

Technological Innovations in Rural India

*A Thesis submitted in partial fulfillment of the requirement for the award of
degree of*

Master of Engineering in Electronic Instrumentation and Control



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DECLARATION

I hereby declare that the report entitled "**Technological Innovations in Rural India**," is an authentic record of my own work carried out as a requirement for the award of degree of M.E. (Electronic Instrumentation & Control) at Thapar University, Patiala, under the guidance of **Dr. Mandeep Singh**, Associate Professor, Department of Electrical and Instrumentation Engineering, Thapar University during January to July 2012.

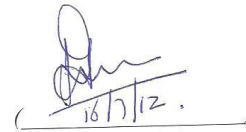


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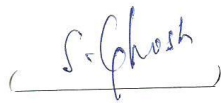

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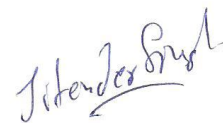
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ABSTRACT

Jugaad is innovation manifested what was so far looked down for a scorn Jugaad now a days as become a creative outcome to circumvent the lack of resources especially in fast developing country like India this concept was conceived and fuelled by the never-say-die spirit of hardworking Punjabis who have withstood adversities in the form of several foreign invaders for the time immemorial. Exploring this concept especially for the technologically related innovations in rural India, we have come across number of examples where application of Jugaad has fruitfully yielded positive results. Apart from documenting these results thesis work identifies two problems related with e-waste management and with renewable resource of standalone electric generation are addressed to and solved for. While e-waste management finally focusing on extracting the useful components and materials for repair and maintenance and for students projects at undergraduate and post graduate level, the problem of renewable electric production is solved by making use of cattle driven power generator.

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LIST OF ABBREVIATIONS

ATM - Automated Teller Machine

ECG - Electro Cardiogram

GIAN - Grassroot Innovation Augmentation Networks

GM - General Motors

GS - Goldman Sachs

HP - Horse Power

IIT - Indian Institute of Technology

IT - Information Technology

PIN - Personal Identification Number

P&G - Procter and Gamble

R&D - Research and Development

S&T - Science and Technology

UPA - United Parties Alliance

US - United States

VC - Vice Chairman

CHAPTER 1

1. Introduction

The only people who change the world are the crazy people who think they can.

-Steve jobs

Innovation and competitiveness have a dynamic, mutual relationship. Innovation thrives in a competitive environment and in turn, plays a key role in the achievement of such an environment. Innovation generates economic value, new jobs in the economy and cultures of entrepreneurship.

Any kind of innovation either large or small starts with small attempts of solving the problems in the different ways. This work illustrates creativeness of the Indian mind and its infinite capability to opportunistically invoke 'Jugaad' especially in rural sector of India [1]. In our country, plenty of innovations exist in the rural segment as more than one third of its population resides in villages and people over there face a new challenges everyday so they have their own mindset to resolve the problems. Innovation is the alternate way to do the task differently or we can say that it is the unconventional ways to solve problems. An effort has been made to study such kind of innovations and main objective is to spread the spirit of Indian innovation worldwide. Also in our country there is a massive problem of unemployment in rural as well in urban areas, for which Jugaad is a novel prospect. A study has been made on existing Jugaads and their implementation to solve the problems and to find the way out. The popular attention towards rural invention couldn't come at a better time for a nation that increasingly values creativity but is still given to rote learning at schools and colleges. Even our roadside mechanics are more pragmatic and practical than those who have obtained Engineering degrees from premier institutions. At present many foreign companies are approaching India for some new ideas. It is a matter of pride that Indians have inborn capability of scientific thinking.

We only have to explore it and appreciate the Jugaads of common people. In short this is the art of holistic thinking, an unbound, resilient creativity and of improvisation and rapid prototyping under severe constraints. Jugaad is a symptom of a structural challenge in India. Inadequate distribution and service networks prevent necessary goods and services from being readily available to those who most need them, owing to that lack, creativeness steps in.

1.1. Definition

As per Wikipedia, “Innovation is the creation of better or more effective products, processes, technologies or ideas that are accepted by markets, governments, and society. Innovation differs from invention in that innovation refers to the use of a new idea or method, whereas invention refers more directly to the creation of the idea or method itself.”

Very often in today’s context innovation to the everyday man means can be best described as to borrow someone else’s idea and apply it to your own need be it in business , product & services or every day home chores. A successful innovation does not have to be an all-new invention. It just could to be a new method to do something in a new and different way that is beneficial to you.

1.2. Why innovation matters?

Innovation is the key idea that shapes our environment, helping us conceive previously unimagined methods and ways to conduct options. Innovation enables us to see potential problems and solutions through a different lens. Innovation puts us on a consistent path to growth. The company or community that fails to innovate is on the road to obsolescence. Peter Drucker once said that the purpose of a business enterprise is to create a customer. Nokia became number one in India by using innovation to create 200 million customers [2]. It introduced regional language support in the mobile sets. Through observing the unique needs of Indian customers, particularly in rural villages where most of the population resides, it segmented them in new ways and put new features on handsets relevant to their unique needs. In the process, it created an entirely new value chain at price points that give the company its desired gross margin. Innovation, thus, creates

customers by attracting new users and building stronger loyalty among current ones. That's a lot in itself, but the value of innovation goes well beyond that. By putting innovation at the center of the business, from top to bottom, companies not only improve their bottom line, but also discover a much-better way of doing things more productive, more responsive, more inclusive & more fun.

Basically people want to be part of innovation which leads to growth, not just endless cost cutting.

A culture of innovation is fundamentally different from one that emphasizes rules and conformity, both in theory and practice. For one thing, innovators have an entirely different set of skills, temperament, and psychology they generally "think out of the box" in every part of their lives. They have a forward thinking pattern, they move from one innovation to the next. Once one innovation is done, the innovator moves to the next. The innovative person, while perhaps not a creative genius is effective at evoking the skills of others needed to build an innovation culture. Collaboration is essential; failure is a regular visitor.

Innovators are comfortable with uncertainty and have an open mind; they are receptive to ideas from very different disciplines. They have organized innovation into a disciplined process that unique to them and are replicable and, they have the tools and skills to pinpoint and manage the risks inherent in innovation. Not everyone has these attributes. Nations cannot build a culture of innovation without cultivating people who do.

1.3. Myths of innovation

The idea of innovation has become encrusted by many myths. One myth is that it is all about new products. That is not necessarily so. New products are, of course, important but not the entire picture. When innovation is the basic way of doing things, it finds ways to innovate not just in products, but also in functions, logistics, business models, and processes. It basically manages to seep itself into all aspects of life and one tends to view life in a different way.

A process like Dell's supply chain management, a tool like the monetization of eyeballs at Google, a method like Toyota's Global Production System, a practice like Wal-Mart's inventory management, the use of mathematics by Google to change the game of the media and communications industries, or even a concept like Starbucks's reimagining of the coffee shop these are all game-changing innovations. So was Alfred Sloan's corporate structure that made GM the world's leading car company for decades, as was P&G's brand management model [2].

Another myth is that innovation is only for geniuses. In a country like India you can view a different innovation almost the same distance as the dialect changes. In India the term is "necessity is the mother of all innovations" (instead of inventions). True innovation matters for the present, not for centuries hence. Innovation is an ever changing exercise.

1.4. Innovation in rural India: Genesis of Jugaad.

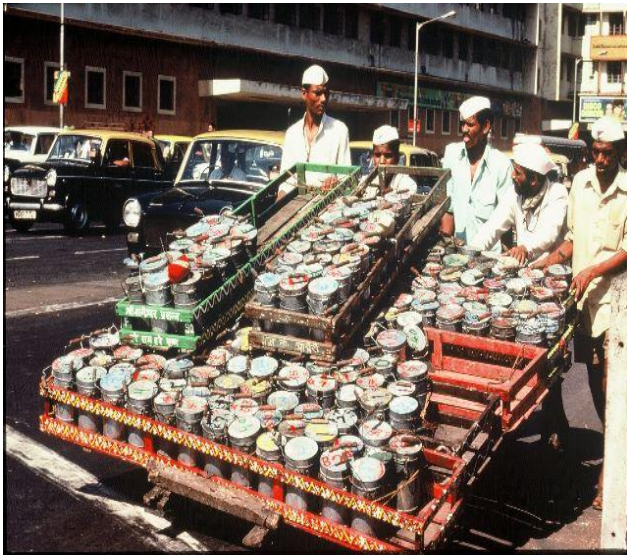
In India more than 70 percent of its population resides in villages. In rural India people face a new challenge everyday so they have their own mindset to resolve the problems; hence they have precious resource of innovation. They are habitual to face new obstacles in day-to-day life; every impediment thus became an opportunity to create something new. Further the necessity to use their competitive advantage and their ability to struggle for survival also makes them innovators. People in rural India have an ability to utilize almost all the things which any one can throw away easily and this concept of optimum utilization of the available resources is very well known as 'Jugaad'. This Jugaad can almost make anything possible. Also Jugaad is for everyone without regard to race creed or color; it does not know any geographical boundaries. The mindset of individuals in rural India is that "where there is Jugaad there is a way" every time they have an alternate way to do the things anyhow. Individuals in rural India would like to do in their own way as per according to their customized application requirement for a particular task and this diversification leads towards the innovation. Moreover a Jugaad technology is the suitable word for such kind of innovations in rural India.

1.5. The Jugaad concept

When everything fails, Jugaad works. Now the question arise what exactly Jugaad is? Jugaad is perhaps the only option when no other option is left, it is a technique of do it now somehow. Nobody can teach or learn Jugaad, for this we have to indulge our self in it for this there is no particular formula; each and every Jugaad is of its own kind, it may vary from person to person and from situation to situation. Moreover the multiple utilization of single product is also a Jugaad, it is all about the reinvention either it is a product or a process. This might well be a legendary but it clarifies the infinite capacity of the Indian mind to “resourcefully” innovate or invoke Jugaad (a word that’s become prevalent internationally). There are number of examples of Jugaad innovations.

1.6. Some examples around are as follows:

1) Dabbawala



Residents of Mumbai are very well familiar with Dabbawalas. It is an example of excellent supply chain management without any paperwork. It is an example of Jugaad process of food delivery.

Figure: 1.1

2) Dial a Motor



Figure: 1.2

This system enables the user to switch ON or OFF an electrical motor with the use of Mobile phones. This mobile operated motor control system is very common in rural India to operate the motor pump from any distant location for irrigation purpose.

3) Hawala



Figure: 1.3

It refers to the money laundering Jugaad for the poor migrants to remit money across countries, faster and more cheaply rather than any other formal bank system. Hawala was legal for centuries before modern governments declared it illegal.

4) Maruta



Figure: 1.4

Many years back, the innovative Punjabis assembled a Jugaad vehicle by mounting a diesel irrigation pump on a steel frame with wheels. This creation was ultra-cheap as compared to the standardized vehicle but did not conform to vehicular regulations.

5) Lassi Maker Jugaad

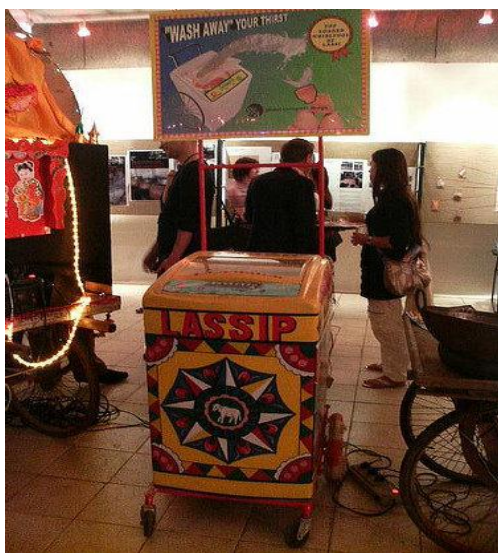


Figure: 1.5

In Punjab and Haryana the people in villages often use the top loading washing machines for churning curd and hence making lassi (Butter-milk) and Butter form curd. And the Jugaad is called LASSI-P.

6) Oorja-Brand Stoves



Figure: 1. 6

Oorja-Brand stoves are the result of a systematic innovation from the Jugaad concept. It is the standardized product developed by the First Energy in Collaboration with Indian Institute of science Bangalore [3]. Oorja stove is a biomass based cooking solution fired by fuel pellets made from ground nut shells, peanuts husk and other agricultural waste.

7) Adjustable Jugaad for Plate-stand



Figure: 1.7

This is a pretty interesting contraption for resting the food-laden plates at a marriage reception or parties thus; Jugaad at its best for this innovative utilization.

8) Motor Cycle Rickshaw



This is an innovative Jugaad in which motor cycle is coupled with the rickshaw cart used for carrying goods and other material.

Figure: 1. 8

9) Head-Load Reducer



Khimjibhai Kanadia, a retired schoolteacher has created an innovative device that has two extended supporting rods from a circular disk that is put on the head to hold the vessel. The mechanism shifts part of the head load to shoulders and thus saves the neck from stress injury.

Figure: 1.9

10) Innovative Seed cum Fertilizer Drill



Figure: 1.10

It is a blend of fertilizer and seed drill to offer maximum work at lower cost. The seed drill works on an advance single metering mechanism which works accordingly for single and multiple rows. This equipment can be used for single seed sowing and also for the mixed cropping sowing. This product is patented (365/DEL/ 2008) and has been in production under the enterprise Shree Art & Agriculture Udhyog, Jodhpur.

11) Low Water Head Turbine



Figure: 1.11

A low water head turbine built by the continuous effort of Mr. Ratanakara; offers solutions to provide electricity to the far off terrains of the India with this advance innovation. The set consist of an alternator which derives it rotation from the turbine shaft and can generate up to 3.5 units of electricity per hour. Also it can be used in Hilly terrains

12) Kammal Plant Growth Promoter



Figure: 1. 12

It is a cost effective Organic product which can increase the crop yields and this plant growth promoter is called KAMMAL. The basic ingredients of this enhancer are Dhathura, Bhang, Aak, Arend and Neem. The base of this mixture is cow urine which is used Improves water retention by soil. The product has been widely acclaimed and certified by reputed Agricultural universities and by ISO 9001:2008 certifications.

13) LPG Operated Iron (Press)



Figure: 1.13

The unavailability of power to major areas has given rise to many innovations and Gas (LPG) Operated Iron (Press). An automatic lighter is fitted to the device for ignition and the inlet of the gas is through the copper pipe. The flow of the gas can be automatically regulated through the knob. It is useful in power cuts for tailors and washer men in rural areas.

14) Portable Multipurpose Processing Unit



This Portable Multipurpose Processing Unit is an excellent result of an extraordinary idea, which is capable of processing various plants like Aloe Vera, Gooseberries, etc. to extract fruitful gel, juice etc. Also it can extract essence from Chilies, Coriander and flowers (Rose, Jasmine, etc.) as well as churn out fruit juice/ pulp from Mangoes, Tomatoes, Oranges, etc. This new innovation has obtained an Indian Patent (367/DEL/2008).

Figure: 14

15) Self transporting generator



Innovative way for Generator set transportation. The mechanism makes use of the prime-mover of the generator to transport the generator set, using a set of gear and clutch arrangement as shown in figure 1.15

Figure: 1.15

16) Motor Bike Powered Irrigation System



Figure: 1.16

This Innovative Irrigation system is powered by a functional motor bike that is on the spot converted to the prime-mover for a pump. This pump is often in used open channels and ponds to deliver water for irrigation or other purposes.

17) Diesel SUV- Jugaad version



Figure: 1.17

This Jugaad version diesel SUV is assembled with of obsolete material and used for agriculture and cattle farming purpose for carrying fodder, grass, grains etc. Also please note the substitute for the door!

18) Motor Cycle Driven Ploughing Device



Figure: 1.18

Motor Cycle Driven Ploughing Device for small farms and for horticulture which may be inaccessible to standard tractors.

19) Multi Crop Thresher



Figure: 1.19

Multi Crop Threshers can process multi crops like wheat, bajara and many more with good efficiency hence it reduces the extra investment for threshing other crops. It uses the power of a tractor; No breakage of grain; cleaning is quite better, no further cleaning is required

20) Scooter-Powered Flour Mill



Figure: 1.20

This scooter powered flour mill is designed by Jehangir Painter from Jalgaon, Maharashtra; now made famous by the film three Idiots. It is a perfect example of Jugaad.

21) Automatic Aarti Apparatus



Figure: 1.21

Automatic Aarti Apparatus is used for worship. Normally Aarti (a Hindu prayer ritual) is performed with the help of five volunteers that perform on drums, bells gongs etc. This mechanized version can perform all these tasks automatically.

22) Jugaad for Espresso Coffee



Figure: 1.22

Pressure cooker turned into an espresso coffee machine with Jugaad modifications in an innovative way. This is a low cost solution with same results.

23) Jugaad Boat for Rescue Operations



Figure: 1.23

This is the best utilization of waste bottles by assembling a Jugaad boat. This Jugaad boat can be utilized in flood areas for rescue operations etc.

24) Jugaad for Anti Car Theft device



Figure: 1.24

A simple but sturdy metallic clamp with padlock on all the three paddles serves the purpose of anti-theft device. The system is low cost and easy to implement.

25) Jugaad for Loaded Truck River Crossing



Figure: 1.25

A loaded truck is boarded on the two boats coupled side to side for crossing the rivers, where river bridge is miles away, and sometimes in accessible.

26) Jugaad for Door Handle



Figure: 1.26

Low cost alternate Jugaad for door handle lock in an SUV. The adjoining figure is self-explanatory in nature.

27) Open Air Double Decker



Figure: 1.27

Faith has no bounds. Several pilgrims take to this Jugaad for open air double decker, suitably converted overnight from a truck by the faithful!

28) The Runway Jugaad



Figure: 1.28

Now Jugaad goes international; This Airport in British overseas territory of Gibraltar is the only airport in the world which has runway crossing the express Highway (between Spain & Gibraltar). Traffic lights are used to stop the traffic while an aircraft takes off or lands! British Airways has daily flights here

And the list is endless, as innovation is a continuous process of developing new Jugaad to meet the ever-changing requirement by implementing new ideas.

CHAPTER 2

2. Literature Review

The topic wise literature review is as follows:

2.1. Jugaad is our most precious resource

In this article, author described the importance of Jugaad as a valuable resource by giving reference of the statements of Global management experts and emphasized on Jugaad as key reason for the success of individuals across the country. He also explained about the concept of frugal engineering for the product development by giving suitable examples of some Jugaad products. Also the author highlights the concept of R&D in Indian industry by implementing frugal engineering and exemplified in the Tata Nano, the cheapest car in the world. Moreover Jugaad will be used to overcome the hurdles. But if deregulation abolishes these hurdles, the main business constraints become lack of quality and affordability, so Jugaad shifts to improving productivity, quality and affordability. That ultimately makes it world class [4].

2.2. India's Next Global Export: Innovation

This article is focused on the concept of borrowing the innovative ideas from India, as author stated that “On a November afternoon, a dozen executives from companies including investment banks Rothschild and Goldman Sachs (GS) and tech research firm Gartner (IT) ringed a conference table in a brownstone on New York's Upper East Side. They were there to learn how U.S. businesses could develop products more cheaply and quickly by borrowing strategies from India. Speaker Navi Radjou, who heads the recently formed Centre for India & Global Business at England's Cambridge University, summed up his advice in one word: Jugaad.” Also he defines the Jugaad as an improvisational style of innovation that's driven by scarce resources. Like previous management concepts, Indian-style innovation could be a fad. Moreover, Jugaad essentially means inexpensive invention on the fly. An individual must be carefully had to pursue Jugaad with regulations and ethics in mind [5].

2.3. Wide angle

Author of this Article Vivek Paul (former VC, Wipro) gives explanation that “Follow three Indian rules josh, Jugaad, and lage raho, and you will be on your way to success!” As an investor and entrepreneur, he has the privilege of seeing India’s new entrepreneurial energy, Instead of making a nation of software coolies. Multinationals in India are adding the magic ingredients of product management and rich talent in business ideas and plans. Kinetic Glue, a social collaboration and innovation company is seeing a rising number of young start-ups creating discussions and document repositories around their ideas. Even free-to-public sites like itundas.com are seeing groups take nascent ideas and solidify them through interaction and experience sharing of ideas which are traded, discussed, developed in India [6].

2.4. Jugaad and its relationship to innovation

Tim Leberecht of frog design wrote about the worth of Indian innovations in a recent Article, as per author’s description the term Jugaad (pronounced “joo-gaardh”) is a colloquial Hindi word that describes a creative ad hoc solution to a vexing issue, making existing things work and/or creating new things with scarce resources. Although sometimes used pejoratively (in the sense of a makeshift cheap fix), it is now widely accepted as a noun to describe Indian-style innovation (some also call it “indovation”) – describing the inventiveness of Indian grassroots engineers and scientists that have led to the pedal-powered washing machine, inspired the extra-low-cost Tata Nano car, or the success of India’s space program. It is, in short, the art of holistic thinking, of unbound, resilient creativity, and of improvisation and rapid prototyping under severe constraints. Jugaad is a symptom of a structural challenge in India, inadequate distribution and service networks prevent necessary goods and services from being readily available to those who most need them. Owing to that lack, creativeness steps in [7].

2.5. Jugaad is a component of human ability

Jugaad is a component of human ability which can be compared to a "Swiss- knife" says, Amrita Chaudhary. JUGAAD is a word that has fascinated the world by its enigma. An ordinary Indian citizen has over the past six decades perfected the art quite naturally

while encountering numerous socio-economic hardships and a variety of political, administrative and environmental challenges in daily life. Jugaad is about carving a successful life; it is regardless about the circumstances or resources that are available. It makes to think on the spot and face the circumstances or situations that demand creative thinking. Tact is the most essential element of Jugaad, and all of us use it to deal with someone or the other in our lives Jugaad is a component of human ability which can be compared to a "Swiss- knife" [8].

2.6. In Jugaad Land

In this Article the innovation in rural India is highlighted and their systematic product formation is exemplified as per the usage of rural requirements. For example there is a briefing of an ATM which is ideal for rural area, developed by Vortex engineering (Chennai based company) with collaboration with IIT Madras and its advantage is that its cost is about one fourth of the currently available ATM machines also It does not require an air conditioned environment and does away with PIN numbers and other such complexities by using fingerprinting and other biometric means of identifying the user. Further in this Article an initiative by Hindustan Petroleum is discussed that Hindustan Petroleum decided that the best way to give low income rural women a better and affordable cooking medium was not to innovate a smokeless choola or to wage a campaign against firewood or dung cakes, but to set up community centers (Rasoi Ghars) in a room, provided by the village community, and equipping it with a water connection, many gas stoves on a cooking platform, and a pay-as-you-use metering facility. There are enough examples out there, in Jugaad land, created by grassroot innovators. Srishti, the Ahmedabad based grassroot innovation development organization, lists innovations ranging from tilting bullock carts, bicycle hoes, motorcycle ploughs, a tree climber to help climb palm trees, even a pomegranate peeling machine fashion. Also innovated by Jugaad Indians are pedal operated washing machines, wind mill operated power generator, and a Rs 1.6 lakh 10 HP tractor (as compared to Rs. 3.5 lakhs tractors commercially available), used by small groundnut farmers . Going forward the problem statement is clear, though the solution is quite hazy but we need to build institutional mechanisms that can harness the Jugaad energy of a billion people to create big, bold

social solutions that work for us, making the world believe that India will create an unassailable position for itself in the new world order by using brains and creativity and doing things differently [9].

2.7. The charms of frugal innovation

This Article is concentrates on the development of new products by thinking out of the box as first break all the rules then design an writer takes the example of GENERAL ELECTRIC'S health-care laboratory in Bangalore, which contains some of the company's most sophisticated products—from giant body scanners to state-of-the-art intensive-care unit equipment like a hand-held electrocardiogram (ECG) called the Mac 400. This device is a masterpiece of simplification. The multiple buttons on conventional ECGs have been reduced to just four. The bulky printer has been replaced by one of those tiny gadgets used in portable ticket machines. The whole thing is small enough to fit into a small backpack and can run on batteries as well as on the mains. This miracle of compression sells for \$800, instead of \$2,000 for a conventional ECG, and has reduced the cost of an ECG test to just \$1 per patient as compared to \$ 10 for conventional ECG machine. In Chennai Tata chemical introduced an even lower-tech device a water filter and it uses rice husks (which are among the country's most common waste products) to purify water. It is not only robust and portable but also relatively cheap [10].

2.8. Jugaad is our word for reinvention

In this Article the thinking capability and utilization of resources is explained with examples of Grassroots Innovation Augmentation Network of Creating new occupational concepts and Provisional vehicle produced by local mechanics. Further the solution chasing capability of Indians is accentuated as the easiest task to do in the world. Millions of Indians use creative means to solve problems on their own. In this process they generate concepts and implement in their routine jobs. One such person is Mansukh Jagani, 42, who already has an invention patented by the Grassroots Innovation Augmentation Network (GIAN) in the US and in India. His Jugaad—an agricultural implement that can level, plough, weed and sow farmland. This machine cost him 40%

less than a mini-tractor. With the help of a Royal Enfield Bullet's petrol engine and a two-wheeled farm tiller [11].

2.9. Innovator network plans giant leap on the back of 3 Idiots

This Article is all about the increasing popularity of innovations of rural india.as the role of such kind of innovations is demonstrated in Movies also for example if you've seen three Idiots, a frothy film about an impoverished, smart-alecky student-inventor who lives by his wits, you can't miss the scooter-powered flour mill, a cycle-powered horse shaver and an exercycle-cum-washing machine. Creativity pays: A scene from the film 3 Idiots, with the scooter-powered flour mill, which was sourced from NIF, in the background. The popular attention to rural invention couldn't come at a better time for a nation that increasingly values creativity but is still given to rote learning at schools and colleges. NIF has 140,000 inventions from 545 districts in its database, generating 220 patent In the spotlight: Jehangir Painter with his scooter-powered flour mill. "Lots of innovations are now going to market," said NIF's chief innovation officer Vipin Kumar, Remya Jose (20), a student from Kerala's Malappuram district, created the exercycle-cum-washing-machine when her mother was ill and father had cancer. The Discovery Channel shot a video of her invention, now a YouTube hit. Mohammed Idris (32), a class V dropout and a barber from western Uttar Pradesh's Meerut district, invented a cycle-powered horse clipper that pares equine hair in half the time that it takes hard-to-find electric shavers. Jehangir Painter (49), a painter from north Maharashtra's Jalgaon town, put together a scooter-powered flour mill to relieve his wife from the tedium of blackout-induced three-hour waits for wheat to be ground. The Indian ability to innovate is not new and is exemplified by the word Jugaad. It has no direct English translation, but refers to the ability to fix up a problem [12].

2.10. Jugaad: The last resort to success

This Article is focused on everyday necessity of Jugaad in various ways and abundant illustrations are explained with their use and requirement. As the author's point of view Jugaad requires better skills. what is there in replacing the old part with something new and expensive, when a component can be made workable with Jugaad, it is something

most of us can't afford to live without, whether it is last minute railway reservation, or the admission of a child in a school that carries prime value, Jugaad delivers all the times, at all the places [13].

2.11. Science of Adjust and Jugaad

This Article is more emphasized upon the origination of development of creative thought. As per author's opinion science of adjustment is Jugaad to arrange for something that will help accomplish a particular task. Further he takes reference from Wikipedia "Jugaad" is also a colloquial Hindi word that can mean an innovative fix, sometimes pejoratively used for solutions that bend rules, or a resource that can be used as such or a person who can solve a vexatious issue. In this Article author highlights the importance of Innovation and Jugaad in every aspect of life by a woman point of view [14].

2.12. The creative age is coming

According to author Daniel Pink the present knowledge age was preceded by the agricultural and industrial ages. What is coming ahead is the creative age, the conceptual age. This promises to be a period when right-brain-driven, creative people will play a major role in economic development. It may just be what plays to India's strengths. Out of the box: The scooter flour mill designed by Jehangir Painter from Jalgaon, Maharashtra, now made famous by the film 3 Idiots, is a perfect example of Jugaad. 'Jugaad', meaning quick, innovative and cheap solutions to problems, will be the most critical component to career success in the future, and our inherent creativity makes us uniquely poised to be ace 'jugadoos'. Likewise Ahmed Khan, managing director, KK Plastic Waste Management Pvt. Ltd, Bangalore, has built 1,200km of roads using, hold your breath, 3,500 tonnes of waste plastic from landfills. It is green and it also makes better roads. "Such roads withstand monsoons and every day wear better than the traditional concrete. India is blessed to have most of the five Cs that promote innovativeness in a society: chaos, challenge, creativity, communication and canalization. India has a visible surfeit of chaos and challenge, which pumps up the creativity [15].

2.13. The Great Indian Jugaad

This Article is all about the ability to get things done by alternate way. The powerful cultural construct has its most popular manifestation in the North Indian word Jugaad. It is the ability to get things done when the law and the rule do not favor. Further the author explained as “You want to fly down to Delhi today, but all tickets are booked what do you do? Do a Jugaad and get your tickets despite all obstacles. You have been shifted to a new city and you want admission for your daughter in the best school in the neighborhood, and admission time is over, all you have to do is get the man who can get Jugaad done and find a way out. A jugaadu is a highly networked and resourceful person who can weave his way through any system and get things done when the straight and narrow path is blocked. He is a critical component of one’s team if one wants to succeed in India.” How does this Indian culture of quick-fixes fit into a very fatalistic worldview? In the typical Indian way of accommodating everything, we surrender to fate for the big things in life but for the small things in life we subscribe to Jugaad and innovation. For others Jugaad is proof of Indian ingenuity and creativeness a demonstration that Indians are not willing to accept fate and are willing to scurry a solution out of any problem. Nothing is insurmountable. Everything can be overcome. If one has the will, there is always a jugaadu way [16].

2.14. Unraveling India's innovative streak

This article gives briefing of small innovation in rural India with examples and hence he stated that obstacles give rise to opportunity to innovate something new as per limitations of available resources. And it is this ingenuity, this ability to create opportunity coupled with liberalization. India's resilience and its ability to assimilate ideas and technologies make it a very interesting place. And this century will be driven by the energy, risk-taking ability, open thinking, and innovation of youth [17].

2.15. We are in India to learn to be frugal

This Article indicates the increasing interest of Industrialists in India the evidence for this is the statement of Mr. Carlos Ghosn, (president and CEO of Renault SA and Nissan) said that European automakers are looking at India to learn from the frugal product planning, engineering and manufacturing of Indian automobile companies. Ghosn, whose visit to India coincided with the launch of the mid-sized sedan Logan, told reporters at Mahindra-Renault's plant here, "We have come here to try and implement principles of what we call frugal product planning and frugal engineering. You are not going to learn these by reading; you are going to learn them by practicing with somebody who is doing as a way of doing [18].

2.16. Energy-technology innovation

Energy-technology innovation (ETI) is the set of processes leading to new or improved energy technologies that can augment energy resources; enhance the quality of energy services; and reduce the economic, environmental, or political costs associated with energy supply and use. Advances achieved through ETI have made large contributions to the improvement of the human condition over the past 100 years. Still more will be required of ETI during the decades ahead if civilization is to succeed in meeting what we believe are the three greatest energy challenges still before it: reducing dependence on oil, drastically upgrading the energy services provided to the world's poor, and providing the energy required to increase and sustain prosperity everywhere without wrecking the global climate with the emissions from fossil-fuel burning. This will require significant enhancements to ETI through deeper analysis of ETI processes, greater investments in ETI, improved innovation policies, and better coordination and partnerships across sectors and countries [19].

2.17. Esprit de Jugaad

Esprit of Jugaad is a Spanish formation which means The Spirit of Jugaad .The Article published in Hindustan times on Saturday, 03-December-2011.This Article is focused upon the simple and commonly used innovation in rural India. India is a country at its

creative best so Hindustan times enumerate the 60 most interesting innovations that work [20].

Some of the selected innovative Jugaads are as follows:

Maruta: Jugaad assembled in the sugarcane fields of UP and Punjab, this bare bones transport is put together using a pump, a wooden plank and old tyres. It has a 20-seater bullock cart trailer attached to its rear. A steering is jacked into the shaft and the 12-horsepower pump engine is hand cranked to give speeds crossing 20km/hour.

Innovative tawa: It's an aluminum tawa with a ribbed base and concentric circles that keep surface hot for long.

Lassi-maker washing machine: Houses in rural Punjab often use their top loading washing machines to churn curd and make lassi. In Ludhiana, an innovative lassiwalla commercially sells his 'lassi-maker' washing machines at a fraction of the price of regular washing machines.

Horse shaver: A barber from UP, Mohammed Idris, uses a bicycle-powered horse-shaver in which the power of the bicycle rotary drive is converted via speed cable to the cutting blade, which cuts the hair.

Tea-making machine: This low cost tea-making machine works on electricity and facilitates the Indian method of making tea by separately pumping in water, adding tea-leaves and sugar, heating, adding milk, boiling and filtering and dispensing automatically into cups.

Fiber Matchsticks: These matchsticks are in the form of thick threads secured together by natural binders such as sabudana. These matchsticks burn longer, are not easily breakable and they are cheap.

Garlic-peeling machine: It can peel large quantities of garlic without damaging the garlic.

Amphibious bicycle: It is a conventional bicycle fitted with four rectangular air floats that support the bicycle in water. The inventor is from Bihar and this device got him profiled on the Discovery Channel.

Gear cycle rickshaw: A double-chain and double-sprocket mechanism has been fitted to a rickshaw and the existing free wheel has been modified by fitting a pawl lifter instead of a spring to produce this helpful system.

Zero-head water turbine: It generates electricity from flowing river water and simultaneously pumps the water for irrigation or other like purposes. Cheaper than its commercially produced rivals in Assam.

Milk Master, the manual milking machine: This milking machine consists of a set of reciprocating vacuum pumps with a vacuum gauge, a suction assembly unit and an air bubble-free gasketed milk canister to collect milk. This is developed by a man from Karnataka.

Air curtains: Yagnesh Mehta of Gujarat used extruded Acrylic Butadiene Styrene to make cheap fins for air blowers. They are light and don't make too much noise.

Indigenous buttonhole machine: It requires only the simple manual adjustment of one element to determine buttonhole length. It can on an average do 100-120 buttonholes an hour, and has a small lamp near the needle, which helps in inserting the thread.

Jaipur foot: Experimenting with rubber components and metal sheets, Dr PK Sethi and Ram Chandra Sharma produced this low-cost, durable, prosthetic foot that has given new life to amputee world over.

Miticool; the village fridge: This down-to-earth fridge is made from special clay and has three or more chambers for cooling water and storing fruits and vegetables.

Amphibious car: Stuck in seasonal floods, mechanic PS Vinod came up with the unique idea of converting his old car into a boat-like float structure fixed above the tyres that could drive through flood water.

Bamboo tooth: Dodhi Pathak of Assam has made false teeth from bamboo, which can bite into chicken and are amazingly cheap at Rs 20 a tooth.

Car for the disabled: A car-fanatic, Mujib Khan modified the brake, clutch and gear arrangement of his car so that he or any other person with disabled legs can drive it.

Coffee nutcracker: Imagine cracking those tough coffee nuts by simply turning a rod. The rotating action of the rods in Sudhakar's machine does exactly that separate the pulp from the berries.

Head-Load reducer: Khimjibhai Kanadia, a retired schoolteacher has created an innovative device that has two extended supporting rods from a circular disk that is put on the head to hold the vessel.

Badminton stroke-practicing machine: Amlan Bhattacharya and Subash Das have made a machine that drops shuttle corks at regular intervals and also spins them using a conveyor belt.

Cotton-stripping machine: The earlier tedious handpicking methods have been replaced by this rudimentary machine that has dust collectors and an automatic feeding system to help it process

Pepper machine: This machine simplifies the task of separating pepper from peppercorns. Pepper bunches are put into a funnel-like structure, that then go through a series of rotating blades that are fitted inside.

Micro Windmill Mobile Charger: This is a small handheld windmill that operates whenever there is a draft of wind. It can charge a mobile phone and other equipment, including laptops.

Tree climber: Made of iron rods and metal wires and grounded with two poles on either side. While climbing, the metal wire spreads around the tree that is connected to the footrest and gets tightened and helps in climbing [20].

2.18 Managing innovation and technology in developing countries

This paper provides a theoretical and conceptual framework analysis for managing innovation and technology in developing countries like India and China. As innovation and technology management is an inevitable issue in the high end technological and innovative organizations. Today, most of the innovations are limited with developed countries like USA, Japan and Europe while developing countries are still behind in the field of innovation and management of technology. But it is also becoming a subject for rapid progress and development in developing countries. Innovation and technology environment in developing countries are by nature, problematic, characterized by poor business models, political instability and governance conditions, low education level and lack of world-class research universities, an underdeveloped and mediocre physical infrastructure, and lack of solid technology based on trained human resources. In the introduction part authors described that Innovation was not always a hot issue in the Silicon Valley. The Section 2 of this paper deals with the issues and challenges in developing countries. The innovation process and technology management is emerging field in the developing-world companies. Innovation and technology environment in developing countries are by nature, poor business model, government conditions, low education level, poor management of technology, and poor condition of infrastructure. Companies in developing countries having advanced technology don't have often detailed idea or knowledge about the required technology. To deal with any kind of technical tools and equipment, production or selection of any appropriate technology, at least basic education is crucial and continuous human resource development can play a significant role in this regard. Education levels in the developing countries are very low. It is also a significant barrier to the management and development of innovation and technology. In fact, one can establish a clear relation between educational needs and the different phases of industrialization. Educational needs demand only basic literacy while in post-industrial phase, more technical, professional skills are required. What is the source of new idea or new technology, definitely, one of the answers is educational institutions. The world top universities belong to developed world. The academies of these top ranked universities have also strong affiliations with entrepreneurs and most of the academies are also entrepreneurs by themselves. Innovation and technology at grass

root level in developing countries is a new emerging attention. These innovations may not be commercialized at global level but these can be new sources of innovation at national level. The real problem is to identify, objectify and patent these innovations and then to commercialize it at national level. Due to limited resources, the research and development (R and D) environment is also not so conducive. Research in these countries is limited to publications and to develop linkages with industries and business world is very poor. Although, most of the countries have realized their significant role in developing new technology and innovation management (like India) but it is not satisfactory and it needed to be matured more significantly. Further authors present the issues and challenges in innovation and technology management and come up with proposed solutions. Like human resource manager, marketing manager, operations manager, innovation manager and technology manager are also crucial for the high end technological and innovative organizations. Still the concept of innovation manager or technology manager in the developing world companies is not practiced. The job description of innovation and technology executive or manager is difficult to be decided yet. But it should be cleared that all these managers or officers should always think about innovation and worry about technology. Chief Technology Officer should have strong background of management, technology, engineering and IT at the same time. He or she can play different roles in organization innovation and technology management. As a Genius, he or she turns great idea into great product or service. Many developing countries are heavily investing in higher, professional and technical education. These countries also send abroad their students for Ph.D. programs, but still research in these countries are limited to publications and to develop linkages with industries and business world is very poor. In real sense, innovation is often born out of the blending of indigenous knowledge with technological and organizational inputs from developed countries. The concern is to facilitate the proper exploitation of such indigenous knowledge in innovation process of relevant countries. The paper is also intended to stimulate the exchange of ideas and new initiatives for innovation and technology management in developing countries. The rest of the paper is structured as it finally; Section 4 presents the conclusions of the paper. In this paper, an attempt has been made to point out key problems in innovation and technology management, which requires

thorough investigation. Most of the innovations are limited to developed countries. Developing countries are still dependent on developed world technology. From the experience of China, India and Mexico suggests that developing countries have strong potential for innovation and technology management. But the challenge is how to approach the issues faced by developing countries. The existence of chief technology management component, developed infrastructure, coordination and linkages development between educational institutions and business world, up gradation of knowledge and skills in the context of country's specific technical, cultural and social environment are only part of indicators of innovation and technology management. Future considerations involve a detailed survey of issues and challenges being faced by companies in developing countries. This could initiate further development in the process of innovation and management of technology in developing world companies [21].

2.19. The Jugaad technology (indigenous innovations)

This is a case study of Indian origin in which authors enlightened the hidden creativity of rural Indian people as they described about a mindset of the innovator. In which he used his/her skills and traits to make things in productive way. Jugaad is the most economical way to do task or a particular work. In India there is huge problem of employment in rural as well in urban areas Jugaad is the new opportunity to those youth who has some new ideas and they are willing to do the work this provide self-employment to the youth in their own areas or regions it also helps in inclusive growth of the India. This study will find the scope of the indigenous innovations (Jugaads) and work towards the patent of the technology so that everyone can use these as per in Indian rural areas the scarcity is more for employment as well as for resources. We used the case study method for the evaluation. The cases are taken from different parts of rural India. In the introduction part they explained importance of Jugaad. Many foreign companies come to India to for new ideas specially in the field of information technology they set up their branches in India they see that Indian minds are full of new ideas. They make close look on the Indian industries to see new innovation or Jugaad. Jugaad is the technique to add value in the product. Jugaad is the different way to do job or task which may not be performed in the present system or condition. Basically it is brainstorming process in which many ideas

come in mind and taking them into feasible arena whether they are practical or not after that choosing the best alternative solution for that problem which is economical at that time. In Jugaad technology the innovator or jugaadee men have to be rational in the nature. He has to be thinking new ideas or finding new paths to get the mission completed these paths are easy to use and easy to understand and easy to apply without much changing the current system it is the process to manage the available resources in such a way that maximum output can be generated in many of the cases the jugaadee person uses the scrap stuff things in such a way that it fully fills its all needs. Jugaad is not used in India but it is globally accepted thing in some nations this might be known as innovation but in Indian context it is called as Jugaad. In India there is a huge problem of employment in rural as well as in urban areas Jugaad is the new opportunity to those youth who have some new ideas and they are willing to do the work this provides self-employment to the youth in their own areas or regions it also helps in inclusive growth of India. Jugaad If we understand the Hindi word "Jugaad" as the ingenuity and improvisation required to get around, or deal with, prohibitive rules and institutions, India's entrepreneurs seem to embody it. Jugaad is a shortcut to the approaches but it does not include the legal work it is done in the four corners of the law. The concept of Jugaad technology is also related with the innovation. Innovation can be defined as the application of knowledge to create additional value and wealth. Innovation involves using knowledge to find new ways to create and bring about change for the better. This definition of innovation has implications for the types of activities within businesses that can be considered innovative. First, innovation does not necessarily involve technology and technological knowledge. Successful innovation can involve the use of any type of knowledge, provided its application results in additional value and wealth. Second, innovation is not invention. Innovation may not even require the creation of new knowledge – be it to the world or to the firm. What it does require is the inspired application of knowledge (old or new) to create additional value. Given this, it is problematic to equate business innovation with business R&D expenditure. R&D involves the creation of new knowledge which can be an important, but is not a necessary component in the innovation process. Moreover, R&D is associated only with the creation of a specific type of knowledge, while innovative activities can involve the creation and use of a

broader range of knowledge. While R&D is an indicator of scientific knowledge creation it says little about how that knowledge is applied to create value and wealth. For instance, the potential disconnect between expenditure on R&D and the creation of value was highlighted in a recent global survey of corporate R&D spending by Booz Allen Hamilton which found no direct relationship between R&D spending and significant measures of corporate success. R&D is undoubtedly an important innovative activity in business, but the above analysis calls into question the usefulness of business R&D expenditure as an indicator of total business innovation. This point is borne out in a number of studies that have found little correlation between business R&D expenditure and the economical way. In this study I have to consider only those cases which are relevant to the Jugaad technology or indeed the Jugaad technology works in it. Finally they concluded that according to the study the only thing is matter is the will power of the innovator or the Jugadde person. It is art of manage things in a way, so that the maximum output can be obtained. "Demand is unlimited, but sources are scare, choosing that option which provides the maximum utility to the user." Choosing the best one is the Jugaad. Jugaad is the basically the mindset of the jugadee (innovator) and it is the customized technology means it is different from place to place. Basically Jugaad is the mixture of art and science because it has no fixed rules and but it needs some technical knowhow for take its benefits. Art in the sense it is used in different situation according to the condition of the job in this part Jugadee person use its own traits and skills of the person. Jugaad is the tool not a jargon it is the basically a mindset of the innovator. In which he used his/her skills and traits to make things in productive way. Jugaad is the most economical way to do task or a particular work. Jugaad is mostly used in small scale or cottage industries in India. In India Jugaad is an Indian philosophy, but it's not unique to India. Jugaad is the technique to add value in the product. Jugaad is the different way to do job or task which may not be performed in the present system or condition. Basically it is brainstorming process in which many ideas come in mind and taking them into feasible arena weather they are practical or not after that choosing the best alternative solution for that problem which is economical at that time. In Jugaad technology the innovator or jugadee men have to rational in the nature. He has to thinking new ideas or finding new paths to get the mission completed these path are easy to use and easy to understand and

easy to apply without much changing the current system it is the process to manage the available resources in a such a way that maximum output can be generated in many of the cases the jugadee person use the scrap stuff things in such a way that it full fill its all needs. Jugaad is not used in India but it is globally accepted thing in some nations this is might be known as innovation but in Indian context it is called as Jugaad [19].

2.20. From Jugaad to Systematic Innovation: The Challenge for India

This is a book written by Prof Rishikesh Krishna, Professor of Strategy & Jamuna Raghavan Chair Professor of Entrepreneurship at IIM Bangalore was launched by Mr. Subroto Bagchi, Vice Chairman, MindTree Ltd., at IIM Bangalore, on Friday, February, 5, 2010. In this book authors express their views that why it is that India is unable to be the source of major industrial innovations on a sustained basis even though it has highly skilled talent and a penchant for Jugaad (creative improvisation)? This book draws on social, cultural, political, economic and managerial arguments to explain this paradox: Firms are the primary agents of industrial innovation. While the incentive for innovation by firms in India has increased after economic liberalization began in 1991, the inputs (funding, trained people and basic research and development) for innovation by firms have not kept pace with firms' needs. Nor has the capacity of firms to innovate. Government's efforts to enhance the availability of inputs to the innovation process have been ineffective because of the lack of a strategic and integrative vision, inadequate resources, and poor implementation. Professor Krishna explains the government's shortcomings in this respect in terms of the political economy of India's innovation policy. Firms have failed to build an innovation capacity because of issues of ownership and control, and a number of deeply embedded social and cultural barriers to innovation. These include poor teamwork, the enduring importance of upward hierarchical progression, and a weak systems and strategic orientation. To overcome these problems, India needs to move from a paradigm of Jugaad (or creative improvisation) to one of systematic innovation. Specifically, India needs to (1) create a critical mass of new, innovative, technology-driven firms, (2) enhance the technological capability of existing micro, small, and medium enterprises, (3) transform large enterprises, (4) create a new incentive system for universities and other institutions of higher education, (5) continue

and enhance the process of dynamic reform of public R&D organizations, (6) change the structure of government involvement in supporting industrial R&D, and (7) create supportive societal conditions for industrial innovation. Replete with a strong conceptual framework, case studies, examples, and data relating to India's innovation performance, this book is essential reading for anyone concerned with the future of Indian industry [22].

2.21. Jugaad: Lessons in Frugal Innovation

Resourcefulness amid serious constraints is known in India as 'Jugaad.' In this article, Accenture's Mitali Sharma suggests this simple concept which gave birth to a \$2,500 car, a \$12 solar lamp, and a life-saving incubator made from car parts might be the antidote to the complexity plaguing your innovation process. What can companies in the developed world learn from innovators who make irrigation pumps from bicycles or solar ovens from old suitcases? Quite a bit, as it turns out. Jugaad is a Hindi colloquialism that refers to constraint-based innovation. While it may also be a way of life in India, where "inventing what you need by using only what you have" is an imperative, it also has been the source of breakthroughs that have improved the lives of millions beyond India in the developing world. In business, Jugaad (pronounced "joo-gaardh") suggests openness to improvisation and outside ideas in a search for the simplest route to solving a complex problem. Jugaad is often mentioned in tandem with "frugal innovation," which involves the delivery of exceptional customer value to low-income customers. Increasingly, however, businesses oriented toward mature economies are using principles of Jugaad/frugal innovation to foster a creative tension they feel will lead to game-changing innovations. More than cutting costs; Jugaad has been the source of breakthroughs that have improved the lives of millions in the developing world. Perhaps the most illustrative of these offerings is the "Car Parts Infant Incubator," which takes advantage of locally available replacement car parts, familiar automobile design, and globe-spanning automotive supply chains to create a life-altering medical device. The baby warmer sells for 5% of the cost of a traditional incubator, and might save as many as 2.4 million infants per year in the developing world. The creators of these products shared an ambition beyond merely slashing costs and features. They sought to make high-value

products that solved fundamental customer needs, while working with local economic realities and constraints. Creating a clean slate; frugal innovation and Jugaad principles are especially important in today's economy, for two reasons. First, corporations adversely affected by the slow economy lack resources for R&D. They need an alternate approach and Jugaad inspires offerings that are economical for the consumer and the supplier, without having to sacrifice margin. Second, the practice has long been considered an "antidote" to the complexity of India, a country of perpetually shifting cultures and profound scarcity. Now the same principles can help address issues faced by multinationals whose capacity for breakthroughs has been stifled by rigid internal processes, long R&D cycles, and above all else, multiple layers of complexity. This alternate approach to innovation is an excellent disruptor of rigid legacy processes because it democratizes innovation, stripping away extraneous features and processes, while opening the door to ideas from unconventional sources. The result is a clean slate, and a chance to re-orient innovation around the customer. With increased frequency, major corporations are embracing these approaches and self-imposing constraints around innovation. They might restrict R&D funds or artificially compress a window of opportunity regardless; the goal is to foster creative solutions, quick experimentation and flexible processes that revolve around the end user [23].

2.22. What CEO's can learn from rural Indian entrepreneurs?

Reena Jana is frog's Executive Editor. Based in New York, Reena is the former innovation department editor at BusinessWeek, and has contributed to a variety of publications including Wired, the New York Times, Harvard Business Review online, Fortune.com, and numerous others. She wrote that even a brief conversation with Navi Radjou, a co-author of the new book *Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth* will take you all over the world in only a few minutes. He speaks in an energetic voice that's brimming with enthusiasm and his thoughts reflect vast knowledge. One moment, he'll be talking about how management lessons learned in rural diabetes clinics in Chennai, India, can be adapted by executives in sleek open-plan offices in Silicon Valley. A few seconds later, he'll discuss how everyday citizens in the favelas of Brazil who "hack" buildings and objects can inspire the C-suite in Fortune 500

companies. The thread that underlies Radjou's research is that in the not-so-distant past, business gurus spoke of innovation and design moving in the opposite directions. Big, profitable ideas were believed to originate from global corporations headquartered in the West, later to be tweaked for other, less wealthy nations and sold at lower prices. But the world's economic forces have been shifting, obviously toward China and India, as well as Latin America and Africa. It's not only the financial growth in these regions that the world is watching; it's also their management and product-development strategies. One of the most talked about terms in this sphere is one called Jugaad. It's Hindi slang that can best be understood as "an innovative fix; an improvised solution born from ingenuity and cleverness." So Radjou writes with co-authors Jaideep Prabhu and Simone Ahuja in *Jugaad Innovation*. Radjou, a former analyst at tech research and advisory firm Forrester and more recently the executive director at the Center for India and Global Business at the Judge Business School at Cambridge, is now one of the world's most visible proponents of the concept. Having interviewed Navi in the past--including for a *BusinessWeek* feature on Jugaad innovation as the Next Big Thing--I was excited to learn more about his deep research into the origins and practice of Jugaad. His book, to be released in mid-April, has already received glowing endorsements from business leaders such as Carlos Ghosn, CEO of Renault -Nissan, Marc Benioff, chairman and CEO of Salesforce.com, and our own Doreen Lorenzo, frog's president. So I called Navi up, and asked him to elaborate more on Jugaad. Our conversation touched on some of the book's main points, and also took us in directions beyond what's included in its chapters. Here's our exchange, only lightly edited and condensed. Why is Jugaad in the collective conscious in the international business world today? Looking at what's happening in today's global business environment, executives are facing more complexity than ever before. There are a variety of factors. One is the growing acceleration of technology's velocity. Another is growing interconnectivity, via social media. And then there is more diversity in the work sphere: there are multiple generations in the workforce. Also, we must consider the issue of scarcity, which is not only an issue in the "East," but also is a reality in the U.S. Statistics has shown there is a shrinking middle class in America. Occupy Wall Street is just the tip of iceberg. Within this complex environment, Western firms are pressured to innovate faster, better, and cheaper. The biggest challenge is that

the innovation tools they have used in the past are not working. Why? Current approaches are too expensive, too rigid, too elitist, and insular. Can you elaborate on what these tools and approaches are, and why they don't work today? Western economies are still obviously very strong and influential globally. Well, look at big pharma. Pharmaceutical companies are known to spend billions in R&D, yet many are in trouble. Money doesn't buy creativity. Western innovation practices tend to be rigid, or at least more so than in fast-moving places. Nokia is learning this the hard way in Africa; their competitor Huawei can crank out new phones in 3-5 weeks. And then think of Six Sigma. It's a nice method to use when the world is stable. But what about when all is haywire...such tools are a handicap when you want to move quickly and fast. My point is that the need for flexibility is growing within Western companies. In terms of current innovation tools being elitist and insular, it's believed by many that innovation is only what a few scientists do. But why not be more democratic? To me, there seems to be a disconnect between the need to innovate faster and cheaper, and companies' capabilities to innovate. Executives will say there needs to be bottom up innovation that's frugal, flexible, and inclusive, meaning it needs to be about serving larger segments of society, to be profitable. These are all issues that emerging markets have been grappling with for many years. Western companies want to find new approaches--and they can find them already in use in emerging markets. They can see case studies of Indian ingenuity in action. In a way, it's similar to Yankee ingenuity in the States. But what's happened in corporate America is that this sense of fast, improvisational innovation got bogged down. Being half-Indian myself, I've seen Jugaad in action in India, and even among Indians living and working in the U.S. and abroad. Can you give us a brief history of the concept? While Jugaad is gaining traction in the Western world, the current approaches I talk about have worked for 100 years or more. Jugaad really first was practiced in a widespread way in the 19th and 20th centuries, and really a lot more after World War Two. That's when the nation was all about scale, scale, scale. We became a democracy. A large and diverse one. As a word, it really refers to the act of resourcefully improvising solutions using simple means in daily life. But what happens in this context is that it can also mean gaming the system. Sometimes Jugaad can involve danger and illegal hacks, or corruption. But in the context of its everyday practice, a sense of Jugaad is primarily used

to deal with adversity in business; Jugaad is really about the mindset of innovators in emerging markets [24].

2.23 Jugaad Innovation

In this book, Navi Rajdou; Jaideep Prabhu and Simone Ahuja talks about examples of Jugaad outside of India. It seems like a pretty global concept already. Yes, it's important to realize that Jugaad-style thinking isn't only practiced in India. In Africa, for instance, there are many communities dealing with constraints. And scarcity is a lot more pronounced, more prevalent there than in India. But there is also an entrepreneurial zeal throughout Africa, where people are coming up with new ways of using their mobile phones to build their businesses, because they don't have PCs or offices. There, Jugaad essentially is a leapfrogging platform. It's not about product. In China, there is a rampant sense of bottom up, interactive, reactive innovation. It's about quick prototyping, which is essentially about design thinking. In Brazil, people improvise solutions using limited means. There is a floating bank there, which its founders set up on boat to reach Amazonian tribes who otherwise wouldn't travel to cities. So they go to them. But there are also Jugaad traditions in the West. In France, there's a term, *system d*. essentially, it's the French version of coming up with makeshift products, using whatever you have at hand. And in the U.S., there has been a long sense of Jugaad. Think of MacGyver. Or "Yankee ingenuity." Today, there's a strong DIY movement, the Maker's Movement, in America and throughout the world. These are all examples of Jugaad. And I also think Jugaad in the U.S. is more about next big social app, rather than the big tech stuff. That start-up sense of lean innovation is definitely Jugaad. Navi Rajdou and his co-authors Simone Ahuja and Jaideep Prabhu talk about the 6 principles of Jugaad. Which are as follows:'

One, ***seek opportunity in adversity***. Never look at a glass as half empty, but as half full. Reframe every challenge.

Two, ***do more with less***. That's about both reducing costs and raw materials, also adding more value. It's not just about cheaper products, but also adding tremendous value. It's not about poor quality.

Three, *think and act flexibly*. Do not be attached to any business model. Think like IBM, which redid its values.

Four, *keep it simple*. Sometimes, companies lose touch with this idea, and tend to over-engineer products. Simplicity also applies to customer interactions, and of course product and organizational goals.

Five, *include the margin*. Often times, in the West, companies look at marginal segments as low income and not profitable. Think of Walmart, now innovating by setting up money centers in stores, several households are under banked. They can cash checks in stores and transfer money. This is the “bottom of the pyramid” as C.K. Prahalad said, but in the United States.

Six, *follow your heart*. This is where you'll find empathy, passion, intuition, all important qualities. Yes, they're less about “knowledge.” But now we're entering a correction era after the Great Recession. By following your heart, you'll find a larger purpose for your company and products, more employee engagement, more loyalty to your brand [25].

2.23 Theory of Jugaad

In this article author considers Jugaad as a word describing a concept of being street smart has been in existence for the last several decades. It has come up as a new buzz word, and has captured the imagination of Generation next in India as well as across the world. Though no formal literature existed on this enigmatic word it was being referred to in day to day conversations right from the corporate board rooms to the class rooms of Business schools. Regardless of what native language an Indian speaks, Jugaad is known to all and used by all. Criticisms have centered on whether Jugaad is an ethical tool or relies on unethical practices. Further he enlightens the Historical perspective and genesis of Jugaad. The word Jugaad came into formal existence in the English sense of the word, after a ‘contraption’, a make do improvised tractor assembled by farmers from the villages of hinterland in India became immensely popular. It was made by mounting a diesel water pump on a chassis of a trolley and attaching it with a steering rod and a wheel; whereas a barrel or a drum placed on the trolley was used as a fuel tank. At a cost of less than Rs 20000/- it was a lifeline for the farmers who could not afford any other

mechanical transport in those days. The above was the Physical manifestation of Jugaad .A solution was created for a seemingly impossible situation and a need .Gradually it became an inspiration to find a common sense solution or the out of the box solution to every, problem, person, thing or a situation. It took a meaning which was larger than life and was to express any and every human expertise in variety of context. This was the psychological manifestation of Jugaad. Today Jugaad has grown into a multi-dimensional and a multifaceted word. Therefore trying to define the word will be an insult to the word itself. It is a concept a philosophy and even a way of life for many. This word has now become popular across the world. Solving a problem somehow or the other with Jugaad at its core makes a Jugaad mindset. Jugaad as a word therefore defies any straight Jacketed definition .It connotes improvisation, creativity, thinking out of the box , resourcefulness, ingenuity, originality , novelty, inventiveness , lateral thinking , collaboration , contraption , intuitiveness , cutting corners ,achieving things against all odd somehow or being street smart. Jugaad is therefore perceived as a Swiss knife and represents “Street Smart multiple intelligence.” Jugaad mindset was best demonstrated in its mind set format in the movie “The Good, the Bad and the ugly” where actor Ali Wallach is caught up in a situation where he has to kill three captive goons but has only one bullet available with him. He takes his .45 caliber colt, making all three guys stand one behind the other and shoots the last guy in the back killing all three in one shot .Today’s Jugaad is all in the mind. Solution for seemingly complex problems; People face a number of problems every day. Most appear “seemingly complex”. We are conditioned to go through the logical motions to solve a problem as taught previously. Because of this conditioning we look for straight jacketed, run of the mill, “as per the book “solutions. Most day to day problems don’t have ready reckoner solutions in any book or, how to do, manuals. That is why they seem, very complex. In fact many problems have very simple solutions. A problem is defined as,” source of perplexity, distress, irritation, concern or pain”. Today Hard science definition of a problem is a conflict between two conditions or observations. The solution as per scientific analysis is a construct.

Also author describes the Fuzzy logic analogy for Jugaad.

Fuzzy logic deals with reasoning that is approximate rather than absolute or exact. The traditional theory of logic uses binary sets having two valued logic as true or false. Whereas fuzzy logic has truth values that range between 0 and 1, thus handles partial truth. It to an extent deals with imperfect truth or partial truth where the truth value may range from completely true to completely false. Fuzzy logic has been applied to artificial intelligence- how it can imitate function of a human mind. Terminology used in Fuzzy logic and examples are based on perception rather than measurement, like very low, decreasingly, unreasonable or low cost etc. In fact life situations are more like fuzzy logic and everything- situations, people, behavior, likes, dislikes have that “somewhat” factor in them and do not necessarily work in a binary fashion. Jugaad also works or Jugaad mindset looks at “real life Problems” the fuzzy logic way.

And at last author explains Chanakya’s Principles of Diplomacy and Jugaad To handle people, situations and relationships is the hallmark of diplomacy. Chanakya’s principles of diplomacy can be applied to break any dead lock, conflict, problem existing between people or groups of people. Saam, Daam, Dand, Bhed is a four word philosophy of chanakya to handle a person or a situation. Briefly these four words mean as under. Saam: to resolve a conflict by explaining your point to your opponent and by a dialogue. Daam: if dialogue doesn’t work then it suggests using money, gift or any materialistic way to lure and resolve the issue. Dand: if both the above fail, one can try punishment or penalty or pain to the other party to give in. Bhed: create differences between the people in the opposition or divide and rule. Jugaad is in a way extension of Chanakya’s Principles of Diplomacy, to handle people, problems and situations on a day to day basis [26]

2.24. The Indian Innovation System By Rangunath A. Mashelkar

Innovation is the key to the production as well as processing of knowledge. Indeed a nation’s ability to convert knowledge into wealth and social good through the process of innovation determines its future. The purpose of innovation is to create a new value for an individual, team or organization, or for a society at large. New values could be in the

form of breakthrough products or services, new strategies, new processes and new methods for organization. We will discuss the issue of the Indian Innovation System, specifically linked to science and technology innovation. The strong Science and Technology (S&T) base of India gives us the confidence that India has a sound S&T capacity. Some achievements Indian science and technology in the post-independence period is something to be proud of. Thanks to the “green revolution,” India is able not only to feed its masses but has enough to spare and export. The “white revolution” has made India the largest milk producer in the world. With a comprehensive defense research and development infrastructure, India is among the few countries of the world, which makes the most sophisticated weapons and weapon systems, including missiles of various descriptions and multi-barrel rocket systems. It has developed low-level tracking radar, night vision devices, and sophisticated ship sonar systems. An indigenous light combat vehicle and a remotely piloted vehicle are at an advanced stage of development. Today, India ranks among the few nations of the world that have a credible capability in space science and technology, including design and construction of satellites and launch vehicles. India’s capability in nuclear science and technology, including nuclear fast breeder reactors, has been the result of indigenous efforts. The entire range of technologies from prospecting of raw materials to the design and construction of large nuclear reactors is now available on a self-reliant basis. There have been other proud moments in Indian science and technology. We had path-breaking developments in parallel computing, breaking into the export market for supercomputers. And India has unveiled the new, PARAM 10000 supercomputer, with a capability of 100 Gigaflops (100,000,000,000 mathematical operations per second). Presently, only the United States, Europe and Japan have such technological capability. In the industrial R&D sector, India has achieved success in many areas. The Indian pharmaceutical industry, which was practically non-existent at the time of independence, has emerged as one of the most competitive producers of therapeutics in the world. It has contributed greatly to improving the standards of healthcare in the country and making modern medicine available to the people at an affordable price. India is a net exporter of pharmaceuticals, meeting more than three quarters of its requirements of bulk drugs and almost its entire requirement of formulations. Agro-chemical is yet another area of success for Indian

S&T. The industry, which was predominantly dependent on imports until the early seventies, is today self-sufficient in all matters of technology and production, thanks to the contribution of the indigenous know-how. In the area of petroleum refining and petrochemicals, the country has made some impressive strides. In the area of industrial catalysis, India ranks among the top few countries possessing world class capability for catalyst development and manufacture, in some cases, even exporting its technology to the USA and Europe. The Indian leather industry has been transformed from a mere exporter of raw hides and skins a few decades ago to a vibrant, modern industry that ranks among the top five export earners. R&D has contributed to the entire range of technical activities from leather processing technologies for curing, tanning and finishing (all environmentally clean), to process automation and modernization of tannery operations, and novel product design. Other innovation systems Many societies in India have nurtured and refined systems of knowledge of their own, relating to such diverse domains as geology, ecology, botany, agriculture, physiology and health. We are now seeing the emergence of terms such as ‘parallel’, ‘indigenous’ and ‘civilizational’ knowledge systems. Such knowledge systems are also expressions of other approaches to the acquisition and production of knowledge. They were, as yet, neglected by modern science, as the pharmaceutical industry has realized. The growing dominance of a single view of the natural world as expounded by modern science will undermine these knowledge systems. Further, the process of globalization is threatening the appropriation of elements of this collective knowledge of societies into proprietary knowledge for the commercial profit of a few. These fragile knowledge systems need to be protected and enhanced through national policies and international legislation, while ensuring their development and proper use for the benefit of their holders. In particular, a greater awareness about the cultural relationships between various knowledge systems needs to be created. A systematic and in-depth analysis of the parallelism of insights between indigenous and civilizational knowledge systems, on the one hand, and certain areas of modern science concerned with fundamental aspects, on the other will have to be launched. In particular, a strong linkage between the indigenous knowledge holders and scientists will be needed in the new millennium to explore the relationship between different knowledge systems. India’s new S&T policy India’s policy on science and

technology would have to be directed along five lines. The first priority will be to use the great powers of science and technology to meet the basic human needs, particularly taking note of locale-specific situations; these would relate to food, health, water, energy, employment, shelter, and the like. The second priority would be to use science and technology to create wealth, both by enterprises as well as by individual Indian entrepreneurs. The third priority would be to embark on a major thrust in emerging knowledge based areas such as informatics, biotechnology, new and renewable energy sources, new materials and environment-related programs. In all of these areas, India can make a major headway and surge ahead of the rest of the world. It would, then, use this position to its advantage in the global technological scenario. The fourth priority does not relate to strategic areas, where neither for love nor for money, will technologies be available to us. This would involve nuclear energy, defense research, and space science and technology. Fortunately, we have built self-reliance and enormous capabilities over the past few decades in all these areas. It is on this powerful base that India will make its confident march into the twenty-first century [27].

CHAPTER 3

3. Problem Definition

Having gone through the genesis, concept and applications of a uniquely Indian innovative way called Jugaad. It is time to apply this concept to solve problems existing in industrial and energy sectors. A set of problems therefore needs to define solution designed and developed, results documented and published in the same fashion as is done with a traditional research. Keeping in the mind the two problems selected to be solved using Jugaad philosophy are defined here as under:

3.1. E-Waste Management

E-wastes are becoming the primary concern owing to inestimable health hazards and environmental pollution. This is alarming and threatening situation for us that despite several guidelines and government policies e-waste is not disposed of properly and even it is not recycled or reused resourcefully and effectively. The challenge is to contain this e-waste rewardingly.

3.1.1. Introduction to e-waste.

The faulty electronics and electrical equipment beyond repair results in e-waste. Also, often changing technology and diverse modernizations can quickly make existing equipment obsolete. It is only a couple of years ago, that the global attention focused upon the increasing e-waste. According to the latest annual report of the Union Ministry of Environment and Forest (MoEF), by the end of 2012, India would have generated a whopping eight lakh tonnes of e-waste.

3.1.2. What is e-waste?

The term e-waste is derived from electronic and electrical waste. The terminated electronic/electrical equipment results as e-waste. So far there is no standard definition of e-waste. The various definitions given by different researchers revolve around the central theme that e-waste is “any appliance using an electric power supply that has reached its end-of-life”. [28]

3.1.3. Why should we bother?

Numerous components of electronic products comprise different hazardous materials which are harmful to human health and the environment if not disposed of carefully. Unfortunately, inappropriate discarding of e-waste results in a substantial encumbrance on landfills because toxic constituents can infuse into the earth and groundwater. The following section provides an overview of the toxic materials found in e-waste, their source and their ill effects on health.

Arsenic: Found in small quantities in the form of gallium arsenide within light emitting diodes; can lead to various diseases of the skin and decrease nerve conduction velocity. It can also cause lung cancer and can often be fatal

Barium (Ba): Found in cathode ray tube (CRT), sparkplugs, fluorescent lamps; may lead to brain swelling, muscle weakness, damage to the heart, liver, kidneys and spleen

Beryllium (Be): Found in Power supply (SMPS) boxes which contain silicon controlled rectifiers and x-ray lenses, Mother boards; Exposure can cause lung cancer.

Cadmium (Cd): Found in Rechargeable NiCd-batteries, fluorescent layer (CRT screens), photocopying-machines, printers; leads to lung cancer, kidney damage and bone disease

Chromium (Cr) VI: Found in Data tapes, floppy-disks; are irritating to eyes, skin and mucous membranes, may cause DNA damage, and even cancer

Lead (Pb): Found in CRT screens, batteries and printed circuit boards; can damage the nervous system, kidneys, and reproductive system

Mercury (Hg): Found in Fluorescent lamps, in some alkaline batteries, relays and mercury wetted switches; bio-accumulates causing brain, kidney and liver damage

Nickel: Found in Rechargeable NiCd-batteries or NiMH-batteries, electron gun in CRT; Affects skin and causes chronic bronchitis, lung and nasal sinus cancers

PCB (polychlorinated biphenyls): Found in Condensers, Transformers; affects immune system, reproductive system, nervous system, endocrine and even causes cancer

3.2. Low cost, low maintenance renewable resource of electric energy for island load

There are many loads (such as remote villages, islands, etc.) that are sometimes away from the main grid. They may require stand-alone generator system (which can provide constant nominal voltage and frequency) to provide local electrical power for their daily demand in small quantity. Other associated problem is concerned with the health of cattle. Due to decrease in farming land, grazing fields are reduced and cattle have no much physical work to perform. Thus, there is need to have cattle exercisers to keep them healthy and fit.

CHAPTER 4

4. Proposed Solutions

4.1. Proposed solution for E-Waste management.

Here we are going to introduce an innovative process which is a “Jugaad” method to tackle this problem. This Indian term “Jugaad” is now recognized internationally and some dictionaries have defined it as *to arrange for something that will help accomplish a particular task*. Alternately it said to be the only option when no other option is left; it is a technique to do it somehow. At present large number of technical institutions are mushrooming which includes engineering colleges, polytechnics and universities etc. E-waste can be procured /collected by universities & educational institutes and the students can be engaged to reuse the working components, which are a valuable resource for them, and may not be available in the open market even at very high cost.

4.2. Proposed solution for low cost, low maintenance renewable resource of electric energy for island load

In addition to the various utilizations and products we can obtain from farm animals, there is a simple apparatus that can use to generate electric power. Cattle power can be used in off-grid systems and may also called stand-alone systems. This is not associated to any electric distribution system or grid. It consists only of a coupling shaft, a gear box, and an alternator. As the animal strides around the central shaft, the shaft’s movement runs an alternator, and electricity is generated. The electric energy can be stored in batteries and be used as when required and also it can be used directly otherwise. The benefits here are two-fold. First is that we get electricity and secondly it is beneficial for the health of animal. Further, with the use of this apparatus there is no harm to environment as this is totally emission free. This is best suited for the remote site applications and rural segments that have small to moderate power requirements. or small power consuming applications which are mostly comprised of small home lighting systems, television, fans, mobile phone charging etc. so it provides people the prospect to overlook traditional electrical power supply and meet their own power needs locally.

5. Methodology

5.1. Methodology for E-Waste management

The innovative process involves the consumption of electronics / electrical components as a sort of remanufacture of new prototype products, innovative research projects and trainer / demonstrator equipment etc. The whole process is to be carried out as per following steps as given below:

Step 1: *Procurement*- Collection of e-waste by universities & educational institutions, even institutions and its staff members have their own e-waste material and students can also contribute in it by collecting from their own home, neighborhood and from nearby localities / colonies; Results in proper disposal and handling of e-waste as it is supervised by professionals. Hence it prevents mixing of e-waste (non-biodegradable) with general domestic and other waste (biodegradable)

Step 2: *Extraction*- Extraction of electronics / electrical components from printed circuit boards and chassis; Helpful for students in technical skill development (soldering / desoldering), Reverse engineering

Step 3: *Testing and segregation*- Categorization of components as 1) Tested OK components and 2) Faulty components; Beneficial for students in learning how to identify and test various electronics components

Step 4: *Reincarnation*- Tested OK components can be used for. Construction of hobby projects, Prototype models, demonstrator / trainer equipment and other innovative multi-disciplinary projects; it will be helpful for students for Identification and testing of various electronic components and hence it may improve their troubleshooting skills

Step 5: *Disposal*- Faulty components must be handed over to Government approved recyclers for further extraction of metals and other material and hence they recover

precious metals like Gold, Silver, Palladium, Platinum etc. Aluminum, Lead and Tin etc; Adequate disposal through proper channel & recovery of precious and scarce metals. The

approximate quantity of metal recovered from 1000Kg of PCBs is Gold 280 g, Precious metals like platinum etc. 94 g, Copper 190 Kg, Aluminum 145 Kg, Lead & Tin 30 Kg, Silver 450 g etc.

Step 6: *Spreading and exhibition*- Displaying and demonstrating innovative and useful prototypes products and their applications; Creates awareness and motivate others that we can do something, somehow by Jugaad way

Step 7: *Education and training*- It incorporates more practical exposure along with theoretical concepts; Makes students multi-ability and industry ready with considerable practical knowledge hence it may contributes escalation to employment opportunities.

5.2. Methodology for low cost, low maintenance renewable resource of electric energy for island load

This preliminary research is based on a Cattle driven electric power generator and the strategy is tested in a real environment. This product is designed and developed to produce localized electricity in villages in most simple & sustainable way. This is just a simple apparatus that can use to generate electric power.

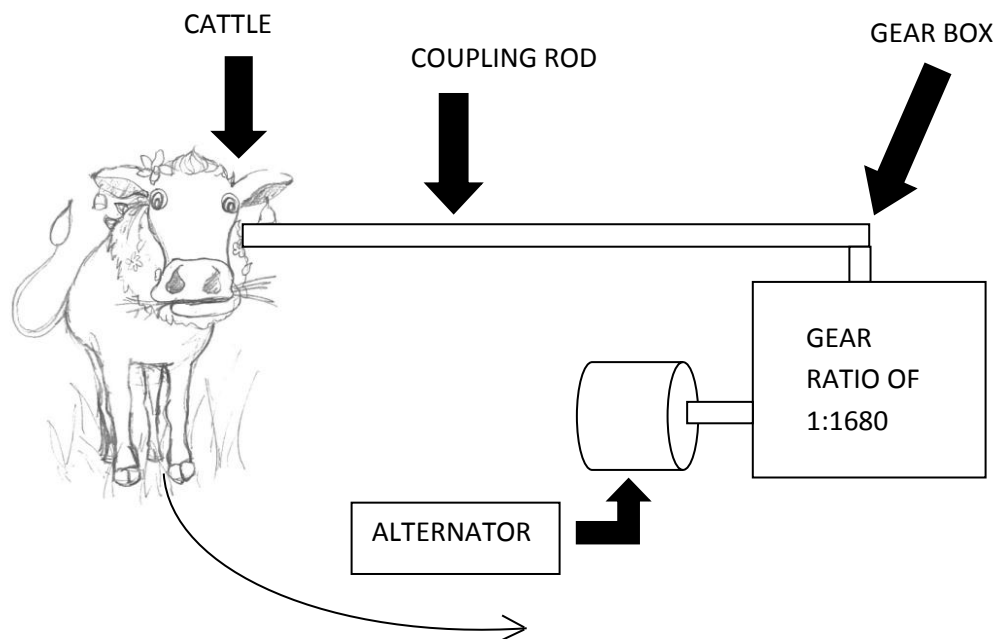


Figure: 5.1 Cattle driven electric generator schematic

It consists only of a coupling shaft, a gear box, and an alternator. Furthermore we can add on battery bank with inverter unit.

It is just like a traditional KOLHU (in which sugarcane juice is extracted by using animal traction). The figure 1 exhibits the structure and functioning of this cattle driven electric generator.

As is clear from the figure, a cow/bull pulls the coupling shaft in a circular motion. Cattle can walk for 3 to 4 hours continuously at natural speed, in a circular path so it is tied to an appropriate lever rod. Distance from center is 6m, which makes the animals move in comfort and can provide sufficient torque.



Figure: 5.2 Preparing for the trials

The motion is geared up with the help of a gear box of ratio 1:1680 and finally it rotates the alternator at 1500-1600. Electricity from the attached generator output is coupled to the load. Further this can be used on-line or off-line (through battery storage).



Figure: 5.3 Gear box of standalone cattle driven generator

It can produce up to 600 watts of electric energy with one healthy cow or buffalo, which is sufficient for small electric power requirements for daily needs. It has zero running cost, zero maintenance cost, zero emission technology, which is convenient to install in rural setups. Cattle are readily available in rural areas and they just sit idle without any work at all in most of the time of the year. The milk yielding cattle are seldom put to use, though they need exercise, barring a few months of their pregnancy and post-delivery period [29].

5.2.1. Description of Apparatus

The apparatus consists of four components as described follows:

- 1) Alternator - 2 KVA, 50 Hz, 1-Phase, 1500 RPM. This costs around Rs7000/-
- 2) Gear box - Gear box consists of three pairs of gear sets of gear ratio 1:10, 1:12 & 1:14. and a bevel set of 1:1 ratio. And this costs Rs5000/- including brackets, ball bearings and lathe machine work and labor charges.
- 3) Foundation – It is a steel frame used for mounting of gearbox and alternator. And this costs Rs550/-
- 4) Coupling shaft- It is a steel pipe of length 6 meters. This costs Rs1100/-

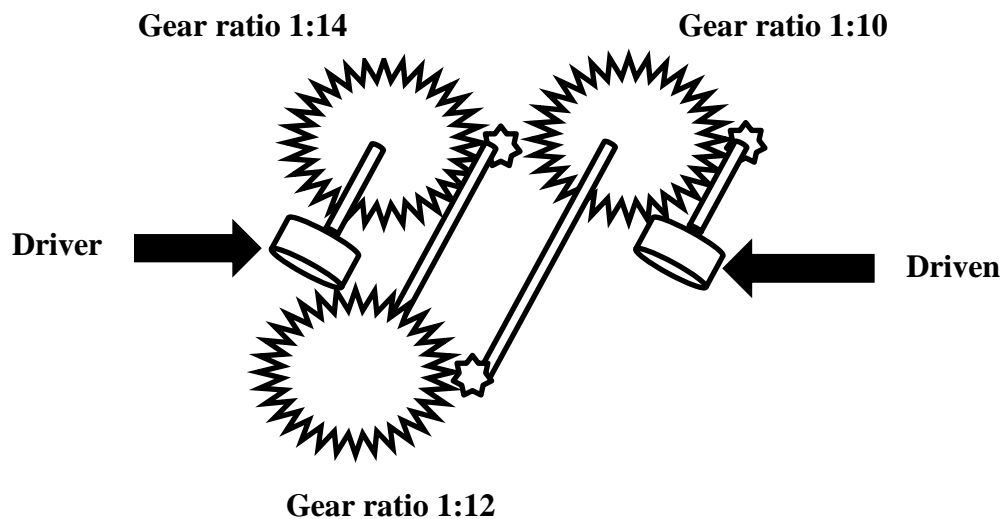


Figure: 5.4 Schematic of gear box

5.2.2. Construction process

The whole construction process is performed in the village nearby with the help of local mechanic of combine harvesters. In first phase we have constructed a gear box with three pairs of gears sets with gear ratio of 1:10, 1:12 and 1:14, (as shown in figure 4.1) also one bevel set is engaged with it for the change in orientation. All gear assemblies on shaft are then installed in an enclosed steel box with brackets and ball bearings. In second phase we mounted the gear box and alternator on a foundation. At last we attached a coupling shaft with a unit.



Figure: 5.5 Bullock in action; generating electricity

6. Results and discussion

6.1. The impact of innovative e-waste management

The method described for innovative e-waste management is a novel approach which is beneficial for students who are really very intelligent but not wealthy, as they can enhance their technical skills and their ability to utilize almost all the things which any one can throw away easily, but they can make it usable. It is favourable for environment as well because due to lack of awareness we are polluting our environment knowingly, unknowingly by dumping the e-waste with regular biodegradable domestic waste from which we can extract various components.

In addition, the faulty components and rest of e-waste will be handed over to the government autorised collection centres and recyclers for further extraction of precious and scarce material. Electrical and electronic equipment comprise several fractions of valuable materials like gold, silver, copper, lead, aluminium, tin etc. Moreover it is a twofold approach, accommodating for universities and institutions for the construction of innovative projects and availability of components at very low cost or no cost for the students. One of the anticipated benefits of this approach to e-waste management is increase in the level of self-confidence in students. The ever present phobia of unemployment amongst the students is one of the major cause of suicides. Thus it may not be a far fetched imagination to assume that this innovative method can help in reducing the suicide rate amongst the techincally qualified youth. Of course, for this we have to indulge ourselves in it and this process requires an initiative to start with this innovative way for recycle and disposal of e-waste.

6.2. Results of Cattle Driven Electric Generator

This method of generating electricity by using cattle power is tested in real environment and it delivers satisfactory results. Cattle engaged with the apparatus walks at pace of 1 rpm approximately which spins shaft of gearbox and gear box designed by us is of ratio

1:1680 so this much rpm is sufficient for 2kva alternator. The output voltage which we have measured is 195 volts (approximately).and we have drawn up to 300 watts of electric energy successfully.

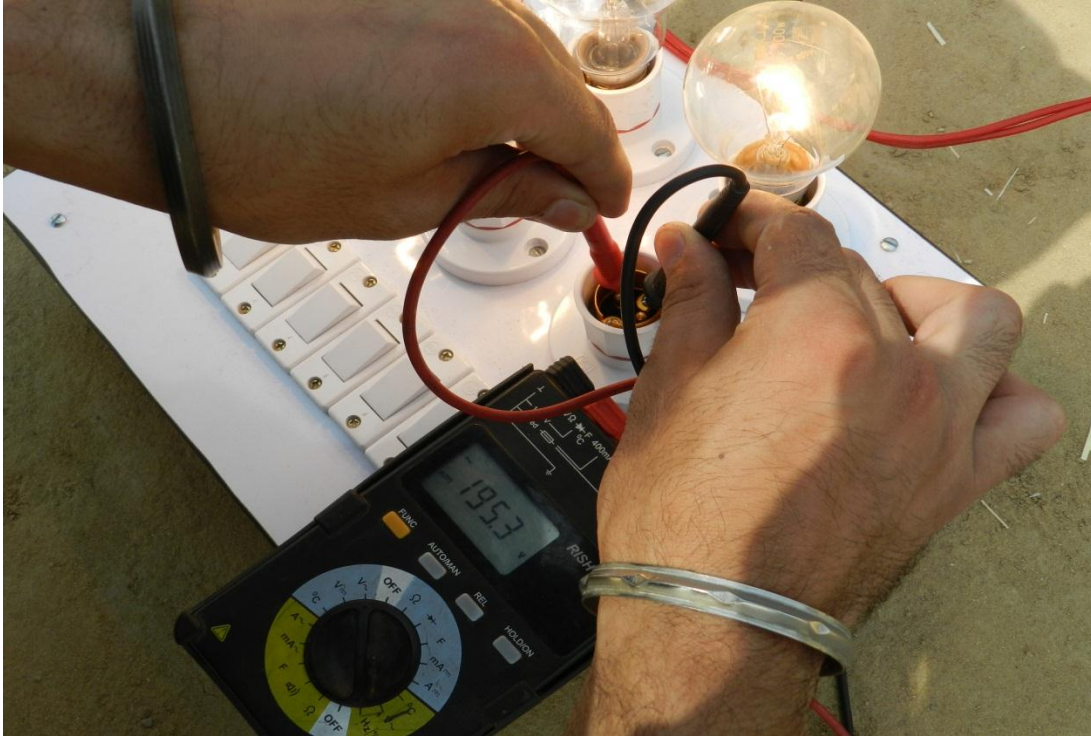


Figure: 6.1 Measurement of voltage generated

However, with higher loads, there appeared a little problem of slip in the gears, for which a new gear design is proposed. Assuming a comfortable 600W output per cattle, a total of 1.2 kWhr of electric energy is generated per hour per pair, and with another assumption that the farmer has two such pairs and they can be alternated for a total of 12 hours in a day, the daily generation comes out to be 14.4 units. One unit electric energy from diesel powered electric generator costs more than Rs10/-. It can be safely assumed that we can produce electric energy of Rs144/- per day, which translates to more than Rs50000/- annually. With initial cost of less than Rs15000/- per system, our payback period is less than four months! This is a somewhat an innovative and unknown technology, which offers a new vision for electric power generation. The unique aspect of cattle driven electric generator is that it works as a sort of exerciser for cattle; keep them healthy and fit.

7. Conclusions

Jugaad is innovation manifested what was so far looked down for a scorn Jugaad now a days as become a creative outcome to circumvent the lack of resources especially in fast developing country like India this concept was conceived and fueled by the never-say-die spirit of hardworking Punjabis who have withstood adversities in the form of several foreign invaders for the time immemorial. Exploring this concept especially for the technologically related innovations in rural India, we have come across number of examples where application of Jugaad has fruitfully yielded positive results. Apart from documenting these results two problems identified with e-waste management and with renewable resource of standalone electric generation were addressed to and solved for.

7.1. Conclusion for Innovative e-waste management

E-waste can be extremely toxic and desires to be disposed of securely. Our main objective is to spread the awareness regarding e-waste. An effort has been made to implement the innovative Jugaad way to tackle this massive problem, by involving educated segment of society for collecting e-waste from different pockets of rural and urban sectors and engaging the unemployed people for organizing the whole process and to train and aware people in rural areas.

7.2. Conclusion for Cattle driven electric generator

Due to rapid growth in the population and standard of living, we are facing with energy crisis. Conventional sources of energy are progressively depleting. Also there are many loads (such as remote villages, islands, etc.) that are sometimes away from the main grid. Cattle power can be used in off-grid systems and may also called stand-alone systems. The cattle powered electric generator is tested in a real environment. Barring a few mechanical problems, it successfully generated 300 W of power with a single cattle and holds promising 600W generation with some modifications. This is a renewable resource of energy which is inexhaustible and free from emissions hence this is a clean energy resource which allows provides local energy independence especially in rural segment. It is beneficial for cattle farmers as it may fulfill their daily electric power needs, along with providing the necessary exercise to the cattle.

CHAPTER 8

8.1. Scope for further work

When everything fails, Jugaad works [30]. This statement itself covers the intensity with which the concept of Jugaad can be employed in every field, from farming to space technology. The concept of e-waste management can be implemented as suggested in the previous chapters to cop up with the environment disaster that is posed by it, while the concept of cattle driven generator needs to be implemented in refined way.

There is need to have a rugged gear system, preferable with five pairs of gears with deeper grooves to avoid slips. The new design must not have any slip on the higher loads and thus will have a longer life. To match the energy produced with that of the load demand on cycle to cycle basis, there is a need to have a storage system using, batteries, inverter and the necessary switching system.

In case the future of Jugaad to be expressed in one word, then the most appropriate choice of that word is “IMMENSE”

REFERENCES

- [1] Rishiksha T. Krishnan; “From Jugaad to systematic innovation”
Available at: <http://iimaalumni.org/n/front/home/pdfaug10/bookshelf.pdf>
- [2] A.G. Lafley; Ram Charan; “Why Innovation Matters” Available at:
<http://www.fastcompany.com/articles/2008/05/why-innovation-matters.html>
- [3] First Energy; “Oorja Stove” Available at: <http://www.firstenergy.in/>
- [4] S.A. Aiyar Swaminathan; “Jugaad is our precious resource” TNN; Economic Times;
Aug 15 2010; Available at: http://Articles.economictimes.indiatimes.com/2010-08-15/news/27567823_1_jugaad-frugal-engineering-innovation
- [5] Jana Reena; “India's Next Global Export: Innovation” BusinessWeek; Available at:
http://www.businessweek.com/innovate/content/dec2009/id2009121_864965.htm
- [6] Paul Vivek; “Wide angle” Available at:
<http://lite.epaper.timesofindia.com/getpage.aspx?Articles=yes&pageid=4&max=true&Articleid=Ar00402§id=2&edid=&edlabel=ETBG&mydateHid=23-11-2010&pubname=Economic+Times+-+Bangalore+-+Technology&title=Follow+3+Indian+rules%3A+josh%2Cjugaad+and+lage+raho&edname=&publabel=ET>
- [7] Tim Leberecht; “Jugaad and its Relationship to Innovation” Available at:
<http://designpublic.in/blog/jugaad-and-its-relationship-to-innovation/>
- [8] Chaudhary Amrita; “Jugaad is a component of human ability”
Available at: <http://newglobalindian.com/books/rise-and-rise-of-jugaad>
- [9] Bijapurkar Rama; “In Jugaad Land” www.bijapurkar.com; Available at:
http://www.bijapurkar.com/successstrategies/ss_state_of_consumer.php
- [10] The Economist; “The charms of frugal innovation” Apr 15th 2010; Available at:
<http://www.economist.com/node/15879359>

- [11] Economic Times Bureau; “Jugaad is our word for reinvention” 28 Jan, 2009; Available at: <http://economictimes.indiatimes.com/features/jugaad-is-our-word-for-reinvention/Articleshow/4044161.cms>
- [12] Halarnkar Samar; “Innovator network plans giant leap on the back of 3 Idiots” Hindustan Times; Thu, Dec 31 2009; Available at: <http://www.livemint.com/2009/12/30222451/Innovator-network-plans-giant.html>
- [13] Shukla Vandana; “Jugaad: The last resort to success” TNN; The Times of India Mar 3, 2002; Available at: <http://timesofindia.indiatimes.com/city/Jugaad-The-last-resort-to-success/Articleshow/2692688.cms>
- [14] Aparna V. Singh; “Science of Adjust and Jugaad” Available at: <http://phoenixritu.com/2010/12/science-of-adjust-and-jugaad/>
- [15] Daniel Pink; “The creative age is coming” Available at: <http://www.livemint.com/2010/01/03211645/The-creative-age-is-coming.html>
- [16] Devdutt; “The Great Indian Jugaad” www.devdutt.com; Available at: <http://devdutt.com/the-great-indian-jugaad/>
- [17] Nath Kamal; “Unravelling India's innovative streak” January 28, 2008; Available at: <http://www.rediff.com/money/2008/jan/28spec.htm>
- [18] The Financial Express; “We are in India to learn to be frugal: Ghosn” Thursday, Apr 05, 2007; Available at: <http://www.financialexpress.com/news/story/195898/>
- [19] Kelly Sims Gallagher, John P. Holdren, Ambuj D. Sagar; “Energy-technology innovation” Journal Article, Annual Review of Environment and Resources, volume 31, pages 193-237; Available at: http://belfercenter.ksg.harvard.edu/publication/807/energytechnology_innovation.html
- [20] Hindustan Times; “Esprit de Jugaad” Available at: <http://www.hindustantimes.com/StoryPage/Print/241749.aspx>
- [21] Murad Ali, Sana Ullah, Pervez Khan; “Managing innovation and technology in developing countries” The 5th annual International New Exploratory Technologies Conference 2008 (NEXT 2008), Turku, Finland; Available at: <http://arxiv.org/abs/0911.1514>

- [22] Singh Sanjeet, Sharma, Gagan Deep, Mahendru, Mandeep; “The Jugaad technology (indigenous innovations)” Asia Pacific Journal of Research in Business Management; Vol. 2, No. 4, April 2011; Available at:
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1827622
- [23] Sharma Mitali; “Jugaad: Lessons in Frugal Innovation” February 27, 2012; Available at: <http://www.innovationmanagement.se/2012/02/27/jugaad-lessons-in-frugal-innovation/>
- [24] Reena Jana; “What CEOs Can Learn from Rural Indian Entrepreneurs” April 9, 2012; Available at: <http://designmind.frogdesign.com/blog/navi-radjou-what-ceos-can-learn-from-rural-indian-entrepreneurs-and-macgyver-and-the-makers-mov>
- [25] Navi Rajdou, Jaideep Prabhu, Simone Ahuja; “Jugaad Innovation” Published by: Random House India – 2012
- [26] Kapoor Virender ; “Theory of Jugaad” Available at:
<http://www.virenderkapoor.com/Theory%20of%20Jugaad%20pdf.pdf>
- [27] Ragunath A. Mashelkar; “The Indian Innovation System” Available at:
<http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan037679.pdf>
- [28] Mandeep Singh, Jitender Singh Virk; “Innovative E-waste management – the Jugaad way” International journal of electronics engineering; Volume 4, Number 1, pp-141 – 143; January-June 2012, ISSN: 0973-7383
- [29] Mandeep Singh, Jitender Singh Virk; “Alternator – the alternate way” International journal of electronics engineering; Volume 4, Number 2; 2012 (in press)
- [30] Mandeep Singh, Jitender Singh Virk; “Where there is Jugaad, there is a way” International journal of electronics engineering; Volume 4, Number 2; 2012 (in press)

PUBLICATIONS

- [1] Mandeep Singh, Jitender Singh Virk; “Innovative E-waste management – the Jugaad way” International journal of electronics engineering; Volume 4, Number 1, pp-141 – 143; January-June 2012, ISSN: 0973-7383
- [2] Mandeep Singh, Jitender Singh Virk; “Alternator – the alternate way” International journal of electronics engineering; Volume 4, Number 2; 2012 (in press)
- [3] Mandeep Singh, Jitender Singh Virk; “Where there is Jugaad, there is a way” International journal of electronics engineering; Volume 4, Number 2; 2012 (in press)