

## Mapping factors which act as catalysts in the promotion of energy efficient and sustainable frugal innovation in India

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**Abstract:** The paradigm of frugal innovations has gained prominence in recent times. These innovations address the issue of environmental stability by bringing out products and services with affordable technology while maintaining a low cost to reach the audience at the bottom of the pyramid. These objectives along with others which are taken up in this literature review are at the factor behind the advent of these 'frugal innovation' and thus explain not only the recent upsurge in such innovations but also the location i.e., the developing countries and especially the case of India, where these innovations are being born.

**Keywords:** Frugal innovation, factors, sustainable development, Pro-poor innovation, Gandhian innovation, Jugaad innovation, Energy Efficiency etc.

### INTRODUCTION

The concept of frugal innovation or the 'doing more with less' approach to innovation has been around for some time now but only recently has gained prominence. The phenomenon is more evident in emerging markets like India and China, who are the pioneers in this sector (Hosseini, 2020). This development bucks the general trend of industrialized countries leading the way in new innovative technologies, products, and services. Frugal innovation overcomes input, income and infrastructure resource constraints to come up with affordable, smart and accessible solutions (Asakawa et al., 2019). The innovation is not defined by making things cheaper but rather making things better by creatively leveraging locally available resources and integrating them with existing technologies (Radjou, 2017).

In India frugal innovation is sometimes called Gandhian or '*jugaad*' innovation (Platt, 2010; 'Asian Innovation', 2012). *Jugaad* is a Hindi word which means a improvised solution or a creative fix in the face of adversity (Radjou, 2017). India has emerged as a trailblazer for frugal innovations. India has distinguished itself by successfully developing accessible, affordable solution to decrease existing product and services disparity in the country ('India bringing', 2016; Singh et. al., 2012). Highest number of frugal innovations are from India (Hossain, 2016). Several successful examples of the phenomenon

are documented in literature (Bound and Thornton, 2012; Sachitanand, 2013; Amos, 2014; Kalla, 2015). A thriving entrepreneurial ecosystem harnessing human creativity to deliver cost efficient and sustainable frugal innovations will help the Indian economy to grow and become self sufficient ('How entrepreneurship', 2021; Hussain, 2018).

This article maps out the factors behind this upsurge in frugal innovations in the context of the environmental, institutional, technological, economic, or socio-cultural changes or developments that have aided such growth. Section 2 of the paper explores and attempts to define the concept of frugal innovation. Section 3 talks about the history of frugal innovation, highlighting the early influence of Gandhian ideas and the impact of rising prominence of green technologies and environmental consciousness in recent times. Section 4 compares and contrasts frugal innovation to conventional innovation. Section 5 explores the association of frugal innovation with the sustainable development. Section 6 and 7 details the factors behind the emergence of frugal innovations in the world and India respectively. Section 8 gives concluding statements and discusses some of the shortcomings of the frugal innovations and policy recommendations.

## II. What is Frugal Innovation?

There is no one single definition of frugal innovation. The definition modifies depending on the approach, process, and outcome of innovation (Soni and Krishnan, 2014). Frugal innovation can seem like a complex and multifaceted notion causing different businesses to interpret and apply it differently (Hossain, 2016). Although lacking consensus, it is agreed upon that the term 'frugal innovation' itself captures the bits and pieces espoused by complementary definitions mirrored in inclusive, reverse, extreme affordability, trickle-up, BOP, and catalytic proponents.

It is noted that affordability, accessibility, availability, and sustainability pose the common issues frugal innovation seeks to address. The focus of these innovations is not just limited to ensuring the profitability for its producers, it also takes into account the needs of other stakeholders of the business, such as the end consumers, the environment as well as future generations. Human creativity is the fuel which powers the frugal innovations (Rajdou, 2017).

Frugal innovation is a unique approach to innovation both in terms of means and its ends (Bound and Thornton, 2012):

- a. Means: Frugal innovation involves distinctive methods and techniques which set it apart from normal business innovation. Such innovation takes the very factors which are its limitation (to production), whether financial, material, or institutional, and turns them around into an advantage. It optimizes the use of resources, either by minimizing their uses in development, production, and delivery or by using new techniques, which results in a significantly lower cost of production. The product may not always have higher performance instead it may be more suitable and more efficient.
- b. Ends: The products, services, or processes are distinctive. In addition to being cheaper, successful frugal innovations can sometimes outperform the alternatives and can be manufactured on a large scale.

It has been observed that most frugal innovations have an definite social mission. Usually, people equate frugal innovation to the creation of cheap, low-tech products, however the following four features of frugal innovations enlisted below contradict this belief:

1. It entails making things better not just cheaper.

2. Frugal innovation extends to both products and services.
3. Frugal innovation is as much about remodeling as it is about 'de-featuring'.
4. Frugal innovation makes process low cost but that does not mean it is low-tech: frugal innovation can be required to, or be combined with frontier science and technology to make goods and services more affordable and accessible to more people (Weyrauch and Herstatt,2017).

### III The history of frugal innovation

Frugal innovation has its origins in the 20th century intermediate or appropriate technology movement. The movement promoted decentralized, low-tech, labor-intensive, energy-efficient, environmentally sound, and affordable technology and application as an alternative to dependence on developed nations for technology transfers (Sianipar et. al.,2013) (Bound and Thornton 2012). Mahatma Gandhi advocated that for India to become self-reliant, adoption and development of local, village-based technology and production is paramount. Teachings of Gandhi greatly influenced economist E.F Schumacher who in a 1962 report for the Planning Commission of India defined the concept of appropriate technology. Schumacher stressed on the importance of intermediate technology in his future publications as well. The popularity of the movement waned over time. The quality of intermediate technology innovations was regarded inferior to traditional technology innovations. In the 1980's need for sustainable development gained precedence over appropriate traditional technology in face of rising environmental concerns. The historic Brundtland commission report, *Our common future* (1987) reflected these new priorities. Encouraged by the new policy consciousness frugal innovation gained traction as an alternate to ensure efficient and sustainable solutions(Bound and Thornton,2012).

The term 'frugal innovation' was spotlighted 2010 article by The Economist magazine. In another article in The Economist in 2011, describes frugal innovation as a process in reverse creating functional products that are simple, affordable and accessible. The article also presents that the phenomenon is sometimes also labeled as 'reverse innovation', 'frugal innovation', or 'constraint-based innovation'.

### IV. Comparison between frugal and conventional innovation

Frugal innovation is in complete contrast to conventional innovation practiced in developed countries. Innovation in developed countries are targeted towards top of pyramid consumers with high purchasing power. The benefits of innovations is expected to eventually trickles down to low income consumers. The traditional innovation model isolates a large section of consumers to benefit from the latest technologies as they cannot afford expensive goods and services due to their diminishing purchasing power. This 'top down' innovation approach of developed countries is not sustainable (Hossain et al., 2016). Factor like stagnating developed economies, rising world population, increasing inequality and the spectre of climate change has made the 'more for more' innovation model unfeasible. The conventional innovation model is leading to widening disparity between existing products and services and current needs of people. The developed countries have now started exploring alternative innovation methods (Hossain et al., 2016).

The bottom-up approach of frugal innovation helps in efficient utilization of limited resources through creative improvisations. Frugal innovations improves competition which leads to decrease in market prices and therefore engages new groups of consumers whose willingness to pay meets the new lowered prices. This in turn increases consumer welfare and total market surplus(Levänen et al.,2016). While some of these innovations were motivated by environmental factors, most were the result of

limiting resource inputs, cost-cutting, or leveraging existing resources in new ways (Bound and Thornton, 2012).

#### **V. Factors Behind Recent Growth of Frugal Innovations:**

Many factors have promoted the trend of frugal innovation as a general rule. Some of these factors which have been recognized in the literature of this field are:

1. Spread of innovation to 'Non-Traditional' sources- Usually it is observed that it is the industrialized nations that finance the high costs associated with research and development of technologies (Tiwari and Herstatt, 2012). Of late, developing countries like India and China have established themselves as up and coming innovation hubs especially in the field of frugal innovation (Herstatt et al., 2008; Prahalad and Mashelkar, 2010). Several emerging economies have successfully fostered thriving entrepreneurial ecosystem by leveraging frugal innovations, resource sharing, knowledge flows and existing capital (Hossain 2018; Igwe et. al.,2020) Constraints posed by the low purchasing power of consumers and the supposed absence of customer sophistication in a large and growing market like India are balanced by significant economies of scale and cost-effective efficient solutions (Tiwari and Herstatt, 2012).

2. Change in Types of Constraints on Innovation- In recent times, these constraints have moved away from pure efficiency or even technical precision, to a 'mission-driven' set of constraints. To create offerings for people who live and work at the least privileged interfaces of the modern world. And this is why frugal innovation has come to the fore, because of a broadly shared view to provide consumer value/amenities with the feature of 'extreme affordability'. This may be due to philanthropic, market, or efficiency-seeking reasons (Hossain, 2018).

3. Changing Tastes and Preferences of the Consumers- It has been observed that affordability and sustainability are replacing premium pricing and abundance as innovation's drivers. Westerners are struggling to tackle this challenge, but some enterprises in developing countries, particularly in India, are showing the way. Rich and the young in both the developed and the developing world are demanding environment-friendly products and services. Affordability and sustainability, not premium pricing and abundance, are driving innovation today (Bound and Thornton, 2012).

4. Resource Scarcity as an Enabling Force- While resource abundance has been traditionally viewed as a facilitator for innovation, scholars are now beginning to rethink resource scarcity also as an enabler. 'Wherever possible we do advocate resource scarcity: Abundance is not only costlier, but it also does not provide the stimuli for finding the innovative solutions that constraints inevitably invite' (Gibbert, Hoegl, and Välikangas 2007, p.17). Gibbert et al cite several research studies that show constraints serve as an enabler of radical innovation. They cite 'resource parsimony' as using only the least necessary resources to obtain desired results.

5. Increasing relevance in industrialized nations- Due to the stagnant growth in developed nations and businesses seeking diversified investment opportunities, demand for frugal production and frugal innovation processes has increased (Hossain, 2018). To take care of rapidly aging societies, new radical frugal approaches to healthcare are being adopted. In the face of successful examples of frugal

innovation there has been rethinking of business models and value chains. The era of digitization has created huge opportunities for frugal innovation especially in service sector (Bound and Thornton, 2012).

#### VI. Factors behind Growth in India:

Frugal innovation, in present times, is a major defining trait of the Indian innovation system. Several factors combined have managed to create conditions for the development of high-impact frugal innovation culture in India which can be applied to other emerging markets too.

1. 'Jugaad' culture: Jugaad is a Hindi language word that means overcoming limitations to come up with a improvised solution or a creative fix in the face of adversity. Jugaad is an indigenous frugal innovation to find stop gap solutions to local issues (Rajdou, 2017). Such grassroots innovations possess intellectual and financial merit. The principles of adapting and improvising in the face of adversity, and the approach of doing more with less can be applied to high-level technologies also (Bound and Thornton, 2012). Jugaad mindset, process, and outcome are beneficial not only to local innovations but also to multinationals whose traditional innovation approach have become too rigid and outdated remain effective. **Jugaad innovation** matters because (Rajdou et. al., 2012)-

a. Jugaad is frugal- Innovators can achieve more with less.

b. Jugaad is flexible- It allows innovators to keep experimenting and course-correct if they reach a dead end.

c. Jugaad is democratic- Jugaad solutions depend on human creativity. It can tap into the ideas and creativity of sections of otherwise ignored customers and employees.

2. Growing Middle Class- A big market with a growing, ambitious middle class creates suitable conditions for frugal innovation. The economic growth that has pulled millions of Indians out of poverty in recent years is also leading to the rapid growth of the country's middle class. McKinsey projections show that by 2025 a continuing rise in personal incomes will cause this to grow at least tenfold. Despite low individual purchasing power, the overall size of the market creates huge purchasing power at lower income levels. The middle and BOP (bottom of the pyramid) class consumers in India and other developing countries are the fastest-growing consumer segments in the world. It has been suggested that serving these budget-constrained consumers can lead to successful frugal engineering and innovation examples (Kumar & Puranam 2012:13). Innovations resulting from frugal products and services can be offered in India and other emerging markets to meet the needs of customers in different segments. Moreover, the same products could also be offered to the budget-constrained niche markets in developed markets and lastly, these innovations can be used to simplify and improve existing products (Kumar & Puranam 2012).

3. Price Sensitive Consumers - The Indian consumer base is growing, but it remains extremely price-sensitive and willing to experiment, sustaining demand for frugal innovation. This is visible in sectors from consumer products to healthcare. In India, over 70 percent of healthcare is provided by private enterprises, forcing providers to be extremely competitive, like patients, private providers are very sensitive about what they pay for equipment and other necessary supplies. This is contributing to a rich seam of innovation in affordable healthcare. 'The beauty of the Indian market is that it pushes you in a corner ... it demands everything in the world, but cheaper and smaller' (Kumar & Puranam 2012).

4. Gaps in service provision - India's large rural population is spread across a land area of millions of square kilometers. Most poor Indians lack access to basic public services such as primary healthcare, drinking water, and sanitation facilities. Necessity is sometimes the mother of invention, and with over 3 million NGOs, India has a strong tradition of civil society and a socially conscious private sector that is willing to fill the void left by the government with radical new approaches (Gambhir et al.,2012,World Bank,2016).

5. Strengths in service and business model innovation create an advantage in creative remodeling of product-service ecosystems- While the revolution provoked by India's software outsourcing story is well known, other stories of revolutionary business model innovation are less well known. The example of Aravind Eye Hospital helps to explain this phenomenon. From its beginnings as a modest 20–bed hospital in the 80s, Aravind had already grown into a 1,400–bed hospital complex by 1992. By then it had screened 3.65 million patients and performed 335,000 cataract surgeries. It now performs 200,000 surgeries a year. At the same time as running a profitable company, it delivered nearly 70 percent of these operations free of charge to the poor. At the heart of its business model is multi-tiered pricing or cross-subsidization – where the core service remains the same but profits from wealthier customers cover deficits from those less available to pay. The network of hospitals are at forefront of providing affordable vision related technologies(Rosenber,2013). This model has been imitated around the world(Sehgal, Dehoff, and Panneer, 2010) .

6. Role of government- governments participation is important for the development of frugal innovation in addition to growing investment in frugal innovation by the private sector. The innovation environment could develop rapidly, with the government's plans for a new \$1 billion 'inclusive innovation fund'. Government's commitment has attracted the attention of institutional and private investors all over the world. Social investors are optimistic about the opportunities in India(Prabhu,2017). Government of India has launched Atal Innovation Mission, a flagship scheme for promote entrepreneurial and innovation ecosystem across different sectors of the economy. The mission also attempt to engage and stimulate young minds to create sustainable solutions for the country .Any such bolstering steps by the government would be extremely favorable for the development of Frugal Innovations. The final Five Year Plan (2012–17) also directed government support for innovation towards meeting national challenges. India's previous prime minister, Dr. Manmohan Singh observed that, *'The overriding objective of a comprehensive and well-considered policy for science, technology and innovation should be to support the national objective of faster, sustainable and inclusive development...Research should be directed to providing 'frugal' solutions to our chronic problems of providing food, energy, and water security to our people.'*

7. An 'inclusive' innovation policy - Governments programmes and policies promote a uniquely 'inclusive model of innovation' for India. The government's willingness to capitalize on new approaches to innovation in technology platforms, connectivity, and collaboration is turning India, into a *'laboratory for innovation in development'*. The initiatives with vast potential to create a platform for future frugal innovation is not framed around innovation at all, but rather around social protection(Bound and Thornton,2012).

## VII. Frugal Innovation And Sustainability

The paradigm of frugal innovation has social, economic and ecological dimensions to its technology. Frugal innovation distinguishes itself by low resource intensity whether its energy, financial capital, fuel, raw material used in production, water etc. (Rosca et al., 2018; Albert, 2019). Leveraging infinite human creativity, frugal innovation promotes social equity and inclusion of local communities to create cost-effective, adaptable, accessible and affordable solutions to modern problems. Sustainability of frugal innovation is one of the advantages it has over conventional innovation. Frugal innovation challenges conventional views to empower and encourages bottom of the pyramid approach to entrepreneurship and sustainable growth. By ignoring frugal approach to innovation developed nations are facing resource scarcity, environmental harm and other negative side-effects of traditional innovation process (Fleurbaey et al., 2014).

Since all these innovations were created with the aim of developing sustainable solutions that address present needs while keeping future needs in mind, their large scale use could contribute to a more sustainable world and bringing about an end to global issues like poverty, world hunger, and social injustice. Not only can we expect initial direct benefits of using such approach; however, the potential for far-reaching, positive domino effects as a result of the proper implementation of these innovations is also tremendous (Rosca, 2018).

Frugal Innovation can be a conduit for positive change. A host of actors comprising development economists, policy makers, educationists, idealistic students, foundations with a social mission, investors seeking both profit and social impact, and bottom of the pyramid consumers potentially voicing frustration with governments. Inability to meet their needs is together making up a social movement for addressing poverty and unmet needs in the shape of global popularity of sustainable development.

*'Innovation can fulfill needs, which are not met by conventional means and this is critical in view of the numerous challenges the country is facing in delivering services to the people, especially at the bottom of the pyramid. In this context India needs more frugal, distributed, affordable innovation that produces more frugal cost products and services that are affordable by people at low levels of incomes without compromising the safety, efficiency, and utility of the products. The country also needs innovation processes that are frugal in terms of resources required and these products and services must also have a frugal impact on the earth's resources and must be designed to be environmentally sustainable. Innovations in India hence need to cast a wider net to benefit more and more people who are currently marginalized by the system.'* (Planning Commission, 2013: Para 2)

### **VIII. Conclusion and Policy recommendations:**

Several factors behind the emergence of frugal innovation as an alternative to the conventional way of innovation, globally and in India, are discussed in this article. Some of the factors work at intra-country levels while others work at an inter-country level have fostered and promoted the growth of frugal innovations. As the reasons for rise the of frugal innovations are not transitory can expect there to be healthy growth in this paradigm. Moreover, the potential benefit to bottom of pyramid groups along with the development of sustainable technologies which are environmentally sensitive makes

frugal innovation not only desirable but essential for sustainable growth in all countries around the world.

Resource constraints can stem from the inability to procure, control, and combine crucial labor, skills, and material for the creation of new products and services. Resource scarcity also includes the inability of vast populations to afford the means to address not only wants but also needs. This large consumer segment poses a challenge for multinational corporations, entrepreneurs, and governments to provide affordable solutions that help mitigate poverty and its consequences. All three sectors need to and are in many ways joining hands to innovate for the global low-income population (Hossain, 2018).

It's apparent that there is a need to move in the direction of frugal innovation by 'doing away with the high-end product features which matter to the top 10% of the population but account for 90% of the cost, one can develop products that meet the needs of 90% of the population at 10% of the cost' (Woolridge, 2010). Since we can observe examples of frugal innovation throughout the system from Flipkart mobile app revolutionized e-commerce (Sachitanand, 2013), ISRO conducting space exploration at a fraction of the cost of developed country counterparts (Amos, 2014), it becomes clear that this isn't a niche activity.

However, that does not mean that frugal innovation does not face any shortcomings or challenges. Innovations purely driven by the cost minimization motive targeted at the poor at the bottom of the pyramid have so far fallen short to meet the high expectations set for them. There is an issue of social stigma around buying functional products at sustainable prices because of perceived (in some cases imagined) low quality of such innovations in the minds of consumers (Tiwari, R.; Herstatt, C., 2012). For example, the disappointing performance of the TATA Nano is attributed by some to its cheapest car' tag (Kalla, 2015). A change in mindset of the consumers will require sustained effort and time. Weak institutions, underdeveloped infrastructure and resource scarcity are some of the factors that both spur and inhibit frugal innovations. Unless such challenges are not improved the country will not be able to translate frugal innovation as a means to sustainable development (Hossain, 2018)

The idea of overcoming adversity through Jugaad is entwined with the very essence of an Indian citizen. India has demonstrated tremendous potential for frugal innovation as a cost-effective, efficient, inclusive, adaptable, accessible, and sustainable solution to its problems. The country can reduce the gap between demand and supply of crucial products and services with indigenous solutions. Frugal innovation can play a role in the growth of transport, renewable energy, finance, telecom, electronics, space sectors to name a few. Surprisingly, despite their importance, agriculture and education are the two sectors of the Indian economy that are yet to benefit from frugal innovation. By identifying opportunities and bridging the supply gaps using frugal solutions India can emerge as an 'Atma-Nirbhar' or self-reliant nation and a global innovation hub.

#### **IX. Limitation of study:**

The factors behind the promotion of frugal innovation discussed in this paper are exploratory in nature claims and are not scrutinized through an empirical or a conceptual framework. Lack of quantitative studies on the topic of frugal innovation limits its scope and understanding.

<b>Reference</b>	<b>Definition</b>
Baker and Nelson (2005)	"Applying combinations of the resources at hand to new problems and opportunities."
Prahalad(2006)	"Products and services that address the underserved or un-served markets at the low-end of the economic system."
Prahalad and Mashelkar (2010)	"Innovation driven by affordability and sustainability, than by premium pricing and abundance approach."
Wollridge (2010)	<i>"frugal innovation or constraint-based innovation is not just a matter of exploiting cheap labor (though cheap labor helps). It is a matter of redesigning products and processes to cut out unnecessary costs"</i>
Sehgal, Dehoff, and Panneer (2010)	"powerful and ultimately essential approach to developing products and services in emerging markets."
Kaplinsky(2011)	"Technological choice and applications that are people- centered, small-scale, labor-intensive, energy-efficient, environmentally sound, and locally controlled"
George et al. (2012)	"Development and implementation of new ideas which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society"
Radjou et al. (2012)	"An innovative fix; an improvised solution born from ingenuity and cleverness."
Gupta (2012)	"FI is a new management philosophy, which integrates the needs of the base of the pyramid (BoP) market as a starting point to develop solutions that are expected to be very different from the alternative solutions."
George et al.,(2012)	"Frugal innovation is .... innovative, low-cost and high-quality products and business models originating in developing countries and exportable to other developing countries or even the developed world, often termed as 'frugal innovation'."
Sharma and Iyer(2012)	"Frugal innovation stems from resource scarcity: utilizing limited resources to meet the needs of low-income customers."
<i>Tiwari et.al.,( 2012a)</i>	"seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) to reduce the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards"
Basu et.al,(2013)	"Frugal innovation is also an innovation process design in which customers are the key focus to develop accessible, adaptable, affordable, and appropriate products."
Cunha et al.,(2014)	"Frugal innovation to be product innovation when there is a scarcity of affluent customers and distinguish it from bricolage, which is when material resources are scarce, and from improvisation, when time is scarce."
Brem and Wolfram(2014)	"Frugal innovation has low to medium sophistication, medium sustainability, and medium emerging market orientation."
Zeschksy et al.(2014)	"Frugal innovations are typically built on new product architectures that enable entirely new applications at much lower price points than existing solutions."

Agnihotri(2015)	"Frugal innovation refers to products and services that are developed under resource constraints."
Hossein et al.(2016)	"Frugal innovation is a resource scarce solution (i.e., product, service, process, or business model) that is designed and implemented despite financial, technological, material or other resource constraints, whereby the final outcome is significantly cheaper than competitive offerings (if available) and is good enough to meet the basic needs of customers who would otherwise remain un(der)served".
Weyrauch and Herstatt (2017)	"Frugal innovation consists of three attributes: substantial cost reduction, concentration on core functionalities, and optimized performance level."
Agarwal et al. (2017)	"Frugal innovation is 'good-enough', affordable products that suffice the needs of resource-constrained consumers."

### CONFLICTS OF INTEREST

There are no financial issues or interest of conflicts to declare.

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