indian states. It is not a charity and uses a professional team to establish appropriate pricing. Today, the water is sold at 25 liters for less than 10 cents (Gambhir et al., 2012). The innovation developed by Sarvajal depends on reverse osmosis and ultra-violet technology that run on reliable electricity supplies. The company opted for a franchise model to expand its reach and has been able to enlist 117 franchisees since its inception in 2008. Currently, this enterprise provides safe drinking water to around 430,000 people per day [7]. Apart from tackling core social issues, franchising has supplementary local benefits that derive from the development of entrepreneurship and the creation of training and employment. It is creating a pool of individuals well versed in local needs and more aware of the means of meeting these needs.

When Sarvajal initially started out, their first challenge lay in explaining why their customers should pay for something that had been available to them for free, although frequently contaminated. Potential customers found it amusing that people would actually pay for water that was provided free of charge by nature. To tackle this problem Sarvajal employed local men and women from the communities they work in, to run educational campaigns that spread awareness about the level of contamination by various pathogens in local water, and the impact that these might have on the long-term health of the community. As people come to understand the benefits of clean drinking water, they begin to register as customers. These individuals know the local dynamics intimately and are the best equipped to catalyse long lasting sustainable change. Technology alone does not make a solution viable - consumers need to be empowered and aware.

Public service innovation has been defined as “creating a new approach to public service, putting it into practice and finding out if it works” (Hambleton, 2015). Hence, it is a process in which new solutions are generated by working *with* people, not *for* them. The co-creation of public services – a process that embraces co-production, co-implementation and co-management, can lead to radical new solutions. The idea is to focus on people as:

- Consumers: refers to the end-users of the goods and services provided and hence, can give input or feedback about these goods/services that they consume
- Customers: refers to those who provide remuneration for the goods/services offered; this implies giving attention to the experience of the person using the service as well as building a relationship with this person
- Citizens: refers to someone who has the right to influence public decisions; free and responsible citizens who know what they need and can help in improving the goods/services provided to them



Fig.13 Public Service Innovation: Co-creation

Source: drawn by author

Improvement of public services lies within the realm of traditional performance management. The focus is on delivering more of the same or similar services in an even more cost-efficient manner (Hambleton, 2015). Innovation is a step beyond this conventional approach. To innovate it is essential for an organization to recognize that it cannot continue to do what it already knows or has been doing. It involves risk taking – an experimental approach that works on a ‘let’s try and see basis’. Innovation is not just about having a radical idea, implementing the idea and making it work is the challenge. Innovations and technologies can be useful if they complement and are used by people to their advantage as intended. It is people/users who drive innovation and change.

An American HIV specialist Mitch Besser arrived in Cape Town in 2000 and was surprised to see that expecting mothers refused to take the drugs needed. Women rather lived with the disease than face the stigma attached to it. For nearly two years he tried to convince these women newly diagnosed with HIV to return to his centre and start taking the drugs, but with fail. The disproportionate ratio of patients to healthcare professionals put a large burden on the nurses, who when Besser arrived had to attend 40 patients a day. The system lacked empathy, the situation needed to be handled with a lot of care and the deficiency of healthcare professionals did not help. One day Besser noticed an older mother, who was HIV+ and taking the drugs she needed to control the condition, counselling a younger mother newly diagnosed with the disease. Because of this support, the younger mother continued coming back for more treatment.

Besser realized that mothers were far more likely to listen to other women in the same shoes. This gave birth to Mothers-2-Mothers (M2M). Mothers are recruited as mentors, given two weeks' training and a modest stipend to support them. They then go to healthcare centres, counselling other women, providing practical tips from their own experiences, talking about how to cope with the stigma and most importantly providing emotional support (Leadbeater, 2014). By 2016, M2M was operating in 10 African countries, employing over 1600 mentor mothers. Almost 2,000,000 new clients were reached by mentor mothers either directly or by partnering with governmental organizations and NGOs [8].

The M2M solution is not technical or scientific but social: mothers working with one another (Leadbeater, 2014). 'With' solutions in which people are participants in creating solutions rather than just receiving goods and services designed for them by professional systems, are social and inclusive. They consider the social aspects of problems and hence, the solutions are not just efficient but also effective for the target audience in the target place.

Jugaad systems lack resources of industrial systems, which compels them to exploit the human tendencies of trust, cooperation and mutual self-help. These qualities help reach parts of the problem that bureaucratic, professional systems are unable to generally reach. Cooperative solutions can further lead to lower costs by operating efficiency at scale – having a wider reach and getting more out of limited resources. They engage and mobilise people as contributors and not solely consumers (Leadbeater, 2014). Doing things together and forming relationships comes naturally to humans. This aspect of human behaviour is tapped into by jugaad innovators to generate problem solving innovations. Further, digital services can contribute to this shift towards shared, collaborative forms of consumption by connecting people, services, knowledge and objects. This collaborative consumption offers leaner solutions – more use/value can be derived by sharing assets.

Going back to the point of public service innovation, one of the main challenges of innovation is to understand how a product or service will fit into the lives of consumers. In the case of M2M, mentor mothers and the women they interact with create a strong social network. They have the capacity to spread innovation just by word of mouth recommendation and emulation. These relationships can be at the core of effective solutions in education, healthcare and welfare in general. Also, the mentor mothers have informal and social knowledge of how to cope with HIV specifically in that social context, which medical professionals do not have. They are the missing link between the patients and the medical system and can hence create better solutions that were formerly lacking.

Consumers know what they want or need, they are increasingly dissatisfied with existing offerings and are seeking personalized solutions. This is especially applicable to the tech-savvy millennial generation (those born between 1982 and 2004). They are evolving from passive individual users/buyers into communities of empowered ‘prosumers’ (Rajdou and Prabhu, 2015) who collectively design, create and share the products and services they want. The co-development of solutions ranges from validating new product concepts and features to co-designing entirely new solutions. Enterprises can use digital platforms such as social media to test product ideas and features. This customer feedback helps eliminate unviable ideas in the early stages of development, saving considerable amount of time and money that can be devoted to solutions that customers actually want. Customer involvement is not just limited to constructive feedback. IBM has a program called First of a Kind (FOAK) that brings together pioneering clients and IBM’s R&D teams to co-invent breakthrough business solutions with cutting-edge technologies. In this way the company can test the market viability of new technologies with leading clients before releasing them on a larger scale.

Similarly, Unilever has an online portal which gives the public a platform to bring forth solutions to various social needs, such as improving access to safe drinking water and storing renewable energy. These ideas help Unilever to develop better products and improve services.

Consumer involvement ranges from large global companies to small social ventures. The logic is simple – those who will eventually use the product or service can and should have constructive contribution to the process of providing that product or service. These ‘prosumers’ can help identify new ideas or issues in existing ones and then develop them into products/services in a faster, better, cheaper way.

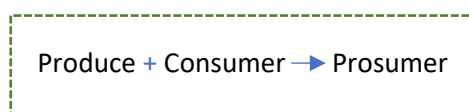


Fig.14 Evolution of the Customer

Source: drawn by author

An innovation model that starts out with customer insights and looks for ways to solve their real problems instead of pushing new technologies onto them, is based on the principle of Engage and iterate (Rajdou and Prabhu, 2015). This cannot be achieved in the confines of a R&D lab, but by engaging with customers in their actual settings to identify their real needs. Large firms with advanced and costly R&D practices are generally built on long and rigid processes that keep the customers at arm’s length. These large corporations are hence not informed enough about for instance, how poorer areas function and what are the requirements of their inhabitants.

SELCO (Solar Electrical Light Company), founded in 1995, set out to provide solar energy to the rural poor of India with the intention of debunking certain myths: poor people cannot afford or maintain sustainable technologies; social ventures cannot be run as successful commercial businesses. Harish Hande, the founder of SELCO faced a major obstacle when he first started out – his potential customers were not able to afford the up-front costs of buying and installing his solar lighting system. The solution - Hande involved a network of small-scale entrepreneurs in the rural communities he wanted to sell his product. These grass root entrepreneurs would own and maintain the solar panels and batteries and rent them out to consumers on a pay-per-use basis (Rajdou et al., 2012). This created a network of users, employees and the company. SELCO’s approach provided the local entrepreneurs an incentive to maintain and distribute the equipment over time.

Today SELCO has 50 energy service centres across five Indian states and has sold, serviced and financed over 200,000 solar systems since 1995 [9]. It has not only provided employment to its own employees but also to many rural entrepreneurs who rent out solar lights to vendors and institutions.

Other than logic, intuition is also required to innovate in some cases. Hande dared to think the unthinkable, he took a risk and succeeded. Jugaad Innovation is a collaborative process, partnering up with other innovators and organizations who are also thinking flexibly and creating smart solutions helps expand the scope of the innovation. The expertise of the marginal groups can and should be used. Their local/informal knowledge is a social advantage that grassroots entrepreneurs make use of. By employing or working with people from the communities that one is trying to help/serve, one gets access to the local knowledge which is valuable for implementation of the innovation. Having an idea is the relatively easy part, putting that idea into practical use is the challenge!

3.2.3 | Simplicity

Keep it simple: Complexity is costly – creating, buying and maintaining complex products is expensive; complex procedures come with higher costs. Simple products on the other hand, are cheaper to make and therefore more affordable. Resources in emerging markets are scarce and costly. Simple solutions use fewer resources and hence are easier and cheaper to produce and consume. They are also easier to install and maintain. Simple designs are inviting to use – they do not require special skills or support systems. “Designing simple products is the key to achieving universal appeal across diverse groups” (Rajdou et al., 2012). India is producing more and more of these simple products.

A prime example is the Nokia 1100. After studying migrant workers in Indian slums, Nokia's ethnographers realized that regular mobile phones were too expensive, complex and dainty for slum dwellers who live and work in dusty, electricity shortage environments. Nokia set out to develop a simple solution for this target audience.

The result was the Nokia 1100 (priced at 1100 INR = 15 USD approximately). This model had a minimalistic design with basic functions of calling and texting, was sturdy and had a long battery life. The additional flashlight feature made it very popular among the truck and bus drivers in India who use it as a light source at night. The model launched in 2003, became an instant hot seller amongst not only the low-income groups, but also the middle-class users looking for an uncomplicated mobile phone. The Nokia 1100 has sold 250 million units around the world, making it the best-selling mobile phone ever [12].



Fig.15 Nokia 1100 was advertised as a phone 'Made for India'

Source: [10]

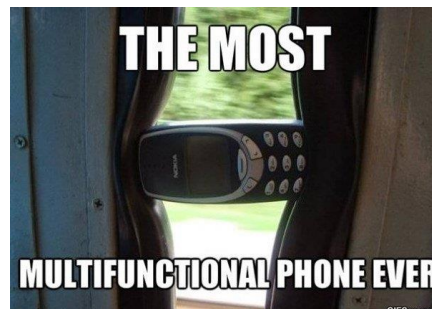


Fig.16 One of the many popular jokes about how sturdy the phone was

Source: [11]

[10] Available online: <https://www.coloribus.com/adsarchive/prints/nokia-1100-mobile-phone-coconut-tree-6544955/> (accessed on 13 August 2018).

[11] Article: These Nokia Memes Are More Popular Than Nokia Smartphone's: A Tribute To Old Nokia. Available online: <https://www.techleaksofficial.com/2018/06/these-nokia-memes-are-more-popular-than.html> (accessed on 13 August 2018).

[12] Article: Nokia's cheap phone tops electronics chart. Available online: <https://www.reuters.com/article/us-nokia-history-idUSL0262945620070503?mod=related&channelName=technologyNews> (accessed on 13 August 2018).

Keep it simple, not simplistic: Simple does not necessarily mean simplistic. Simple solutions can be used to tackle complex problems. Systems that allow all the pieces to fit well seamlessly can fit smoothly into daily life. Take a practical example: ‘saving lives at birth - a simple solution to a complex problem’.

Dr. Sathya Jeganathan is a paediatrician in Chengalpattu Government Medical College, a rural hospital in the South Indian state of Tamil Nadu. She faced a high rate of infant mortality in her clinic – on an average, 39 out of every 1000 infants died at birth. Wanting to decrease infant mortality in her hospital, Dr. Jeganathan tried to import incubators from the U.S., but soon realized that this wouldn’t be an economically or socially viable option. The setup costs of these incubators were extremely high, and the staff and maintenance required to handle this equipment was not suitable for her hospital. So, she designed a low-cost infant warmer with local craftsmen and neonatal nurses. This minimalist incubator comprised of a wooden table made from locally harvested wood, a Plexiglas top and standard 100-watt light bulbs that would adjust according to the baby’s temperature (Singh and Lillrank, 2015). The simple design made it easy to use and maintain. Once the first working prototype of the incubator was implemented by Dr. Jeganathan in her hospital, infant mortality reduced by 50 percent. Now she is working with the Lemelson Foundation, a U.S.-based organization that supports entrepreneurs in emerging markets, to rescale her invention so it can be distributed across other rural hospitals in India [13].

The cost of high-end incubators can go up to 20,000 USD. Dr. Jeganathan’s incubator on the other hand costs only 100 USD to build. It carries out the same fundamental function as the former: keeping babies warm. “Rather than offering overengineered products, jugaad innovators in emerging markets offer products that are easy to use and maintain and address customers’ fundamental needs.” (Rajdou et al., 2012). Their simple inclusive design appeals to a wider audience from diverse socio-economic groups.

So, can we say jugaad solutions are more than ‘just good enough’? Are they in fact better?



Fig.17 Dr. Jeganathan’s Baby Incubator

Source: [13]

Bigger isn't always Better: Jugaad innovators focus on creating no-frills, straight-to-the-point products that provide the customer what they really need. This simplicity makes their solutions affordable and accessible to not only the mainstream customers but also to those at the bottom of the pyramid. Devising these kinds of solutions only comes from working with the constraints of demanding environments. These conditions enable people to go the extra mile to find simpler, durable solutions that meet the needs of people.

Take the motorcycle ambulance for instance – a robust motorcycle with a sidecar compartment where a patient can either sit or lie down on a specially adapted stretcher. These vehicles are nimble enough to reach areas that are otherwise inaccessible by four wheelers. This simple concept is helping save lives in remote regions where people had been dying because they could not make it to the hospital on time. The solution emerged out of adversity – underserved areas with lack of (or no) road infrastructure. The jugaad mindset converted something people already use into a small solution to a big problem.



Fig.18 Motorcycle ambulance, India
Source: [14]



Fig.19 E-Ranger, Malawi
Source: [15]

Simpler is invariably better. Simple solutions tend to be easy to use, accessible, low-cost, inviting and most importantly, they serve a clear need. Their no-frills nature entails minimum use of resources. This not only makes them simple and 'lean', but also 'clean'.

[14] The Indian Express. Article: 'Motorcycle-ambulances help save lives in Chhattisgarh forests', 2016. Available online : <https://indianexpress.com/article/lifestyle/health/motorcycle-ambulances-help-saves-lives-in-chhattisgarh-forests-2935290/> (accessed on 20 August 2018).

[15] The Guardian. Article: 'Could motorbikes cut deaths in childbirth in Africa? 2009. Available online <https://www.theguardian.com/society/katineblog/2009/may/13/motorbike-ambulances-childbirth> (accessed on 20 August 2018).

3.2.4 | Low environmental impact - Green

There seems to be a trade-off between green solutions and prices. Generally green/organic/ecofriendly alternatives are expensive – customers pay a premium for them. In contrast, constraint-based innovation is driven by resource scarcity and/or the motivation to use the least possible resources in developing solutions. The entrepreneurial spirit behind it is, Jugaad. The intended benefits of jugaad: these products/services are affordable to a broader market. It also has unintended benefits: judicious use of resources reduces material consumption, conserves scarce resources. Hence, the jugaad approach not only reduces prices but is also environmentally sustainable which is the whole point of green solutions. Therefore, Green products can be made for emerging markets.

There are various examples across different periods in human history of innovators who would combine or recombine different component parts to create novel inventions or innovations with limited resources/under constraints. Such innovations are called Combinatorial Innovations (Varian, 2003). They are based on the principle of Yukti, the Sanskrit word which means “union, combination, junction, and connection” (Monier-Williams, 2005), an important element of the concept of Jugaad. The focus of the jugaad approach is on leveraging existing scarce resources to generate market value. Thus, available technologies, skills and processes are assembled to create new combinations that are more accessible by a wider audience (Sharma, 2012). It involves re-thinking processes and improving on existing ones.

For instance, all over India street vendors sell flavored frozen water in small plastic tubes, called ‘Pepsee’ which is popularly consumed. When small holes are made in these thin tubes, they become perfect for drip-irrigation. It is uncertain when and where this idea of turning pepsee into a drip-irrigation system came from, but once it did, it spread like wildfire. The plastic tubing is cheap - one-kilogram roll costs only 50 INR (less than a dollar). This means that a farmer can create a drip-irrigation system for 50 USD per hectare. Also, the rolls are light weight, so they can be easily moved to water more land (Leadbeater, 2014).

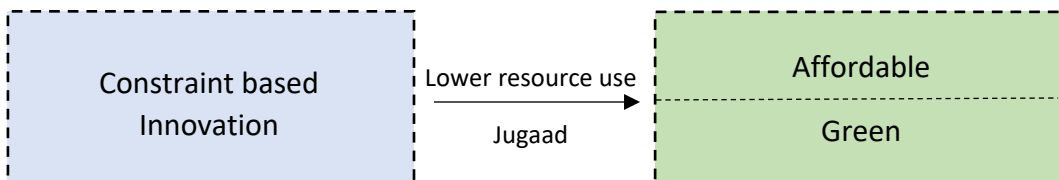


Fig.20 Green Constraint-based Innovation
Source: drawn by author

To make such jugaad systems work, another component is required: an organization to bring all the processes together. In much of the developing world social entrepreneurs are pioneering local jugaad solutions which are sustainable because they are designed to work for producers and consumers with limited resources. With the vast majority of the world's population living in developing countries, it is these grassroots initiatives and social ventures that would play a crucial role in meeting sustainable development objectives (Sharma, 2012).

Every community has an innate capacity to come up with effective solutions to solve the problems they face on a daily basis (Gupta et al., 2003). According to this view, rather than tapping into underserved consumers, grassroots innovators aspire to address social problems by providing appropriate, socially acceptable and sustainable solutions. The argument is that under conditions of scarcity, the human mind is stimulated to think "out of the box" (Keupp et al., 2013). Hence, it is likely that "more innovative, sustainable solutions will increasingly emerge from serving the BoP markets than from the developed markets" (Prahalad, 2004).

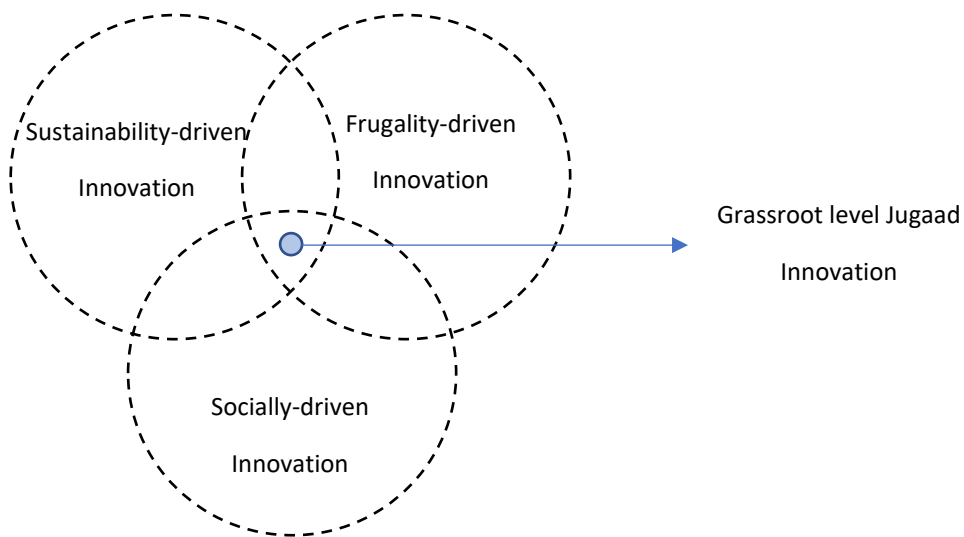


Fig.21 Grassroots Innovation: intersection of three dimensions

Source: drawn by author

Take the case of Arunachalam Muruganatham (AM), a jugaad innovator from India. AM comes from a very poor family in the Southern city of Coimbatore. He was shocked to discover that his wife and all the other women in his village and surrounding villages used old rags or even husk as sanitary pads during menstruation. Poor women could not afford to buy the sanitary pads mostly manufactured by MNCs in India. He calculated that the pads were being sold at more than 40 times the cost of the raw materials [16]. AM then set out to make a hygienic sanitary pad and create a simple machine to make cheap yet quality sanitary pads. Given the strong social stigma associated with sanitary pads, he encountered great difficulty in finding volunteers to test his early prototypes. After working on his idea for nearly five years, he was able to finally create a low-cost machine using materials at hand. This innovation is gradually revolutionizing menstrual health for rural women in India. AM's technology is a valuable low-carbon alternative to large-scale plants. Furthermore, according to the inventor, the machine can be in the future adapted to use other natural fibers like bamboo and banana leaves [17]. There is also an on-going diffusion of his innovation to different parts of the developing world.

In conclusion, there is no special attention paid to sustainability in jugaad processes. The focus is on using available resources to their maximum potential in order to derive maximum benefits/value from them. Limited use of resources itself is an environmentally friendly strategy - sustainability and lower environmental impact are merely consequences of jugaad. Innovation is generally associated with the invention of the new, from scratch and using additional resources. It instead needs to involve 're'-thinking- making better use of what we already have. That means reusing existing technologies and developing existing ideas because they are cheap to develop and put in practice; designing products in a way that they can be reused over and over again. To meet expanding needs within tightening constraints, we need innovation guided by the ethic of 're'.

42

[16] BBC News. Article: 'The Indian sanitary pad revolution'. Available online: <https://www.bbc.com/news/magazine-26260978> (accessed on 22 August 2018).

[17] The Economist. Article: 'Cut from a different cloth'. Available online: <https://www.economist.com/business/2013/09/14/cut-from-a-different-cloth> (accessed on 22 August 2018).

3.3| Transitional change and its relation to Jugaad (long - term durable change)

In response to the various contemporary problems – food, water, transport, mobility, healthcare, education, energy, climate; we need innovation that provides long term solutions, not short-term fixes. In short, radical transformations towards a sustainable society or **sustainability transitions**. To understand the relation between sustainability transitions and Jugaad, let's look at some concepts associated with the theory of transition.

3.3.1| Theory of transitional change

Co-evolution:

In the transition context, co-evolution occurs in a scenario where interaction between societal subsystems influences the dynamics of the individual subsystems, leading to irreversible patterns of change (Kemp et al., 2007). Transitions are co-evolution processes that involve both the development of technical innovations and their use/application at a societal scale. This use includes the immediate application by the intended consumers as well as broader embedding of these technologies in the system – policies, regulations, infrastructures, markets.

Importance of users:

Users are not passive innovation consumers, but active agents, that provide crucial insight which if used can be very helpful in technological development. The end users hence ought to be involved in design decisions. The involvement of users is crucial because they provide feedback about how the new technology matches their preferences and requirements. Lundvall (1988) described innovation as an interactive learning process, where user-producer interactions are crucial. Users can articulate unforeseen problems and propose innovative solutions (they bring practical knowledge and personal experience to the table). Along with all the other factors, co-evolution of users/consumers is also essential.

Multilevel perspective:

Transition as a result of the interference of processes at three levels – innovative practices (niches), structure (regime) and the landscape/context (Grin et al., 2010). So, innovation alone cannot make a change, it must be supported by the structural system and the landscape/long term exogenous trends. Transition is a multi-level process.

Socio-technical regimes comprise of different groups – policy makers, users, innovators and special interest groups. These social groups interact and form inter-dependent networks and hence, co-evolve. The core problem of transitions is not the development of innovations and new technologies, but their relationship with the existing regime. Innovations are important, because they are the seeds of transitions. But “the environment into which the seeds are sown is, of course, the main determinant of whether (and till which extent) they will sprout” (Mokyr, 1990).

Multi-phase perspective:

Along with being a multi-level process, transition also has multiple phases. A system innovation is a transition from one socio-technical system to another (Geels, 2005). Innovations and advancements in technology have historically contributed to system innovation and hence, transitional change. A standard example is the shift from horse-drawn carriages to automobiles. This transition led to firstly, the obvious change in infrastructure in terms of road network. Secondly, regulations and traffic rules were devised to deal with the increasing number of vehicles. There were political and institutional impacts as well – policy makers had to make decisions about allocating funds to transport infrastructures. Lastly, this led to the development of a new automobile industry. Hence, all these elements co-evolved and overlapped for the transition to take place.

Phases in system innovation:

The first phase is the emergence of the novelty which generally happens in order to solve some problem in the existing regime. The context is crucial for innovation. Because there is uncertainty about the best technical design, actors improvise on the basis of the design rules from the existing landscape and engage the users to find out what they want. Design of new technology is often initially interpreted with that of old technologies. It's a back and forth process (re-thinking), not necessarily new technologies from scratch but improving existing ones (Leadbeater, 2014). This means that the notion of radical innovation may well be ex post.

The second phase occurs when the new technology is improved by customer engaging, trial runs, feedback. New practices are often inspired by old ones that no longer worked in new settings (Marvin, 1990). Like mentioned before, these novelties emerge in order to solve problems or meet some requirements that are not being met in the existing regime. But it is not only existing problems, expected problems are also important. Scarcity of resources is an existing challenge faced by developing nations. Yet, the frugal approach is something that should be adopted by developed nations as well.

The third phase is when the new technology diffuses and becomes established in the existing regime. With the breakthrough in mainstream markets, the new technology enters in a competitive relationship with the established regime. Lastly, new technologies gradually replace the old or function in addition to the old – serving different groups. The creation of a new socio-technical regime requires a wide range of transformations – new infrastructures, policies, user practices, organizations, dynamics. These adjustments can take time.

Social learning:

Knowledge is developed through interaction between various stakeholders – in this way there is interaction between different types of knowledge: technical, practical, personal experience. Hence, innovation is a collaborative process that takes advantage of different types and forms of expertise and can penetrate at the societal system level (stakeholders jointly try to find sustainable solutions to shared problems). *Transitions are multi-actor processes* and require collaboration between these different actor groups. There is an inherent connection between the social and technical aspects. Technologies are always “technologies-in-context” (Rammert, 1997) and need to fulfil a function in that context.

3.3.2 | Relation to Jugaad

Sustainability transitions can also be defined as a quest for new value systems (Grin et al., 2010). As mentioned before, Jugaad is generally looked at as a quick fix or a solution to fulfil the immediate need. Yet when we look at it through an entrepreneurial lens, jugaad is really an improvised solution born from ingenuity and cleverness (Rajdou et al. 2012). The entrepreneurship spirit of jugaad is to find innovative and creative solutions for everyday needs/problems of people, particularly those who are disadvantaged. The Jugaad innovation approach functions on certain values – frugality, context appropriateness, simplicity and environmental sustainability. Hence, it is lean, social, simple and green. These values/characteristics make the jugaad approach to innovation more than ‘just good enough’.

Jugaad solutions are robust – they are designed to be long-lasting, to be used over a period of time and not to become obsolete quickly or be replaced by a newer technology. They aren’t just temporary solutions.

Jugaad solutions are rooted in context. They are designed with the focus of meeting the actual local needs. They make the most of what is available, including human resources. The local entrepreneurship, workforce, knowledge, relationships and connections are utilized as a social advantage over other forms of innovation that tend to keep this valuable resource at arm’s length. Users are active agents who contribute to the process to make the end result more efficient and effective.

The Jugaad approach is to do 'more with less'. To make use of the available resources and derive maximum benefit out of them. This frugal mindset is not only of the innovators/producers, but also of the consumers. Consumers want 'paisa vasool' (Hindi), which literally translates to getting the return on your money. It is the drive to extract every last drop of value from a purchase, so people feel that they got their money's worth. Consumers with a frugal mindset want to use an item to its fullest, without any form of wastage. This requires constant re-invention: things are re-used in different ways, recycled, passed down and shared. This is the jugaad approach or mindset that is common to both the innovator and the intended user of the innovation. This approach not only makes these solutions (goods/services) affordable in terms of price and hence accessible to a larger number of people, but also makes them environmentally sustainable. The use of least possible resources reduces relative impact on environment. Jugaad systems are and ought to be clean in addition to being lean considering the expansive population they have the potential to cater to. Otherwise, low-cost solutions simply breed more demand and so take a toll on the environment.

Jugaad systems are simple and hence produce simple, inclusive solutions that can be accessed and used by maximum and a variety of people. Even though they are simple, these solutions can solve complex, widely prevalent problems specially for those groups who are generally ignored and need innovative solutions the most. These ideas can practically be implemented and hence easily used.

To conclude, Jugaad innovation is sustainable. It can be a driver of long-term durable change. What it needs is a System. A system in terms of policies, regulations, infrastructures and markets. All these elements need to co-evolve in order for it to be embedded in the structure. It cannot be successful if the environment into which it is implanted is not supportive. Scattered innovations at small scales in comparison to the larger scheme of things will not be able to make a significant difference. What is required is a larger structural system that channels and harnesses the Jugaad Innovation approach and concept to be a catalyst in transitional change.

Chapter 4

Jugaad solutions for Sustainable Transition

4.1 | Regime – Niches Dynamics

As mentioned in the previous chapter (section 3.3.1), **transition** is a multi-level process that involves three distinct levels – innovative practices (niche experiments), structure (the regime) and long-term exogenous trends (the landscape). Transitional change can only come about when these niche technical innovations serve their intended users and when they get embedded into the regime. These niches can only make a difference if the regime into which they are intended to be embedded is supportive. Hence, the relation between the niche and the existing regime is what is crucial. The Regime/structure and Niche in this case consist of the following elements:

Regime

Government	policies/regulations/infrastructure/funding
Market	MNCs/domestic firms
Users	demanding customers with modest means/behavioural norms or mindset of users – e.g. energy or water saving tendencies
Knowledge	technology/science/research

Niche

Innovators individuals/social ventures/companies

Fig.22 Regime | Niche

Source: drawn by author

Innovation is the instigator of transitional change. Hence, innovation in addition to being a multi-phase process, is also governed by the multiple levels of transition – *landscape, regime, niche* (Geels, 2005; Grin et al., 2010). The sociotechnical landscape is the wider context, which influences regime and niche dynamics (Rip

and Kemp, 1998). It consists of long-term trends in markets, industries, politics, society, demographics and the environment; hence is slow to change.

Niches are the incubators of innovation; they provide the right conditions in terms of freedom and space for creative ideas to transform into innovations. Niche actors (such as entrepreneurs, enterprises, start-ups, social ventures, individual jugaad innovators) work on radical innovations that deviate from existing regimes. These niches in the larger context, can be characterized as 'little victories' (Pugalis and Giddings, 2011). They may operate at the grass roots scale but have the potential to be exported to larger scales through networking between the actors involved. Thus, a sum of little victories can result in a larger victory. Empowering niches in terms of resources, finances, favorable regulations and space for experimenting is a key factor for transition (Avelino, 2009). An empowered niche may cluster with other empowered niches and emerge into a niche-regime (Grin et al., 2010).

The multi-level perspective on transitions (Geels, 2011) provides an ideal-typical representation of how the three levels interact dynamically in the unfolding of socio-technical transitions. Although each transition is unique, the general dynamic pattern is characterized by transitions resulting from the interaction between processes at different levels:

- (a) niche-innovations build up internal momentum,
- (b) changes at the landscape level create pressure on the regime, and
- (c) destabilization of the regime creates windows of opportunity for niche innovations.

In the case of Jugaad innovation, the interaction between the three levels and the effect of this dynamic on transition is a non-linear process. In the existing landscape, there is a large demographic at the bottom of the pyramid. The public authority section of the regime is not entirely able to meet the needs and demands of this economic stratum. This problem has created a window of opportunity for novelties/niche innovations to emerge at different scales and stages. These are alternative practices or technologies generally developed by outsider (outside existing regime) entrepreneurs, firms and organizations. These frugal innovations emerge out of existing technologies. Hence, the idea is not to substitute the existing technologies (unlike the Geels model), but to compete with them and add to the pool of available solutions. Increasing competition in the market with more and more value-oriented solutions is good for demanding customers.

The Geels model also talks about the symbiotic relationship between niche and regime: 'Radical innovations are initially developed in niches. If they have

symbiotic relations with the regime, they can be easily adopted as add-on or component replacement. These adoptions are driven by economic considerations (improve performance, solve small problems), leaving most regime rules unchanged. When the basic architecture remains the same, this is a transformation pathway. But the adopted novelties may lead to further adjustments as regime actors explore new combinations between old and new elements and learn more about the novelties. This may lead to technical changes or changes in user practices, perceptions, and search heuristics. This may create space for new adoptions of niche-innovations. Sequences of component innovations can thus, over time and under influence of landscape pressures, add up to major reconfigurations and regime changes' (Geels and Schot, 2007).

Depending on the maturity level of niches (Juggad innovations), they can gradually lead to adjustments in regime rules. Niches can be considered competent and mature when they develop into a tangible solution from an idea; and when this solution can scale up and diffuse to native as well as adapt to other similar contexts. Hence, it's a two-way street: niches need to be developed to make any real difference in the regime and the regime needs to provide a supportive environment for niches to reach a competent level of development. Like in the case of the the niche innovations in the energy and water market (refer to Sections 4.3.1 and 4.3.2) - the innovations were initially adopted to solve particular problems, but eventually enabled adjustments/changes in the basic architecture of the regime: change in user perspectives (water safety, healthcare awareness, community involvement, use of renewable sources of energy), change in stakeholder dynamics (public-private partnerships, role of the government, involvement of large establishments with smaller ventures) and the change in the way research and development is conducted.

It is clear that innovation cannot be carried out in isolation – actors working together is essential for making any tangible impact. 'The linkages between processes at different levels are made by actors in their cognitions and activities, the dynamics (of the transition) are not mechanical, but are socially constructed' (Geels, 2005). Also, niche solutions cannot eradicate all problems on their own. However, taken together and in large numbers, such innovations can and are making a difference. A common criticism is that these models lack scale and cannot therefore make a significant dent on the large challenges in the long term. However, these small-scale models serve as inspiration for other social entrepreneurs to get involved, thus providing opportunities for scaling out. And increasingly, larger organizations including large domestic firms, multinational corporations along with public authorities are becoming involved (refer to Sections 4.3.1 and 4.3.2). Niche innovations cannot acquire substantial momentum until they interact with regime dynamics. Hence, it's a give and take between the regime and niche - all the elements (Fig.22) of the regime/structure and the niche need to co-evolve.

The Jugaad Innovation trend has the possibility to grow in the following stages (Fig.23):

- A niche phenomenon functioning in small segments of society
- A significant trend functioning in distinct, but large section of society
- A mega trend that is adopted throughout society, cutting across social strata

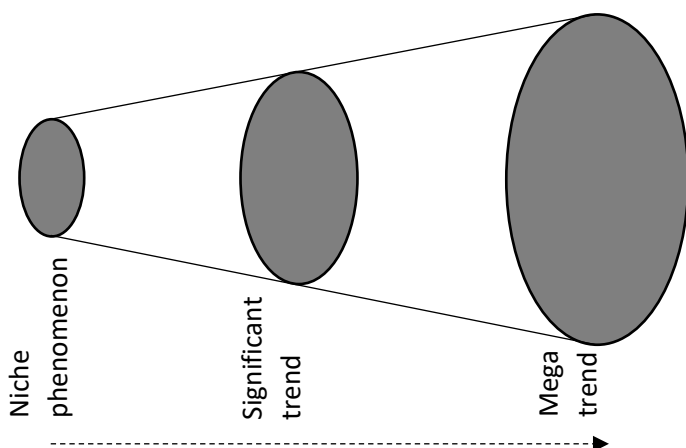


Fig.23 Possible diffusion of Jugaad Innovation

Source: drawn by author

4.2 | Mapping Jugaad Solutions

Following are cases of Jugaad innovation divided into the following spheres:

Healthcare	5
Energy	4
ICT	3
Water	2
Food & Nutrition	2
Transport	2
Miscellaneous	2
Total	20

Fig.24 Cases: Jugaad Innovation

Source: drawn by author


Case <i>Jaipur Foot, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Jaipur Foot is the world's largest provider of prosthetic limbs, with more than 60,000 prosthetic fittings per year in Asia, Africa and Latin America. The original Jaipur Foot was developed in 1968 by Ram Chandra, a sculptor in Jaipur, India. Using rubber, wood and tire cord, he designed and manufactured a prosthetic foot for under 45 USD as compared to its American equivalent costing 8,000 USD.</p> 	<p>Scale is key for this organization – the objective is to provide treatment to maximum people, free of cost. Hence, it is very cost-conscious process. Locally available materials and basic tools are used to create these products. It is a highly labor-intensive process that capitalizes on the large supply of skilled artisans in India and their manageable labor rates. The organization uses the camp system: temporary facilities set up in various remote areas of India, to expand its reach. These camps are funded by private organizations or the government.</p>	<p>Artificial limbs that are imported or locally made generally don't facilitate postures common in India such as squatting, walking barefoot or sitting cross-legged. The Jaipur foot was designed keeping in mind the lifestyle and local conditions of rural poor in India. It is a light weight artificial limb that closely resembles a natural foot and is suitable for use even by farmers who work in the rain and irrigated fields.</p>	<p>Both fabrication and management of the Jaipur Foot are fast and simple processes. The foot incorporates locally available materials and equipment. These include a die, tread rubber compound, sponge rubber, cosmetic rubber, nylon cords, a vulcanizer, wood, and scissors. A Jaipur Foot artisan is a craftsman with several years of experience who is further trained for several more years to mold, sculpt, and form the Jaipur Foot. An on-site doctor supervises the entire fabrication and fitting process.</p>	<p>Resource - light manufacturing process that relies entirely on skill and expertise of human capital.</p>

Table.1


Case <i>Aravind eye care system, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Aravind eye care system is one of the largest facilities in the world for eye care and has grown into a network of eye hospitals, which have treated a total of nearly thirty-two million patients and performed nearly four million eye surgeries, the majority of which were inexpensive or free. This innovative model makes treatment accessible to marginalized groups who normally do not receive quality (or any) healthcare.</p> 	<p>Affordability is obtained through achieving scale economies. This model has applied manufacturing strategies and scale to surgical eye care. Each doctor at Aravind performs about 2600 surgeries per year. These measures have pushed down the average cost of surgery. Because of high patient numbers, the revenue from paying patients not only covers costs for Aravind's free services but also generates a surplus that funds growth and expansion.</p>	<p>Large populations are not only taken advantage of in terms of number of people served, but also the available medical professionals already trained or that can be trained. The organization provides large scale employment along with structured training programs to healthcare professionals and associated workers.</p>	<p>This sustainable business model uses simple innovations in the organization of workflow—from patient identification to treatment. As a result of which, it is able to provide high quality eye care to the poorest people in rural and urban India.</p>	<p>Sustainability is a result of the highly frugal model: it manages to reach the desired result under tightening constraints.</p>

Table.2


Case <i>Low cost incubator, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Dr. Sathya Jeganathan, a paediatrician in Chengalpattu Government Medical College, a rural hospital in the South Indian state of Tamil Nadu designed a low-cost infant warmer. Once the first working prototype of the incubator was implemented by her in her hospital, infant mortality reduced by 50 percent.</p> 	<p>The cost of high-end incubators can go up to 20,000 USD. Dr. Jeganathan's incubator on the other hand costs only 100 USD to build, because of the simple materials and process used. It carries out the same fundamental function as the high-end incubator: keeping babies warm.</p>	<p>The model was designed by Dr. Jeganathan with the help of local craftsmen and neo-natal nurses. The product is easy to install and can be maintained easily by the staff working in her hospital, unlike the imported complex equipment.</p>	<p>This minimalist incubator comprises of a wooden table made from locally harvested wood, a Plexiglas top and standard 100-watt light bulbs that adjusts according to the baby's temperature. The simple design makes it easy to use and maintain.</p>	<p>Sustainability is a result of the highly frugal model: it is successful in solving the problem of high infant mortality rate, while staying inside the constraints.</p>

Table.3

Case <i>Mobile diabetes clinic, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Dr. V. Mohan, a world-renowned diabetes specialist based in Chennai devised an ingenious jugaad solution involving a mobile diabetes clinic. The clinic is a large, renovated van donated to him by the World Diabetes Foundation and equipped medical equipment and a satellite dish to broadcast images from the van to the city hospital.</p>	<p>The van travels from village to village. Patients enter the van and look through the eye piece of the medical device within. An image of their eye is beamed via V-SAT to the physician sitting in the clinic in Chennai. Based on this image the doctor makes a prompt diagnosis that is relayed back to a local health volunteer in the van. The local health volunteer then communicates the diagnosis and treatment plan to the patient. When the van leaves, the local health volunteer ensures that the patient follows up on the doctor's advice and returns for a check-up when the van makes its next visit to the village.</p>	<p>The role of the local health volunteer is key in this model. These volunteers are often people who may have no more than a high school education. Dr. Mohan selects and trains them in his city hospital. They then return to their village communities to play this important role in the healthcare model. Importantly, they do not receive a wage for their labor. What they benefit from is the training they receive, and hence the job opportunities that open up for them.</p>	<p>Diabetes is a major health problem in India's rural areas where many people do not know what the disease is or how to manage it. Moreover, it is hard for people from the countryside to come to the city for treatment as this costs money and takes time away from work in the fields. The mobile hospital is a simple, frugal, effective way to bring treatment to the patients.</p>	<p>The health care model uses a simple system of a mobile treatment center to serve people who otherwise would not have access to treatment. It simply makes use of local volunteers to carry out its function.</p>

Table.4


Case <i>GE's Mac 400 ECG machine, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>GE Healthcare, an American multinational conglomerate realized that the existing heavy and expensive ECG (electrocardiogram) machines were not suitable for emerging markets. GE's researchers in India, hence came up with the MAC 400 – a portable ECG machine that costs one-tenth and weighs one-fifth of its counterpart in western markets.</p> 	<p>The device itself is affordable, the per-scan cost is low as well.</p>	<p>The machine is specially built for rural Indian clinics - it is portable and robust enough to for doctors to carry them to rural clinics from cities. Its rugged printer, for example is an adapted version of the portable ticket machine used in Indian bus stations.</p>	<p>The device is robust, affordable, portable, easy to use and maintain. It is made of several off-the-shelf components.</p>	<p>Existing technology adapted and modified to meet the requirements of rural Indian clinics who otherwise would not have benefitted from such a technology.</p>

Table.5


Case <i>Isang Litrong Liwanag (a liter of light), Philippines</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>To address the problem of high cost of electricity in Filipino slums, Illac Diaz invented an ingeniously simple solar bottle bulb (SLB). The bulb produces more light than what a standard window might let in, enabling residents of slums and shantytowns to work in their normally dark homes during the day.</p> 	<p>The SLB is simply a recycled plastic bottle filled with bleach-treated water to prevent formation of mold. This bottle is hung from the roof and the water inside refracts sun rays producing the equivalent of a 55-watt light bulb. Since its plastic, the bulb won't break or leak during the typhoon season.</p>	<p>Jugaad innovators like Diaz spend time with customers in their natural settings to observe and identify what kind of a solution can work for them. In this case it had to be something simple yet effective, that costs close to nothing.</p>	<p>This is the simplest way of creating a light source using only a plastic bottle and water. It can be assembled, installed and maintained by anyone. It is a small simple solution that goes a long way for the people it serves.</p>	<p>Old plastic bottles are re-used in this process that provides light to an underserved community.</p>

Table.6


Case <i>Vortex Gramateller, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>To overcome unreliable power supplies prevalent in rural areas, Vortex Engineering designed and built an ATM with a solar panel that consumes approximately 10% of the total energy requirement of a conventional ATM. The idea is to extend banking services to customers who are unserved. This innovation has diffused not only within India but also to other nations with similar socio-economic conditions in South Asia, the Middle East and Africa.</p> 	<p>Vortex ATMs use the scarce power resource efficiently and frugally - they run on 72 units of power supply, whereas conventional ATMs require 1800 units. The total cost of ownership for Vortex machines comes to 50% less than that of conventional ATMs.</p>	<p>Apart from running on solar energy, Vortex ATMs also have an in-built fingerprint identification system that has eliminated the need for customers to enter an identity code, which makes the ATMs easy-to-use for illiterate customers.</p>	<p>In rural areas of developing nations, the power supply is erratic. Thus, solar-generated electricity is often the most feasible power option. This innovation simply uses an abundantly available resource to run a service that is otherwise not easily available in such areas.</p>	<p>Only five hours of sunshine is enough to charge the backup batteries for a day. The solar model generates less heat and thus eliminates the need for continuous air conditioning; it can cope with temperatures between 0 and 50 degree Celsius.</p>

Table.7


Case <i>SELCO (Solar Electrical Light Company), India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>SELCO Solar Private Limited is a social enterprise in India that works to bring solar power to underserved businesses and households. This company is making solar power a feasible option for the rural population. Its business model is highly innovative, whereby allowing the full costs of solar power to be covered over time. Thus far, SELCO has sold over 200,000 solar systems in India.</p> 	<p>The innovative model has debunked the general notion that green solutions are too expensive for the poor. It has emerged as a successful business venture by co-creating value with the consumer.</p>	<p>This model is completely run by and for the people. It has created a network of small-scale entrepreneurs in the rural communities where the product is sold. These grass root entrepreneurs own and maintain the solar panels and batteries and rent them out to consumers on a pay-per-use basis. Hence, SELCO has not only provided employment to its own employees but also, to many rural entrepreneurs who rent out solar lights to vendors and institutions.</p>	<p>It uses a simple business model that involves the community where it intends to sell its product. At the end of the day, people are willing to use this mode of electricity because they are getting value for their money and their needs are being met.</p>	<p>SELCO provides solar-powered electricity which is safer, greener, and cheaper than kerosene-lit lamps or other traditional sources of electricity, that emit harmful gases.</p>

Table.8


<p>Case <i>Husk Power Systems, India</i></p>	<p>Frugality</p>	<p>Context - place & people</p>	<p>Simplicity</p>	<p>Low environmental impact</p>
<p>Husk Power Systems (HPS) is a domestic company that provides power to rural Indians using proprietary technology that has been developed by the firm to cost-effectively generate electricity using a biomass gasifier that creates fuel from abundant rice husk waste. HPS operates 35–100 kW mini-power gasification plants and electrifies off-grid villages in India.</p> 	<p>The cost of the service is about half the cost of the kerosene that most villagers use to power lamps that provide far less light than the compact fluorescent lights (CFL) bulbs distributed by the company. As of 2018, Husk Power Systems serves 120,000 people through its 75 plants in rural India.</p>	<p>HPS works on a build-own-maintain basis and hires and trains local people with modest education levels, with special preference given to women.</p>	<p>Similar to SELCO, it uses a simple business model that involves the community where it intends to sell its product. It enhances access to reliable energy services, since the majority of the targeted users live in remote areas where there is no access to electricity or the existing grid connection is unreliable.</p>	<p>HPS uses abundant rice husk waste to power a small biomass gasifier & significantly reduces kerosene and diesel use. The kerosene savings cut greenhouse gas emissions by an estimated 125 tons/year CO2 equivalent per power plant when assessed as part of the Clean Development Mechanism certification.</p>

Table.9

Case <i>C-Dot, Department of Telecommunications, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Centre for Development of Telematics (C-DoT) is an indigenous public sector enterprise that was able to formulate innovation strategies with meagre resources that dramatically expanded the market for telecommunications in India, to reach the vast expanses of rural and urban markets in the 1989-2000 decade. Before this the Indian market depended on imported technologies that were expensive and not suited to the socio-economic conditions of developing nations.</p>	<p>C-DoT's initial emphasis was on rural applications, low power consumption, and minimization of peripheral equipment like air-conditioning by using devices that enabled less heat production. The enterprise utilized 35 million USD to develop an alternative tele - communication system to rival global giants. This was a meagre sum considering the enormous task at hand that its western counterparts had spent decades and 1300-1400 million USD to accomplish.</p>	<p>The objective was to solve the chronic shortage of, along with discovering a cost-efficient way to deliver the benefits of Tele - communications to India's underprivileged rural population. Hence, a group of Indian engineers in this field were picked to develop a technology that would be relevant to India and Indian conditions, which would be capital-sensitive and labor-intensive, rugged and cheap.</p>	<p>It was a simple design that capitalized on existing resources – equipment, technologies, knowledge manufacturers and frugal mindset. It kept in mind the target audience and adopted suitable strategies to reach its objective under constraints.</p>	<p>To minimize waste, C-DoT undertook two tasks: first, ensured that when design upgradations were initiated, new components were retrofitted into the same common structure, and critical components were not thrown away. Second, in conducting repairs, C-DoT replaced defective components instead of the entire subassembly. This was made possible by the way it was designed.</p>

Table.10


Case <i>Sakshat tablet, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Sakshat is a low-cost handheld computer launched by the government in 2011, costing only 2,500 INR (about 35 USD). The Indian government wants to provide broadband access and low-cost access devices across all government-funded colleges and universities in India as educational aids.</p> 	<p>It is low cost device made of basic components, priced at only 35 USD, which is further slashed by half for students.</p>	<p>The ministry of Human Resources Development issued an open challenge, with specifications and the price target for the handheld computer, and had various teams worked towards the goal. Ten teams competed; a group led by the Indian Institute of Technology in Jodhpur ultimately designed the prototype.</p>	<p>The tablet has a resistive touch screen and comes in a ruggedized plastic casing, has two gigabytes of flash memory, two USB ports, along with headphone and video output jacks and Wi-Fi capability. It is a simple no-frills device unlike its western counterparts, that carries out the basic functions of a tablet that are most essential.</p>	<p>Sakshat uses the Android operating system and consumes a meagre two watts of power, which is supplied by an internal lithium-ion battery that could be charged using a solar-powered charger.</p>

Table.11

Case <i>Banking on phones, Philippines</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Filipinos are avid users of text messaging. Globe Telecom recognized this and became the pioneer in mobile financial services. In 2004 it launched the G-Cash, which allows its users to send and receive cash and make payments to various businesses and services through text messaging. The system also allows domestic and international money transfers. Smart Communications provides similar services with its Smart Money program.</p>	<p>Mobile phones are widely used by most people in developing nations. This innovation uses an existing device in order to deliver another important service to mobile phone owners.</p>	<p>A large section of people in developing nations do not have bank accounts, but they have mobiles. This service brings the bank to the people. Apart from this, the two companies have created over 1.5 million new entrepreneurs, reselling airtime and facilitating mobile financial services.</p>	<p>These companies simply recognized and built on the potential customers' routine of text messaging, in order to create a banking service suitable for them.</p>	<p>An existing device and technology were improvised to provide a service to people, who otherwise did not have easy access to it.</p>

Table.12


Case <i>Sarvajal, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Sarvajal has established reverse osmosis plants in villages that are run by franchisees. Since its inception in 2007, it has enlisted 117 franchisees that provide clean drinking water at minimal prices. Villagers can buy 25 liters of water for less than 10 cents. The plants are monitored and maintained by Sarvajal.</p> 	<p>The company opted for a franchise model to expand its reach. On an average, each franchisee provides drinking water to around 500 people per day. A new franchisee makes an initial payment to Sarvajal and arranges the land and electricity whilst sourcing the water. The machines are provided by Sarvajal. For the first three months, all the revenue goes to the franchisee, and thereafter, 40% is shared with Sarvajal. In return, the parent company supports business development.</p>	<p>Sarvajal employed local men and women from the communities they work in, to run educational campaigns that spread awareness about the severe health consequences of drinking contaminated water. These individuals being from the respective communities understand the local dynamics well and hence were able to convince people to invest in clean drinking water since the water available to them was highly contaminated, although free.</p>	<p>The system is easy to install and maintain. The aim is simple: providing people a basic amenity – clean drinking water that they can afford.</p>	<p>The model uses existing technologies – reverse osmosis and ultra violet technologies for purification and puts them into practice in a way that the resulting product is affordable and hence meets the needs of its intended user.</p>

Table.13


Case <i>Tata Swach water filter, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Tata Chemicals launched its low-cost water purifier, Swach - derived from the Hindi word for clean, is a very low-cost water purifier that can be manufactured using locally available resources. Costing around 7 USD, it is affordable for people living at or near subsistence levels.</p> 	<p>It is a value-oriented product that is affordable for the producer as well as for the potential consumers.</p>	<p>The product is targeted at the BoP markets, most of whom do not have any filter and cannot afford the more expensive ones. The Swach purifier helps eliminate 90% of the contaminants and almost all of the most serious pathogens that cause most of the major diseases. The product is better than what the potential customers have now, which for most of them is nothing.</p>	<p>Swach uses commonly available rice husk ash, pebbles, and crushed cement to get a filter bed that can trap almost all of the common harmful coliform bacteria. Early Tata studies have suggested a large reduction in water-borne diseases from the use of this filter. Hence, it is a simple product that reaches its objective of purifying water.</p>	<p>The product does not require electricity or running water and is the cheapest purifier in the industry.</p>

Table.14


<p>Case <i>Cooking chulhas and cooking fuels, India</i></p>	<p>Frugality</p>	<p>Context - place & people</p>	<p>Simplicity</p>	<p>Low environmental impact</p>
<p>In India, the chulha is the primary traditional cooking stove used for indoor cooking. These traditional chulhas are prepared by putting mud bricks together and then a mixture of wood and cow dung is routinely prepared as a fuel for these chulhas.</p> 	<p>There are about 160 million mud chulhas in India. Most people at the BoP use chulhas as their primary source for cooking due to its easy affordability.</p>	<p>The chulha is a simple, affordable and hence, suitable method of cooking for many people. It is estimated that a house spends around 150 to 200 INR on fuel in a month varying according to the family members and the usage, as compared to 400 to 450 INR for an LPG cylinder.</p>	<p>The common fuels they use for chulhas include wood and cow dung. Both of these are easily available. People collect dry wood (broken from trees) from the nearby parks, gardens or small jungles. They collect it on a weekly basis.</p>	<p>Research says that 3–4 kg of wood is sufficient for a day's cooking and the burnt wood is used again along with some fresh wood. The waste/ash remaining after cooking can be utilized in washing utensils.</p>

Table.15


Case <i>Lifesaving dot, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>A bindi is the traditional dot Hindu women wear on their forehead to signify the third eye of intuition. Grey for Good, the philanthropic arm of Grey Advertising is providing women in India with a bindi that doubles as an easy, inexpensive iodine patch to get more iodine through skin absorption. The project, called the Life Saving Dot, is testing the bindis on women in rural parts of the west Indian state of Maharashtra.</p>	<p>The bindi has been distributed free of cost to 1 lakh tribal women in Maharashtra who did not use iodised salt. Each woman received 30 bindis, one for each day of the month.</p>  	<p>Iodine deficiency is a major threat in India specially amongst women. The soil is poor in this mineral and iodized salt is more expensive. The creators at Grey were trying to find a way to combat iodine deficiency, when doctors told them it can be absorbed through the skin. So, they developed an iodine patch, but to give it wider appeal it was designed as a bindi.</p>	<p>The bindis are coated with 150 - 200 micrograms of iodine, a micronutrient that would be absorbed by the skin. The bindi dispenses the iodine in 4-5 hours but the women prefer to wear it throughout the day as there are no side effects.</p>	

Table.16


<p>Case</p> <p><i>Motorcycle ambulances, India /e-rangers, Africa</i></p>	<p>Frugality</p>	<p>Context - place & people</p>	<p>Simplicity</p>	<p>Low environmental impact</p>
<p>Motorbike ambulances are being used in various parts of India and rural Africa. These ambulances comprise of a standard motorcycle with a sidecar where the patient can either sit or lie down. These jugaad ambulances are saving lives and especially reducing maternal deaths by preventing delays in getting pregnant women/patients to hospitals.</p> 	<p>It's a low-cost innovation that uses robust and affordable motorcycles. They are easy to maintain and since the motorbikes are commonly used, it is easy to find spare parts. Running costs are also much lower than a four-wheeler ambulance.</p>	<p>The target population of motorbike ambulances are people residing in obscure, disconnected areas with limited infrastructure. Hence, the solution must be a vehicle that is rugged and durable, but at the same time compact enough to maneuver through narrow roads and uneasy terrains. Motorbike ambulances fit the bill and can be used to meet the needs of these areas.</p>	<p>The simplest innovations are easy to use and effective because they look and feel like something people already use. Motorbikes are already commonly used in these areas. Hence, making use of them as ambulances is a simple innovation for everyday life that serves a clear need.</p>	<p>An existing, widely used technology has been improvised to be used to carry out a function that will benefit many people who earlier were deprived of this basic service. It does not require any new resources or technologies to assemble and put into practice.</p>

Table.17


Case <i>Revolo, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Revolo is low-cost plug-in parallel hybrid solution for cars, developed by KPIT Cummins Infosystems, an Indian engineering and IT services provider in 2010. By installing the Revolo kit, cars running on gas can be converted into fuel-efficient, high performance hybrids.</p> 	<p>The objective is not only to reduce the cost of innovation for the innovator, but also for the customer. The Revolo system costs 80 percent less than other hybrid car options, priced at 1300-3250 USD for Indian market and around 5000 USD for western markets. Hence, car owners get more value at less cost.</p>	<p>The system captures the kinetic energy generated every time the brakes are applied and stores it in its batteries for later use. It is hence, most suitable for stop-and-go city traffic anywhere in the world.</p>	<p>It is a functionally minimalist solution that aims to provide maximum value to customers. It is an affordable, retrofittable system that can be fitted into any car easily irrespective of the car manufacturer. Hence, it benefits both: car owners and auto manufacturers.</p>	<p>The Revolo technology boosts fuel efficiency by 35 percent and reduces green house gas emissions by at least 30 percent. This system is a simple, affordable solution that transforms almost any car into a fuel-efficient, low impact hybrid.</p>

Table.18

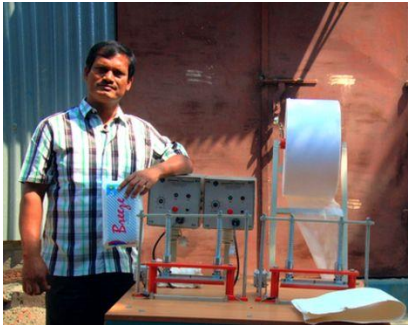
<p>Case</p> <p><i>Low cost hygienic sanitary pads, India</i></p>	<p>Frugality</p>	<p>Context - place & people</p>	<p>Simplicity</p>	<p>Low environmental impact</p>
<p>Poor women cannot afford to buy the sanitary pads mostly manufactured by MNCs in India.</p> <p>Arunachalam Muruganantham (AM), a jugaad innovator from India calculated that the pads were being sold at more than 40 times the cost of the raw materials. Hence, he decided to create low-cost sanitary pads for the women in his community.</p> 	<p>AM invented a machine to create low-cost hygienic sanitary napkins made of pine wood pulp. The machine is simple to build and operate. It requires minimal skills and requires very little electricity. Production is distributed among small-scale production units, usually based in local communities. This frugal innovation is gradually revolutionizing menstrual health for rural women in India.</p>	<p>The mission was not just to increase the use of sanitary pads, but also to create jobs for rural women. The machines are sold to these women for around 80,000 INR (approximately 120 USD), and with each machine capable of producing around 1000 pads in a day (in an eight-hour shift), each pad could be sold at a profit of around 0.076 USD, which gives a healthy return to the machine owners.</p>	<p>AM's invention has improved the lives of thousands of poor women who could not afford the expensive sanitary options offered by Western companies. These napkins do not possess all the same attributes as a Western product, but they do meet basic needs. It has also helped in reducing the stigma around menstruation in various communities.</p>	<p>The central feature of AM's innovation is a sustainable decentralized model of empowerment. AM's technology is a valuable low-carbon alternative to large-scale plants. Furthermore, according to the inventor, the machine can be in the future adapted to use other natural fibers like bamboo and banana leaves. There is also an on-going diffusion of his innovation to different parts of the developing world.</p>

Table.19


Case <i>MittiCool - clay refrigerator, India</i>	Frugality	Context - place & people	Simplicity	Low environmental impact
<p>Mansukhbhai Prajapati, a potter from a village in Gujarat developed the MittiCool clay refrigerator. The MittiCool is targeted at the hundreds of millions of rural Indians who would like a refrigerator but cannot afford one or do not have access to a reliable supply of electricity to run one.</p> 	<p>It is a highly affordable innovation that uses widely available materials like clay and water. Mansukhbhai improvised many technical as well as business solutions to bring his idea to life. Mitticool was the first product that he mass-produced in his factory. He soon built other products from clay, such as a nonstick frying pans and various other household items.</p>	<p>Mansukhbhai had not only a detailed knowledge of clay products and their manufacture but also understood the mindset and aspirations of rural consumers as an insider. Eventually, he trained women in his village in industrial pottery techniques, so that the product could be mass produced in his new factory along with other products that he consequently developed. He single-handedly created an industry that employs large numbers of people in his own community.</p>	<p>MittiCool (<i>mitti</i> means “earth” in Hindi) has a simple process of working: in a terracotta box, water from the upper chamber seeps through the side walls, cooling the food in the lower chamber through evaporation.</p>	<p>This appliance is made entirely of clay, except for a glass door and a plastic faucet at the bottom. It costs around 50 USD, consumes no electricity, is 100 percent biodegradable and produces zero waste over its lifetime.</p>

Table.20

4.3| Examples of Transition Dynamics

All the above-mentioned cases (Section 4.2), have one thing in common – they all used elements of the Jugaad mindset to come up with an innovative idea and then, turned it into a feasible practice; not just a temporary fix. Jugaad, as we know can be a temporary fix or a one-off solution as well. For instance, street juice vendors in many parts of India convert the manual juicer into an electric one by attaching a small electric motor to it. This makes extracting juice easier and quicker, enabling them to earn more money. This can be seen as a small-scale quick fix. But when a jugaad mindset, technical talent, aspiring firms, low purchasing power and demanding customers come together, then it can become a solution in the true sense – make a difference in the broader sense.

Further, let's examine how Jugaad has made a sustainable/long-term impact, specifically on two spheres/markets:

4.3.1 Water

4.3.2 Energy

4.3.1| The Water Market

BoP water markets tend to be predominantly urban, even though majority of BoP households are rural. Growth has been particularly rapid in peri-urban areas that lie outside municipal water supply areas. BoP population in rural areas largely relies on 'free' sources for its water needs - surface water and wells. Some of these sources are safe and protected, others are subject to serious contamination and consequently health hazards. The variety of contaminants - waste, heavy metals, chemical and biological agents require a range of solutions (Hammond et al., 2007). A range of organizations – domestic and global companies, social ventures, research institutes, public private partnerships; are developing innovative solutions to provide safe drinking water to those who do not have affordable access to it.

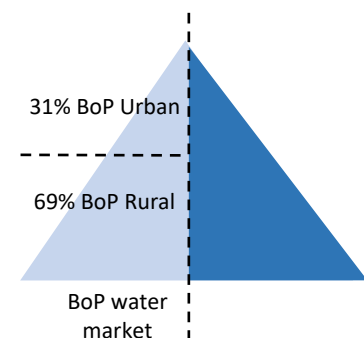


Fig.25 Water market in India

Source: drawn by author

Domestic and Global Enterprises

Cleaning up the water – New Technologies

Various big companies are competing in the market for **affordable water filtering technologies** in India. Two of the major ones are Hindustan Lever Limited (HLL), a division of consumer products giant Unilever and Tata Chemicals, a subsidiary of Tata Group conglomerate. The 9-litre storage capacity model of HLL's water filter – *Pureit*, costs 2600 INR (35 USD). Tata *Swach* (Table.14) on the other hand costs 1700 INR (23 USD) for the same storage capacity (Venkatesha, 2014). These technologies do not require electricity or running water to function.

However, according to external testing, the microbiological purification efficacy of Swach does not reach international standards. Yet, its efficacy is considered to be good enough, as water quality is measurably improved (Bhathena et al., 2014). External research has shown that Pureit reaches international standards for microbiological purification efficacy, and no additional measures for microbiological treatment are required (Clasen et al., 2006). These products are significantly less expensive than the majority of the existing water purification solutions in the market (Ahlstrom, 2010). Companies like Tata and Unilever aim to fulfill the basic need of safe water, hence preventing contaminated water related diseases and ailments.

These enterprises exemplify a strategy of **focusing on the unique needs** of the lower income groups by creating suitable products and technologies. Given the large and highly competitive domestic market with value-conscious customers, most with modest means, Indian businesses have learned to be highly creative in developing value propositions. Thus, they are inventing entirely new product and service concepts to satisfy the needs of these consumers and doing so with extreme **frugality**.

Social Ventures

Willingness to pay for clean water

Apart from the cost, another barrier that keeps people from clean drinking water is the consumer education about the importance of clean drinking water. There is a significant section of the population who is not inclined towards paying for water, when they can just get it for free from natural sources.

Organizations like *Sarvajal* (Table.13) in India are spreading **awareness** about the importance of investing in clean drinking water and the consequences of consuming contaminated water. Sarvajal is a social enterprise whose mission is to provide affordable clean drinking water to those who do not have access to it, specifically in rural areas. It capitalizes on **local human capital** to reach and convince people – employs local men and women from the communities that are aimed to be impacted through this service, and hence where this awareness needs to be spread.

It is not a charity and uses a professional team to establish appropriate pricing. The main aspect of its business model is **scalability**. The company opted for a franchise model to expand its reach. It has enlisted 117 franchisees since its inception in 2008 and operates in 16 out of the 29 states in India [7].

Public Private Initiatives

The power of Partnerships

There are various instances of private companies partnering with the government as well as NGOs partnering with private companies in order to improve service and accessibility.

In the Indian state of Andhra Pradesh, *Heritage Livelihood Services*, a private enterprise partners with the Hyderabad city Metropolitan Water Supply and Sewerage Board to bring services to peri-urban areas of the city. The government sub-contracts the company-owned water trucks to supply clean water well below the rates of alternative water suppliers. The company also engages local community organizations to educate people and spread awareness about the value of clean water.

WaterHealth International, an MNC operating in India with both public and private funding, has developed a range of products using an ultraviolet (UV) water disinfection system – from household units to scalable community water systems and franchised water stores. A pilot in a village in the state of Andhra Pradesh, confirmed that low income communities are willing to pay for treated water, with 80 percent of households signing up in a place where before no one had paid for water. Since 2006, the company has successfully installed and is operating over 450 decentralized Community Water Systems called WaterHealth Centres across 5 states in India, run by the members of these communities (Hammond et al., 2007). These water treatment systems enable the community to be the provider as well as the customer.

Both these examples show that the **involvement of government bodies** enables private enterprises to implement business strategies that benefit those who are otherwise un(der)served. Furthermore, such **partnerships between different stakeholders** can be used to transform systems in different spheres.

4.3.2 | The Energy Market

India has the largest energy market in Asia, with 163 billion USD in annual household spending. 52 percent of that market falls under the BoP income groups, which accounts for nearly 70 percent of the population. Rural areas account for 70 percent of the BoP energy market. The BoP income segments in rural areas spends 70 billion USD on energy – nearly 45 percent of national per household energy spending. Yet in each of these BoP income segment rural households, energy spending per day is less than 2 USD on average (Hammond et al., 2007). This presents a large market waiting to be served. Following are some of the initiatives taken by different stakeholders in order to serve this segment of the population.

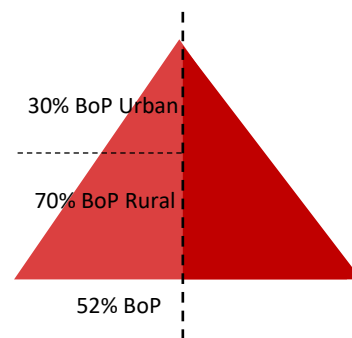


Fig.26 Energy market in India

Source: drawn by author based on presented data

Unconventional Partnering

Food for thought

Propane or LPG are the main fuel source for cooking in the higher income groups. Whereas firewood is the primary fuel source for cooking in the BoP income groups in India. As illustrated in Table.15, the traditional cooking stove (chulha) used by a large population in India is prepared by putting mud bricks together and then a mixture of wood and cow dung is routinely prepared as a fuel for these chulhas.

The energy giant *Shell*, with the support of its private sector- focused Shell Foundation along with two Indian NGOs – the Appropriate Rural Alternatives Institute (ARTI) and Development Alternatives Group, is developing and marketing low polluting biomass fuels and cooking devices. The aim is to create sustainable market systems to sell affordable stoves in India.

Many such large companies are working to solve big problems with simple solutions, though technological innovation. This is a good example to illustrate how when proper engineering, technical innovation and a proper set up are applied to a Jugaad solution, it turns into a solution in the true sense – has the potential to have long-term, tangible impact.

Moreover, its efforts like these that **combine high-tech academic research and civil society engagement with a market-driven business model, to develop and put in practice an innovative solution to an existing problem in the regime.**

Social Ventures

Let there be light!

For lighting, kerosene is still the most commonly used fuel for more than half of the BoP population in India. Naturally, kerosene use rates fall dramatically as we move up the income brackets as electricity becomes the main lighting source. Now the question is how to provide low income groups a feasible, sustainable and yet affordable solution for lighting.

Here comes the sun: Solar photovoltaic systems are gradually and successfully progressing in areas that are in off-grid locations (not served by electricity grid stations), for general household use. SELCO (Solar Electric Light Company), is a small Indian enterprise founded in 1995, that is providing household size photovoltaic systems at affordable rates to urban and rural poor. At SELCO, the **poor are looked at as partners**, innovators, inventors, enterprise owners in order to develop solutions that are truly inclusive and not designed based on assumptions of what the poor need (Table.8). Hence, it is a **context-specific innovation** that focuses on using sustainable energy to solve problems rooted in the landscape.

Scalability: Because such solutions are often specific to a particular community, they are less likely to generalize to other groups. Harish Hande (founder of SELCO) readily admits that his model, designed for urban and rural Karnataka state, may not apply to the neighboring states of Maharashtra and Tamil Nadu for reasons to do with culture, geography, income distribution, and so on. So, instead of attempting to scale up his solution, he has opted to scale out by training others like him from these states who would be able to take the applicable elements of his model and tailor them to their own requirements (Dash et al., 2010). Today, SELCO has 50 branches across 5 Indian states. It has various local **financial partners** and has also received international recognition and support through its alliance with SELF (Solar Electric Light Fund), a US based NGO. In 1997, SELF installed the first Solar Home System (SHS) directly financed by the World Bank's first-ever loan for solar photovoltaic systems and signed up farmer societies to be electrified by SELCO-India under the World Bank - Global Environment Facility program.

SELCO and various other similar domestic enterprises are contributing to creating access to affordable, reliable, sustainable energy services for all.

Chapter 5

Conclusion

“Playing with scarcity evokes different improvisations than playing with abundance”

- (Schrage, 2000, p.5)

Engaging scarcity rather than avoiding it may be the precondition for the discovery of novel innovation methods. New products may result from new ways of approaching the product innovation process itself. Moreover, successful innovation at the BoP involves working within constraints or working within an ‘innovation sandbox’ (Prahalad, 2012). After deep consideration of consumer preferences, needs and lifestyles; broad parameters can be set within which the innovation occurs. These parameters form the boundaries of the ‘innovation sandbox’, within which the innovation is developed.

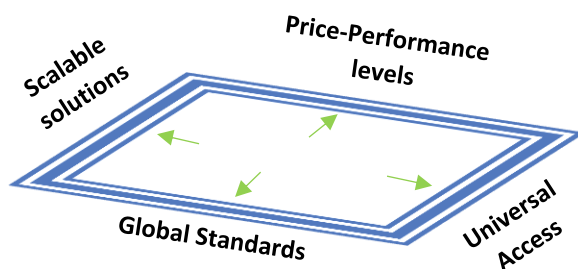


Fig.27 Innovation ‘sandbox’ for healthcare in India (Prahalad)

Source: drawn by author

The four sides of the sandbox represent the core requirements for the healthcare industry in the Indian market. Within the constraints of these requirements is where the innovation needs to take place for a successful healthcare system.

Indian jugaad is commonly considered to be a frugal form of innovation birthed from a resource constraint environment. The BoP has adopted jugaad as a form of low-cost innovation that suits their income and acts as a coping mechanism with their limited resources. Jugaad in this research, refers to innovations (products /services/processes) that use available resources to their maximum potential (extract more value from less resources) and result in solutions that are accessible,

sustainable and give value for money. BoP markets have become a new source of radical innovation; hence managers must focus on creating awareness, access, affordability and availability to develop these markets (Prahalad, 2012). The BoP has a large contribution to markets in every sector - food, energy, housing, transportation, health, ICT and water.

This research has delved into the concept of Jugaad innovation, not just as a quick fix, but as an efficient and effective way of survival at the BoP. This has many **implications for markets** – serving this population will require both, a new mindset and a new business model.

Targeting the poorest of the poor requires a flexible and coherent market model that involves creating solutions from the bottom up. This includes understanding the basic needs of the consumer to create innovative products that meet these needs at very low prices. Multi-national corporations, domestic firms, small-scale industries and micro-entrepreneurs can look forward to tailoring existing products or designing new products that suit the jugaad way of living at the BoP.

Adaptability is crucial as well. Jugaad innovators sense and respond to rapid changes in their environment by dynamically reinventing their business models. Indian entrepreneurs who practice jugaad are a resilient bunch: they continually find their way around the various hurdles they face in every stage of the process (Rajdou et al., 2011).

Another main factor is having a business model that is based on a local network of representatives, sponsorships, entrepreneurs and various other stakeholders. This will ensure that the innovation reaches remote and underserved areas that the existing alternatives aren't able to reach. Also, involvement of local communities will enable smoother acceptance and adoption of the innovation amongst the targeted population.

Bundled together, these principles constitute a distinctive model. While most corporations view the marginal segments as being unprofitable, jugaad innovators invent inclusive business models for profitably serving the millions who live on the margins of society. They do so by devoting special attention to overcoming innumerable barriers with creative solutions. For these entrepreneurs, including the margin not only provides for greater social good, it also makes great business sense. The BoP market provides a sizeable opportunity with substantial potential pay-offs for companies. This opportunity is too important to not be made the most of.

Innovation is what drives 'smartness'. It is crucial for organizations to remain competitive across regions. Most innovation programs are built on the assumptions of affluence and abundance. However, there are consumers in the

United States and Europe asking for inexpensive or value-for-money products and services. We see billions of first-time consumers in China and India—where economic growth is surging, and 2 to 3 billion people will join the middle class in the next decade—who can afford only the cheapest offerings (Prahalad and Mashelkar, 2010). We see the rich and the young in both the developed and the developing worlds demanding environment-friendly products and services.

“Earth provides enough to satisfy every man’s need, but not every man’s greed.”

- Mahatma Gandhi

Affordability and sustainability were Gandhi’s touchstones. Its affordability and sustainability, not premium pricing and abundance that should drive innovation today. A potent combination of constraints and ambitions has ignited this new genre of innovation in emerging economies.

In India, the frugal approach is ingrained in the minds of people. Many tend to prefer to use products/services that are simple, affordable and most importantly provide value for money; as long as they meet the quality requirements. This mindset is not entirely limited to emerging economies. There exist many groups in developed economies as well, who prefer frugal products although they may be affluent enough not to base their purchasing decisions solely on cost factors. This kind of frugality - “frugality by choice” can be motivated by a variety of factors: environmental sustainability, moderation or need to reduce waste and the demand for simple products that reduce both cost and complexity.

A frugal, flexible and inclusive approach to innovation and entrepreneurship has global appeal. Given the growing scarcity of resources worldwide and the increasing pressures on household and government budgets everywhere, it is very likely that this appeal is no mere fad or fashionable trend that will burn out in a year or two. If anything, it appears that the relevance of this kind of activity will grow and that emerging markets will lead the way in demonstrating how it should be done. A new global dynamic is taking shape in which ideas, applications and people are flowing in both directions (Leadbeater, 2014).

Technology is what seems to generally be associated with the concept of ‘smart’. The Jugaad school of technological innovation believes in robust and long-lasting technologies, that are not made to be replaced. This is what makes it stand out from the rest; and what makes it smart. Moreover, transition processes are not about the breakthrough of one technology, but about the co-evolution of multiple technologies. Complementary technologies, that is, technologies which enable the functioning of other technologies, are important. Also, old and new technologies

form a type of symbiosis- novelties interact with existing technologies and act as an add-on to contribute to the pool of available solutions.

Changes in the regime may result from a chain of events – changes in one dimension of the regime may trigger policy innovations, which in turn may trigger changes in other dimensions. Niche experiments are crucial for system innovation, because they help induce wider changes in the regime. The success of a novelty (to solve existing problems) is governed by its interaction with the existing regime (Section 4.1). Managing transitions implies searching and experimenting in order to find promising options to resolve persistent problems. Hence, transition management can be referred to as a quest for robust solutions (Grin et al., 2010).

As mentioned in Chapter 3 (Section 3.3.2), Jugaad Innovation can be a driver of long-term durable change. What it needs is a **System** - a larger structural system that channels and harnesses the Jugaad Innovation approach to be a catalyst in transitional change. A system in terms of policies, regulations, infrastructures and markets.

The government remains the primary custodian of public services, given the scale at which these services need to be provided. Hence, the government needs to develop new policies/solutions regarding how these services can be made accessible to all. The services currently delivered by social entrepreneurs (niches) are only a drop in the ocean compared to the scale at which they are required. They cannot possibly meet the vast demand on their own. What can be done is that their services can be used by the government as an addition to the existing solutions.

A number of schemes launched by the government are trying to tackle the same issues as social entrepreneurs. The government has the resources, the social entrepreneurs have the innovative solutions derived from local knowledge and networks. Hence, the government can outsource service delivery to social enterprises and the private sector by paying for outcomes. In this way, the state acts as a commissioner, enabler, regulator, partner and patron.

The government can also provide an enabling environment to ensure that niche innovations flourish by generating demand. One example is the creation of the government - sponsored health insurance policy in India, Rashtriya Swasthya Bima Yojana, which provides hospital cover of up to 400 USD per annum for a family of five [18]. By extending coverage to nearly 300 million citizens below the poverty line, the market for social enterprises delivering health services has been opened to millions of potential new customers.

Also, policy measures can be built to incorporate grassroots entrepreneurs when thinking of sustainability by providing incentives and subsidies to these initiatives. Schemes supporting frugal innovation at the grassroots level will help increase the innovative potential of inclusive and green growth.

The government can play a critical role in creating a set of standards, a body of knowledge, and a community of practitioners around the concept. Universities and public R &D institutions are a large source of innovation. Hence, institutes to encourage research and training in frugal innovation practices could be set up, possibly within existing establishments. Involving scholars from a range of disciplines is a good way to advance knowledge and understanding of cities, as well as to improve urban life.

The state remains the largest provider of public services. Niche innovations are filling up some, but by no means, all of the gaps in service provision. They have contributed to improving equity of provision and driven down costs. Hence, jugaad innovation complements the existing structure, but does not replace it.

Different kinds of organizations are engaged in Jugaad Innovation – social entrepreneurs, grassroots initiatives, domestic firms, MNCs and the government. They all have their strengths and weaknesses. Large domestic firms and MNCs lack the detailed ground-level knowledge of social ventures and can engage with these smaller players to implement their business models efficiently and effectively in these contexts. Social ventures on the other hand, lack scale and resources which the government can provide them. Hence, alliances/partnerships between different types of organizations can be mutually beneficial and help in achieving inclusive growth.

LIST OF REFERENCES

A

- Abrol, D., Gupta, A. (2014). Understanding the diffusion modes of grassroots innovations in India: A study of Honey Bee Network supported innovators. *African Journal of Science, Technology, Innovation and Development*, 6(6), 541-552.
- Acemoglu, D., & Zilibotti, F. (2001). Productivity differences. *Quarterly Journal of Economics*, 116(2), 563-606.
- Acemoglu, D. (2002). Directed technical change. *Review of Economic Studies*, 69(4), 781-810.
- Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2017). A Systematic Literature Review of Constraint-Based Innovations: State of the Art and Future Perspectives. *IEEE Transactions on Engineering Management*, 64(1).
- Ahlstrom, D. (2010). Innovation and Growth: How Business Contributes to Society. *Academy of Management Perspectives*, 24(3), 11-24.
- Ahuja, S., & Chan, Y.E. (2014). The Enabling Role of IT in Frugal Innovation. *Proceedings of the International Conference on Information Systems, Auckland, New Zealand*.
- Ahuja, S., & Chan, Y.E (2016). Digital Platforms for Innovation in Frugal Ecosystems. *Proceedings of the 76th Annual Meeting of the Academy of Management (OCIS Division), Anaheim, USA*.
- Ahuja, S., & Chan, Y.E. (2014). Beyond Traditional IT-enabled Innovation: Exploring Frugal IT Capabilities. In the *Proceedings of the 20th Americas Conference on Information Systems (AMCIS) Savannah, Georgia*.
- A Liter of Light (2015). Available online: <https://literoflight.org/> (accessed 20 October 2018).
- Anderson, J., & Markides, C. (2007). Strategic Innovation at the Base of the Pyramid. *MIT Sloan Management Review*, 49, 83-88.
- Ansari, S., Munir, K., & Gregg, T. (2012). Impact at the 'bottom of the pyramid': The role of social capital in capability development and community empowerment. *Journal of Management Studies*, 49(4), 813–842.
- Atkinson, A. B., & Stiglitz, J. E. (1969). A new view of technological change. *Economic Journal*, 79(315), 573-578.
- Avelino, F. (2009). Empowerment and the challenge of applying transition management to ongoing projects. *Policy Sciences* 42(4), 369-390.

Avelino, F., & Rotmans, J. (2009). Power in transition: an interdisciplinary framework to study power in relation to structural change. *European Journal of Social Theory*, 12 (4), 543-569.

Avelino, F., Grin, J., Pel, B., & Jhagroe, S. (2016). The politics of sustainability transitions. *Journal of Environmental Policy and Planning*, 18 (5), 557-567.

Avellino, F. (2017). Power in Sustainability Transitions: Analysing power and (dis) empowerment in transformative change towards sustainability. *Environmental Policy and Governance*, 27 (6), 505-520.

B

Baker, T., & Nelson, R. E. (2005). Creating something from nothing: Resource construction through entrepreneurial bricolage. *Administrative Science Quarterly*, 50(3), 329–366.

Barca, F. (2009). An agenda for a reformed cohesion policy: A place-based approach to meeting European Union challenges and expectations. Independent Report prepared at the request of Danuta Hübner, Commissioner for Regional Policy, April 2009. Brussels: EU Commission.

Bathena, Z.P., Shrivastava, S., Londhe, P., & Brown, J. (2014). Microbiological performance of novel household water treatment devices in India. *Water Science and Technology: Water Supply*, 14, 91–98.

Bhatti, Y. A. (2012). What is Frugal, What is Innovation? Towards a Theory of Frugal Innovation. *SSRN Electronic Journal*, 1-45.

Bound, K., & Thornton, I. (2012). Our frugal future: Lessons from India's innovation system.

Brem, A. (2011). Linking innovation and entrepreneurship - literature overview and introduction of a process-oriented framework. *International Journal of Entrepreneurship and Innovation Management*, 14(1), 6-35.

Brem, A., & Ivens, B. (2013). Do Frugal and Reverse Innovation Foster Sustainability? Introduction of a Conceptual Framework. *Journal of Technology Management for Growing Economies*, 4(2), 31-50.

Brem, A., & Wolfram, P. (2014). Research and development from the bottom up – Introduction of terminologies for new product development in emerging markets. *Journal of Innovation & Entrepreneurship*, 3(1), 1–22.

C

Carlson, C.R., & Wilmot, W.W. (2006). *Innovation: The Five Disciplines for Creating What Customers Want*. Crown Business.

Chen, D., Li, J., & Shapiro, D. (2008). FDI Knowledge Spillovers and Product Innovations of Chinese Firms. University of Oxford, SLPTMD Working Paper, No. 028.

Chen, J., Jin, X., He, Y., & Yao, W. (2006). TIM based indigenous innovation: experiences from Haier Group. IEEE International Conference on Management of Innovation and Technology.

Chotukool: India's first mobile food and beverage cooler. Available online: <http://chotukool.com> (accessed on 16 May 2018).

Christensen, C.M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press.

Christensen, C. (2003). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business Review Press.

Clasen, T., Nadakatti, S., & Menon, S. (2006). Microbiological performance of a water treatment unit designed for household use in developing countries. *Tropical Medicine and International Health*, 11, 1399–1405.

Cohen, W., & Levinthal, D. (1989). Innovation and learning: Two faces of R&D. *Economic Journal*, 99(397), 569-596.

Cohen, W.M., & Levinthal, D.A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128–152.

Concilio, G., & Tosoni, I. (2018). *Innovation Capacity and the City: The enabling role of design*. Springer International Publishing.

Concilio, G., & Rizzo, F. (2016). *Human Smart Cities: Rethinking the Interplay between Design and Planning*. Springer International Publishing.

Costello, G.J., Donnellan, B., & Curley, M. (2013). A Theoretical Framework to Develop a Research Agenda for Information Systems Innovation. *Communications of the Association for Information Systems*, 33(26).

D

Dash, S., Radjou, N., Ahuja, S., & Prabhu, J. (2010). Here comes the sun: Selling solar solutions the SELCO way. Cambridge Judge Business School Case.

Dorfman, N. S. (1987). *Innovation and Market Structure: Lessons from the Computer and Semiconductor Industries*. Cambridge, MA: Ballinger.

Drazin, R., & Schoonhoven, C.B. (1996). Community, population, and organization effects on innovation: a multilevel perspective. *Academy of Management Journal*, 39(5), 1065-1083.

E

Energy for the Masses: Husk Power Helps Fuel India. Available online:
<http://www.ecomagination.com/energy-for-the-masses-husk-power-helps-fuel-india> (accessed on 11 October 2018).

F

Fu, X., & Gong, Y. (2011). Indigenous and Foreign Innovation Efforts and Drivers of Technological Upgrading: Evidence from China. *World Development*, 39(7), 1213-1225.

G

Gambhir, A., Singh, S.K., Sotiropoulos, A., & Duckworth, S. (2012). *Frugal Innovation: Learning from Social Entrepreneurs in India*. Serco Institute.

Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, 31(8-9), 1257-1274.

Geels, F.W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36, 399-417.

Geels, F.W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, 1(1), 24-40.

Geels, F.W. (2005). The Dynamics of Transitions in Socio-Technical Systems: A Multi-Level Analysis of the Transition Pathway from Horse-Drawn Carriages to Automobiles (1860-1930). *Technology Analysis and Strategic Management*, 17(4), 445-476.

Geels, F.W. (2005). *Technological Transitions and System Innovations: A Co-evolutionary and Socio-technical Analysis*. Edward Elgar Publishing.

George, G., McGahan, A.M., Prabhu, J., & Macgahan, A. (2012). Innovation for inclusive growth: Towards a theoretical framework and a research agenda. *Journal of Management Studies*, 49, 662-683.

Girma, S. (2005). Absorptive capacity and productivity spillovers from FDI: A threshold regression analysis. *Oxford Bulletin of Economics and Statistics*, 67(3), 281-306.

Govindarajan, V., & Ramamurti, R. (2011). Reverse innovation, emerging markets, and global Strategy. *Global Strategy Journal* 1, 191-205.

Govindarajan, V., & Ramamurti, R. (2013). Delivering world-class health care, affordably. *Harvard Business Review*, 91, 117-122.

Govindarajan, V., & Trimble, C. (2012). *Reverse innovation: Create far from home, win everywhere*. Harvard Business Press.

Grameen Shakti. Available online: <http://www.gshakti.org/> (accessed on 12 October 2018).

Grin, J., Rotmans, J., & Schot, J. (2010). *Transitions to sustainable development: new directions in the study of long-term transformative change*. Routledge, New York.

Gupta, A.K. (2012). Innovations for the poor by the poor. *International Journal of Technological Learning, Innovation and Development*, 5(1/2).

Gupta, A., Sinha, R., Koradia, D., Patel, R., Parmar, M., Rohit, P., Patel, H., Patel, K., Chand, V.S., & James, T.J. (2003). Mobilizing grassroots' technological innovations and traditional knowledge, values and institutions: Articulating social and ethical capital. *Futures*, 35, 975-987.

Gupta, A. K. (2013). Tapping the Entrepreneurial Potential of Grassroots Innovation. *Stanford Social Innovation Review*, 11(3), 18-20.

Gupta, A. K. (1997). The Honey Bee Network: Linking Knowledge-Rich Grassroots Innovations. *Development*, 40 (4), 36-40.

Gupta, V. (2008). An Inquiry into the Characteristics of Entrepreneurship in India. *Journal of International Business Research*, Special Issue 1, 7 (S1), 53-69.

H

Hambleton, R. (2015). *Leading the Inclusive City: Place-Based Innovation for a Bounded Planet*. Bristol, UK: Policy Press.

Hammond, A., Kramer, W.J., Tran, J., Katz, R., & Walker, C. (2007). *The Next 4 Billion: Market Size and Business Strategy at the Base of the Pyramid*. World Resources Institute.

Health care in India: lessons from a frugal innovator. *The Economist*, April 16th, 2009. Available online: <https://www.economist.com/business/2009/04/16/lessons-from-a-frugal-innovator> (accessed on 6 September 2018).

Heeks, R. (2012). IT Innovation for the Bottom of the Pyramid. *Communications of the ACM*, 55(12), 24-27.

Heeks, R. (2012). Emerging Markets IT innovation for the bottom of the pyramid. *Communications of the ACM*, 55(12), 24-27.

Hossain, M. (2017). Mapping the frugal innovation phenomenon. *Technology in Society*, 51, 199-208.

Hughes, N., & Lonie, S. (2007). M-PESA: Mobile Money for the unbanked, Turning Cellphones into 24-Hour Tellers in Kenya. *Innovations Technology Governance Globalization*, 2, 63–81.

Husk Power Systems, India (Case Study Summary). Available online: <https://www.ashden.org/files/Husk%20winner.pdf> (accessed on 14 October 2018).

Husk Power Systems: Lighting up the Indian Rural Lives. Available online: http://oikos-international.org/wp-content/uploads/2013/11/oikos_Cases_2013_Husk_Power.pdf (accessed on 14 October 2018).

I

Immelt, J. R., Govindarajan, V., & Trimble, C. (2009). How GE is disrupting itself. *Harvard Business Review*, 87, 56–65.

J

Jiatao, L., & Rajiv K. K. (2009). Developing new innovation models: Shifts in the innovation landscapes in emerging economies and implications for global R&D management. *Journal of International Management*, 15, 328-339.

K

Kemp, R., Schot, J., & Hoogma, R. (2007). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Journal of Technology Analysis & Strategic Management*, 10(2), 175-198.

Keupp, M.M., & Gassmann, O. (2013). Resource constraints as triggers of radical innovation: Longitudinal evidence from the manufacturing sector. *Research Policy*, 42(8), 1457-1468.

Khan, R. (2016). How Frugal Innovation Promotes Social Sustainability. *Sustainability*, 8(10).

Khanna, T., Krishna G. P., & Richard B. (2010). *Winning in Emerging Markets: A Road Map for Strategy and Execution*. Harvard Business Press.

Krishnan, R. T. (2010). *From jugaad to systematic innovation: The challenge for India*. Bangalore: Utpreraka Foundation.

Kumar, N., & Puranam, P. (2012). Frugal engineering: An emerging innovation paradigm. *Ivey Business Journal Online*, 76, 14-16.

Kumar, N., & Puranam, P. (2013). *India Inside: The Emerging Innovation Challenge to the West*. Harvard Business Press.

Kumar, V., Chand, V. S., Zhang, L., Odora Hoppers, C. A., Zhang, W., Esders, M., & Gupta, A. K. (2013). Grassroots Innovations for Inclusive Development: Need for a Paradigmatic Shift. *Vikalpa: The Journal for Decision Makers*, 38(3), 103-122.

L

Leadbeater, C. (2014). *The Frugal Innovator: Creating Change on a Shoestring Budget*. Palgrave Macmillan.

Lundvall, B.-Å. (1988). *Innovation as an interactive process: From user-producer interaction to the National Innovation Systems*. Technology and economic theory, London, Pinter Publishers.

Lundvall, B.-Å. (1985). *Product Innovation and User-Producer Interaction*, Aalborg. Aalborg University Press.

M

Mair, J., & Martí, I. (2006). Social entrepreneurship research: A source of explanation, prediction, and delight. *Journal of World Business*, 41(1), 36-44.

Marvin, C. (1990). When Old Technologies Were New: Thinking About Electric Communication in The Late-Nineteenth Century. *The Journal of American History*, 19(3).

McKinsey Quarterly. (2005). Innovation blowback: Disruptive management practices from Asia, 1, 34-45.

Mitra, B. S. (1995). India's 'informal' car. *Wall Street Journal - Eastern Edition*, 225(21).

Mokyr, J. (1990). *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford university press, Inc.

Moorman, C., & Miner, A.S. (1998). Organizational Improvisation and Organizational Memory. *The Academy of Management Review*, 23(4), 98-723.

Mukerjee, K. (2012). Frugal innovation: the key to penetrating emerging markets. *Ivey Business Journal*, 74 (4), 1-3.

Munshi, N. V. (2010). Value Creation, Social Innovation, and Entrepreneurship in Global Economies. *Journal of Asia Pacific Business*, 11 (3), 160-165.

N

Nohria, N., & Gulati, R. (1996). Is Slack Good or Bad for Innovation? *The Academy of Management Journal*, 39(5), 1245-1264.

O

Orlikowski, W.J., & Barrett, M. (2014). Digital Innovation in Emerging Markets: A Case Study of Mobile Money. MIT Center for Information Systems Research Briefing, 14(6).

P

Pansera, M., & Sarkar, S. (2016). Crafting sustainable development solutions: Frugal innovations of grassroots entrepreneurs. *Sustainability*, 8(1).

Pavlou, P. A., & El Sawy, O. A. (2010). The 'Third Hand': IT-enabled Competitive Advantage in Turbulence Through Improvisational Capabilities. *Information Systems Research*, 21(3), 443-471.

Perrini, F., Vurro, C., & Costanzo, L. A. (2010). A process-based view of social entrepreneurship: From opportunity identification to scaling-up social change in the case of San Patrignano. *Entrepreneurship & Regional Development*, 22(6), 515-534.

Petrick, I. J. (2011). Innovation in Emerging Markets. *Research Technology Management*, 54(4).

Pina e Cunha, M., Rego, A., Oliveira, P., Rosado, P., & Habib, N. (2014). Product Innovation in Resource-Poor Environments: Three Research Streams. *Journal of Product Innovation & Management*, 31(2), 202-221.

Prabhu, J., & Jain, S. (2015). Innovation and entrepreneurship in India: Understanding jugaad. *Asia Pacific Journal of Management*, 32 (4), 843-868.

Prahalad, C.K. (2005). *The Fortune at the Bottom of the Pyramid*. Wharton School Publishing.

Prahalad, C.K., & Hart, S. (2002). *The Fortune at the Bottom of the Pyramid*. *Strategy+ Business*, Issue 26.

Prahalad, C.K., & Mashelkar, R.A. (2010). Innovation's Holy Grail. *Harvard Business Review*, 88, 132-141.

Prahalad, C. K. (2004). Why selling to the poor makes for good business. *Fortune*, 150(10), 70-72.

Prahalad, C. K. (2012). Bottom of the Pyramid as a Source of Breakthrough Innovations. *Journal of Product Innovation Management*, 29 (1), 6-12.

Prasad, V. C. S., & Ganvir, V. (2005). Study of the principles of innovation for the bop consumer- the case of a rural water filter. *International Journal of Innovation and Technology Management*, 2 (4), 349-366.

Pugalis, L. & Giddings, B. (2011). A renewed right to urban life: A twenty-first century engagement with Lefebvre's initial "cry". *Architectural Theory Review*, 16 (3), 278-295.

R

Radjou, N., Prabhu, J., & Ahuja, S. (2012). *Jugaad innovation: think frugal, be flexible, generate breakthrough growth*. John Wiley & Sons.

Radjou, N., & Prabhu, J. (2015). *Frugal Innovation: How to do more with less*. Public Affairs.

Radjou, N., & Prabhu, J. (2012). Mobilizing for Growth in Emerging Markets. *MIT Sloan Management Review*, 53, 1-8.

Radjou, N., & Prabhu, J. (2013). *Frugal Innovation: A New Business Paradigm*. INSEAD Knowledge Publications, 1-3.

Radjou, N., Prabhu, J., & Ahuja, S. (2010). More for Less for More: How to Disrupt in the Age of Scarcity. *Harvard Business Review*.

Rammert, W. (1997). New Rules of Sociological Method: Rethinking Technology Studies. *British Journal of Sociology*, 48(2).

Rao, B. C. (2013). How disruptive is frugal? *Technology in Society*, 35(1), 65-73.

Rao, H., & Drazin, R. (2002). Overcoming Resource Constraints on Product Innovation by Recruiting Talent from Rivals: A Study of the Mutual Fund Industry, 1986-1994. *Academy of Management Journal*, 45(3), 491-507.

Rauch, A., Frese, M., Wang, Z., Unger, J., Lozada, M., Kupcha, V., & Spirina, T. (2013). National culture and cultural orientations of owners affecting the innovation-growth relationship in five countries. *Entrepreneurship & Regional Development*, 25(9/10), 732-755.

Rip, A., & Kemp, R. (1998). Technological change. *Human choice and climate change*, 2, *Resources and Technology*, 327-399.

S

Saraf, D. (2009). India's Indigenous Genius: Jugaad. *The Wall Street Journal*.

Sarkar, M. (2011). Moving forward by going in reverse: emerging trends in global innovation and knowledge strategies. *Global Strategy Journal*, 1(3/4), 237-242.

Schrage, M. (2000). *Serious play: How the world's best companies simulate to innovate*. Boston, MA: Harvard Business School Press.

Sehgal, V., Dehoff, K., & Panneer, G. (2010). The importance of frugal engineering. *Strategy Business*, 12, 1-5.

SELCO: Solar Lighting for the Poor. Available online:

http://www.growinginclusivemarkets.org/media/cases/India_SELCO_2011.pdf (accessed on 17 October 2018).

SELCO Solar Pvt Ltd, India (Case Study Summary, 2009). Available online: https://www.ashden.org/files/SELCO%20full_0.pdf (accessed on 19 October 2018).

SELCO Solar Lights Rural Lives. Available online: <http://www.treehugger.com/renewable-energy/selco-solar-lights-rural-lives.html> (accessed on 19 October 2018).

Seyfang, G., & Haxeltine, A. (2012). Growing grassroots innovations: exploring the role of community-based initiatives in governing sustainable energy transitions. *Environment and Planning C: Government and Policy*, 30(3), 381-400.

Seyfang, G., & Smith, A. (2007). Grassroots innovations for sustainable development: towards a new research and policy agenda. *Environmental Politics*, 16 (4), 584- 603.

Sharma, A., & Iyer, G.R. (2012). Resource-constrained product development: Implications for green marketing and green supply chains. *Industrial Marketing Management*, 41(4), 599-608.

Simmie, J. (2003). *Innovative Cities*, Routledge.

Singh, M.G., Gambhir, A., & Dasgupta, J. (2011). Innovation in India: affordable innovations. *The Global Innovation Index 2011, Accelerating Growth and Development*, 77-86.

Singh, R., Gupta, V., & Mondal, A. (2012). Jugaad - From "Making Do" and "Quick Fix" to an Innovative, Sustainable and Low-Cost Survival Strategy at the Bottom of the Pyramid. *International Journal of Rural Management*, 8(1/2), 87-105.

Singh, V.K., & Lillrank, P. (2015). *Innovations in Healthcare Management: Cost-Effective and Sustainable Solutions*. CRC Press.

Stahlecker, T., & Koschatzky, K. (2010). Cohesion policy in the light of place-based innovation support: New approaches in multi-actors, decentralised regional settings with bottom-up strategies? Working papers: Company and Region, Fraunhofer ISI.

Stewart, F. (1983). Macro-policies for appropriate technology: An introductory classification. *International Labour Review*, 122(3), 279.

Sustainable Development Goals. Available online: <https://sustainabledevelopment.un.org/> (accessed on 14 April 2018).

T

Tallon, P. P. (2011). Value Chain Linkages and the Spillover Effects of Strategic Information Technology Alignment: A Process-Level View. *Journal of Management Information Systems*, 28(3), 9-44.

Tanriverdi, H., Rai, A., & Venkatraman, N. (2010). Research Commentary — Reframing the Dominant Quests of Information Systems Strategy Research for Complex Adaptive Business Systems. *Information Systems Research*, 21(4), 822-834.

Tata Chemicals launches Tata Swach. Available online:
<http://www.tatachemicals.com/media/releases/200912dec/20091207.htm#.VfK5Z2qqk>
(accessed on 20 October 2018).

Tata Nano - OEM, Supplier Relationship. Available online:
<http://tatacars.blogspot.com/2008/01/tata-nano-oem-supplier-relationship.html> (accessed on 17 May 2018).

Tata Swach Products. Available online: <http://www.tataswach.com/products> (accessed on 13 October 2018).

Tidd, J., Bessant, J.R., & Pavitt, K. (2005). *Managing Innovation: Integrating Technological, Market and Organizational Change*. Hoboken: Wiley, 3rd edition.

Tiwari, R., & Herstatt, C. (2012). Open global innovation networks as enablers of frugal innovation: propositions based on evidence from India. Working Paper, Technologie-und Innovations management, Technische Universität Hamburg-Harburg, 72.

Tiwari, R., & Herstatt, C. (2012). Frugal Innovation: A Global Networks' Perspective in *Die Unternehmung*. *Swiss Journal of Business Research and Practice*, 66, 245–274.

Tödting, F., & Tripl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research Policy*, 34(8), 1203-1219.

U

Urpelainen, J., & Yoon, S. (2016). Solar products for poor rural communities as a business: lessons from a successful project in Uttar Pradesh, India. *Clean Technologies and Environmental Policy* 18(2), 617–626.

V

Varian, H.R. (2003). *Innovation, Components and Complements*. University of California, Berkeley.

Venema, V. (2015). The Indian sanitary pad revolutionary. Available online:
<http://www.bbc.com/news/magazine-26260978> (accessed on 15 September 2018).

Venkatesha, R. (2014). *Portable Water Purifiers*. Thesis available at:
www.researchgate.net/publication/301547870_Portable_Water_Purifiers (accessed on September 10, 2018).

Vortex. Available online: <http://vortexindia.co.in/> (accessed on 21 October 2018).

W

Weill, P. and Woerner, S.L. (2013). The New Digital Divide: Emerging Trump Developed Economies. MIT Center for Information Systems Research, Research Briefing, 13(10).

Wierenga, M. (2015). Local Frugal Innovations: How do resource-scarce innovations emerge in India? Thesis available at: <https://aaltodoc.aalto.fi/handle/123456789/18429> (accessed on July 3, 2018).

Williamson, P. J. (2010). Cost innovation: preparing for a 'value-for-money' revolution. *Long Range Planning*, 43(2), 343-353.

Willoughby, K. W. (1990). Technology choice: A critique of the appropriate technology movement. *Futurist*, 24(4), 45.

Why Do You Need a Water Purifier? Available online:
<http://www.pureitwater.com/IN/products> (accessed on 13 October 2018).

Wylant, B. (2008). Design Thinking and the Experience of Innovation. In: *Design Issues*, 24(2),3-14.

Z

Zeschky, M., Widenmayer, B., & Gassmann, O. (2011). Frugal innovation in emerging markets. *Research Technology Management* 54 (4), 38-45.

Zeschky, M., Winterhalter, S., & Gassmann, O. (2014). From Cost to Frugal and Reverse Innovation: Mapping the Field and Implications for Global Competitiveness. *Research Technology Management*, 57(4), 20-27.

- [1] Ministry of Housing and Urban Affairs, Government of India. Available online: <http://smartcities.gov.in/content/innerpage/what-is-smart-city.php> (accessed on 18 June 2018).
- [2] smart-cities.eu. Report: Smart cities Ranking of European medium-sized cities (Final Report, October 2007). Available online: http://www.smartcities.eu/download/smart_cities_final_report.pdf (accessed on 18 June 2018).
- [3] Available online: 8ate.blogspot.com/2009/06/koi-jugaad-hai.html (accessed on 27 June 2018)
- [4] Aravind Eye Care System. Available online: <http://www.aravind.org/> (accessed on 3 July 2018).
- [5] World Bank, 1997, India - The Indian oilseed complex: capturing market opportunities: Main Report (English). World Development Sources, WDS 1997-2. Washington, DC: World Bank. Available online: <http://documents.worldbank.org/curated/en/461811468752374364/Main-Report> (accessed on 17 August 2018).
- [6] ITC, e-CHOUPAL. Available online: <https://www.itcportal.com/businesses/agri-business/e-choupal.aspx> (accessed on 17 August 2018).
- [7] Piramal Sarvajal. Available online: <http://www.sarvajal.com/who-we-are.php> (accessed on 8 July 2018).
- [8] Mothers 2 Mothers 2016 Annual Report. Available online: <https://www.m2m.org/wp-content/uploads/2018/04/2016-Annual-Report-1.pdf> (accessed on 3 August 2018).
- [9] SELCO Solar, India. Available online : http://www.selco-india.com/about_us.html (accessed on 3 August 2018).
- [10] Available online: <https://www.coloribus.com/adsarchive/prints/nokia-1100-mobile-phone-coconut-tree-6544955/> (accessed on 13 August 2018).
- [11] Article: These Nokia Memes Are More Popular Than Nokia Smartphone's: A Tribute To Old Nokia. Available online: <https://www.techleaksofficial.com/2018/06/these-nokia-memes-are-more-popular-than.html> (accessed on 13 August 2018).
- [12] Article: Nokia's cheap phone tops electronics chart. Available online: <https://www.reuters.com/article/us-nokia-history/idUSL0262945620070503?mod=related&channelName=technologyNews> (accessed on 13 August 2018).
- [13] Voice of America. Article: 'Lemelson Foundation Promotes Inventive Solutions to Poverty'. Available online : <https://www.voanews.com/a/lemelson-foundation-promotes-inventive-solutions-to-poverty-79420592/416507.html> (accessed on 19 August 2018).
- [14] The Indian Express. Article: 'Motorcycle-ambulances help save lives in Chhattisgarh forests', 2016. Available online : <https://indianexpress.com/article/lifestyle/health/motorcycle-ambulances-help-saves-lives-in-chhattisgarh-forests-2935290/> (accessed on 20 August 2018).
-

[15] The Guardian. Article: 'Could motorbikes cut deaths in childbirth in Africa? 2009. Available online <https://www.theguardian.com/society/katineblog/2009/may/13/motorbike-ambulances-childbirth> (accessed on 20 August 2018).

[16] BBC News. Article: 'The Indian sanitary pad revolution'. Available online: <https://www.bbc.com/news/magazine-26260978> (accessed on 22 August 2018).

[17] The Economist. Article: 'Cut from a different cloth'. Available online: <https://www.economist.com/business/2013/09/14/cut-from-a-different-cloth> (accessed on 22 August 2018).

[18] Rashtriya Swasthya Bima Yojana. Available online: http://www.rsby.gov.in/about_rsby.aspx (accessed on 12 November 2018).

Saiba Gupta
Politecnico di Milano