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Cost Benefit and Economic Return on Productivity of Reuse and Recycle

Reusing Fractions of Legacy Municipal Solid Wastes in India

Conversion of marble waste into a value added composite materials

Hospitals- Enormous Waste Powerhouses

Realizing Total Customer Experience through Six Sigma Marketing

Social Inclusiveness of National Food Security Bill: Issues and Concerns

Changing Dynamics of Formal- Informal Labour Market in Uttar Pradesh

Impact of Self Help Group -Bank Linkage Programme

Factors Influencing Consumers Thoughts on Green Marketing Practices

Environmental Proactiveness and the Power Sector: The Indian Scenario

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Reusing Fractions of Legacy Municipal Solid Wastes in India: A Circular Economy Approach

RICHA SINGH, BAKUL RAO, KRISHNANAND MAILLACHERUVU AND SHYAM R. ASOLEKAR

Management of the so-called legacy wastes (i.e. aged wastes) is one of the challenging tasks faced by developing nations including India. Such sites are often those locations where fresh wastes are not brought because the sites are fully packed and inoperable. The un-scientific operations at those abandoned dumpsites have led to various long term challenges such as ground and surface water pollution, air pollution, dumpsite fires, and on-site scavenging - which have been periodically creating massive threats to public health. This paper focuses on management of legacy wastes by adopting feasible, affordable, and environmentally sound technological options aimed at recovery of the maximum possible resources and also generate energy from the combustible waste fractions obtained from mining of these dump sites. The study envisages the need of integrating the circular economy approach with sustainable waste management in India by utilizing waste fractions for gainful applications and ensuring that negligible amount of waste is ending-up into the dumpsites or landfills.

It is hoped that this study will serve two purposes, i.e., energy and land recovery by scientific and systematic management of the combustible and inert fraction of the legacy wastes and conversion of reclaimed land to scientific landfills by installing composite liner system for a sustainable landfilling practice. As an add-on, the reclaimed land can also be sold or used for any other purposes after satisfying the adequate fit-for-use criteria for the specific application.

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INTRODUCTION

With expanding urbanization and industrialization, there is an increase in the amount of solid waste generation. Due to this, the management of solid wastes has emerged out as global concern over the last few decades. Land disposal either in the form of scientific containments or sanitary landfills and/or open unscientific dumpsites is a global practice being followed for the ultimate disposal of municipal solid waste (Nagendran *et al.*, 2006; Lacoste and Chalmin, 2007; Asolekar and Gopichandran, 2005). The un-scientific land disposal of solid waste is responsible for creating massive mounds of open dumpsites in India and other developing nations.

It has been recognized that the unlined unscientific dumpsites are creating irreversible environmental hazards in the form of puddles of leachate flowing through the adjoining area and reaching into the groundwater (Vaccari *et al.*, 2018). The long-term issues of GHG emissions (such as methane), local pollution, groundwater pollution, surface fires, and limitations on urban development often make this mode of disposal a menace to be managed. Especially the old dumpsites are a well-known source of dislocated local pollution due to the process of generation of high strength hazardous wastewaters known as leachates. Many studies have revealed the hazardous impacts of un-scientific dumping of solid waste (Flyhammar, 1997; Xiaoli *et al.*, 2007; Renouet *et al.*, 2008; Raghav *et al.*, 2013).

Open dumpsites such as Deonar in Mumbai, Ghazipur, Okhla, Narela-Bawana and Bhalswa in Delhi, Bingipura and Laksmipura in Bangaluru, Dhapa and Garden reach in Kolkata and many more in different cities are few of the examples of unscientific solid waste dumping in India. (Banerjee, 2016). Several incidences have been reported over the past few years due to the un-scientific

dumping of solid waste. Incidences such as landfill fires have been reported in Deonar in the year 2016 followed by 2018 which severely affected the air quality of the adjoining area (Bhattacharya and Yadav, 2017; Pinto, 2018). In another incident in Ghazipur dumpsite in Delhi, two people died due to the collapse of fifty tons of garbage which came crashing down like a 16-story-high building (Pinto, 2018).

Reportedly most of the dumpsites in India have been functional since the 1970s and 1980s and have reached their maximum operational capacity due to the growing population and cannot expand any more (Rodić and Gupta, 2017). Also, the public protests and complaints over ground and surface water contamination and land constraints have prompted the policy makers towards more sustainable and environmentally sound management of the wastes. The development of national legislation on solid waste management, in particular, the Solid Waste Management (SWM) Rules 2016 and Swachh Bharat Abhiyan 2014 have also contributed in creating awareness among the

authorities to address the problem of waste disposal in their jurisdiction.

In order to address the long-term environmental impacts due to unscientific dumpsites, there is an urgent need to reclaim these sites to create land for building new scientific landfills and increasing the life of the landfills typically referred to as '*extended landfill capacity*'. Also, the waste buried in the old dumpsites (typically regarded as *legacy waste*) should be recycled for gainful applications.

There is a need to integrate the legacy waste management with the circular economy principles which rely on the so-called "9 R" framework; *namely*, refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover (Potting *et al.*, 2017; Kirchherr *et al.*, 2017). A typical dumpsite containing legacy waste is depicted in **Figure 1** (Pirana dumpsite in Ahmedabad). The occurrence of polymeric and combustible waste is clearly visible in the Figure 1.



Fig. 1. Pirana dumpsite in City of Ahmedabad, State of Gujarat (photographed in June 2016)

The present study is aimed at exploring the potential of legacy waste to be utilized for gainful application promoting the idea of resource conservation and circular economy. A framework of circular economy of the legacy waste fractions has been presented in this study.

2. Concept of Circular Economy for Sustainable Waste Management

Production of any material requires the extraction of raw materials and energy from the earth for its manufacturing. Typically, a manufactured product after its production and

consumption finally ends up in the landfills. This approach has been termed as the linear economy model - consisting of three stages, *namely*, take, make, and dispose (Millar *et al.*, 2019). As a result, this economic model generates an enormous quantity of solid waste. Therefore, the circular economy approach was incorporated in the integrated solid waste management strategies to promote the recycling of the resources within the products' life cycle and minimizing the waste generation in European countries (Moraga *et al.*, 2019). According to the principles of resource conservation and circular economy, wastes from

any source should not be treated as an environmental liability but as a resource that could be fully integrated into a “Sustainable Business Model.” Many of the researchers have highlighted the stern need of articulating circular economy in the national policies of sustainable development (McDowall *et al.*, 2017; Homrich *et al.*, 2018; Korhonen *et al.*, 2018; Schroeder *et al.*, 2019).

Reportedly, India is generating more than 62 million tons of solid waste every year (W to E Report, 2014). Out of which, nearly 80% to 90% is ending up into the open dumpsites (Sharholly *et al.*, 2008; FICCI, 2009). Under the Swachh Bharat Abhiyan (SBA) by the Government of India and the Solid Waste Management Rules 2016, many of

the municipal corporations and urban local bodies are promoting efficient systems for collection and treatment of the solid waste fractions. The biodegradable fractions (organic waste) are treated in composting plants to produce manure. According to one report of Down to Earth, 616 waste to compost centralized facilities are installed in the country, out of which 52 centralized composting plants are currently operational, and another 147 are under construction as per the claims of SBA (Sambyal and Agarwal, 2018). The anaerobic digestion of the organic waste to derive methane has also been adopted by many municipalities. However, a major portion of biodegradable waste continues to be disposed of in the dumpsites. If

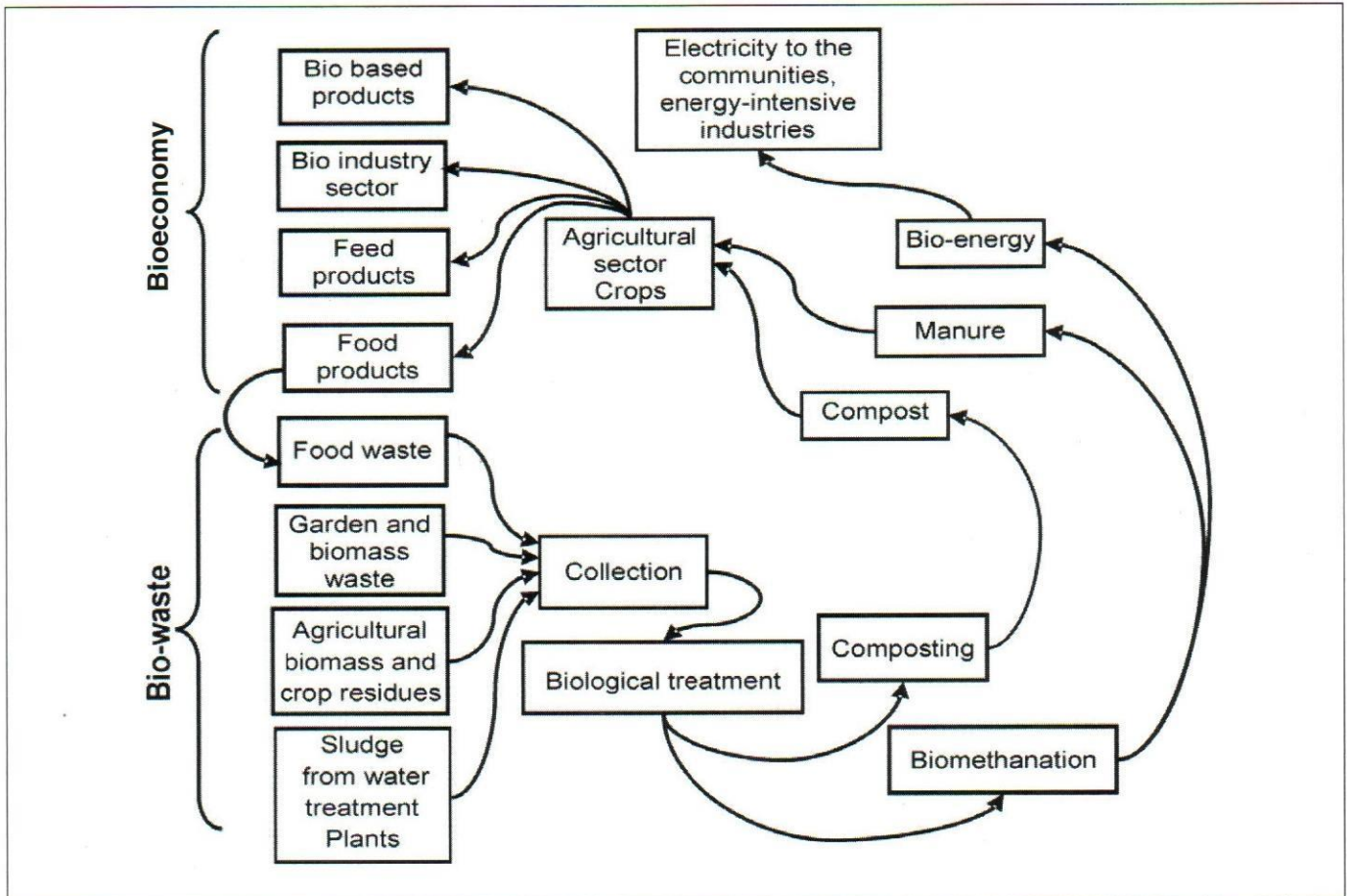


Fig. 2. A model for management of biodegradable fraction of solid waste based on the concepts of “circular economy”(adapted after Razza *et al.*, 2018)

appropriate technologies such as composting and biomethanation are put in practice nearly 50% of the solid waste generated in India could be restricted to reach the dumpsites.

This would not only help in minimizing the landfill footprint but also reduce the GHG emissions due microbial decomposition of the organics in the dumpsites (Razza *et al.*, 2018). **Figure 2** is depicting an ideal model of

circular economy of organic waste where food wastes, garden waste, agricultural biomass (crop residues) and sludge generated from water treatment plants (collectively known as bio-waste) are segregated and subjected to biological treatment such as composting and biomethanation. The compost produced can help the farmers and contributes in sustainable agriculture. Also, the bio-energy and organic manure derived from the anaerobic digestion (biomethanation) could be beneficially utilized for gainful applications.

On the other hand, a very small fraction of recyclable waste such as paper, plastics, metals, glass etc are segregated by workers in the informal sector. The polymeric wastes, such as PET bottles are collected by rag-pickers, which are further sold to the 'kabadiwallas' i.e. scrap-vendors (W to E Report, 2014). The plastic waste is also utilized in the RDFs processing plant for deriving energy from the waste. One important point to highlight here is the fact that waste to energy application though sounds useful, but it is based on the so-called 'recovery phase' of the circular economy framework. As a result, more serious efforts are needed to enhance the recycling rate of the material and promote the "9R framework" of circular economy. This can be achieved by installing material recovery facilities (MRFs). The first seven R-based framework (i.e. refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover) must be explored before subjecting them to conventional recycling and recovery facilities. Clearly, not even a small fragment of polymeric waste should be disposed of in landfill. It would be best to subject the remaining polymeric wastes to pyrolysis to obtain gaseous and liquid fuels after exploring the '9 R framework'.

It is interesting to note that all these efforts alone cannot solve the problem of waste management in India. It has to be understood that the problem of dumpsites and the management of aged waste has to be addressed along with the fresh solid waste. In developed economies the definition of waste is only limited to the "fresh solid waste", however, in developing countries such as India it is not only limited to fresh solid waste, it also includes huge quantum of waste trapped in the aged old dumpsites – which are typically referred to as 'legacy waste' (Maillacheruvu and Asolekar, 2017).

In context of integrated waste management, landfills are considered as untapped resource for waste to energy along with valuable recyclable materials, precious metals, etc. (Dubey *et al.*, 2016). The most important point, which

articulates the necessity of landfill mining and reclamation is the space issue particularly in the densely populated areas, where the location of such landfill facilities hinder the necessary city expansion (Zhao *et al.*, 2007).

"Dumpsite reclamation" or "landfill mining" is a term, which is generally used for such activity, where a dumpsite or a closed landfill (after completion of its active lifespan) is subjected to a series of processes including excavation, sorting, segregation, resource recovery and final disposal of waste residues (Hogland *et al.*, 2004; Krook *et al.*, 2012; Quaghebeur *et al.*, 2012; Winterstetter *et al.*, 2018). This practice has been efficiently followed in many of the developed countries, including the US and European nations. In India, it could be of great benefit where the goal is not only the recovery of resources but also to curb the pollution by preventing the continuous contact of leachate with the groundwater and surface water bodies. The concept of resource conservation and recovery emphasizes mainly on minimizing the use of the environment as a sink for wastes residuals but – perhaps more importantly – minimizing the use of virgin materials for economic activities (Anderson, 2007) and conserving it for the future generations thereby promoting the idea of so-called "sustainable development." However, this comes with many challenges, including the scale of operation and the contamination of the materials excavated from landfill mining.

For example, the polymeric scrap waste, which could be used for the manufacturing of plastic products would not exhibit the same properties and may contain contaminants such as heavy metals, high level of ash, and other impurities (Canopoli *et al.*, 2018) after it is disposed of in the dumpsite. Reportedly the polymeric waste degrades with time in a dumpsite and releases micro-plastics (He *et al.*, 2019) which deteriorate its properties. Due to which, instead of recycling, "recovery" is an appropriate solution for the utilization of the waste plastics obtained from excavation of old dumpsite. Canopoli *et al.* (2018) reported that pyrolysis is a cost-effective treatment technology for plastics waste recovered from landfills, which produces pyrolytic oil having similar characteristics with that of petroleum products. As a result, no natural resources are needed for the production of new materials, and discarded products no longer remain as waste. But, this may need some additional steps in the product recycling such as cleaning and drying of the recovered polymeric wastes. Similarly, other waste fractions can also be utilized, which will help in minimizing

the burden on the landfills and restricting the natural resource depletion.

According to Potting *et al.* (2017), “in a circular economy, the materials from a discarded product ideally maintain their original quality so they can be applied again in the same type of product.” However, in Indian scenario, since the level of contamination in the waste is high (especially in case of mixed and un-segregated waste which is extracted from the old dumpsites); it is difficult to utilize the waste for manufacturing the same product. Recycling materials from legacy waste might be an energy-intensive process, and the recycled materials may not be used for the same purpose as that of original material. Therefore, the recycled materials are generally used in lower quality requirements. In such cases, the material chain can be longer than a single product chain.

3. Indian Case Studies

It has been recognized that the conventional method of scientific capping or landfill cover is not a sustainable solution for managing the dumpsites in India. The main objective of installing engineered capping system is to prevent infiltration of precipitation, thereby minimizing the formation of leachate and controlling the emission of landfill gas into the atmosphere (Simon and Müller, 2004). However, such capping systems are highly ineffective in preventing the flow of leachate into the groundwater, which is a major concern in the case of “un-lined” dumpsites in India. Long term issues associated with un-lined dumpsite could be a major bottleneck in the sustainable management of the wastes in India.

Therefore, to effectively manage the old stockpile of wastes “landfill mining” is suggested based on the feasibility study conducted on Pirana dumpsite (located in Ahmedabad City in the State of Gujarat) by the research group headed by Prof Shyam Asolekar in IIT Bombay (Maillacheruvu and Asolekar, 2017). The study suggests an innovative strategy for extending the capacity and life of solid waste landfills through the recovery of scrap polymeric and combustible materials for “Refuse Derived Fuel” (RDF) and inerts for “Refuse Derived Construction Products” (RDCP) through landfill mining.

In India, very few studies (pilot studies and research projects) have been conducted addressing the need for landfill mining with main focus on the characterization of legacy waste and landfill's composition to evaluate its resource potential. Kurian *et al.* (2003) had studied the

wastes from two different dumpsites, Kodungaiyur and Perungudi, near Chennai in the State of Tamil Nadu, India. Reportedly, the fine fraction (>10 mm size) constituted nearly 65% of the total waste excavated. It was suggested that the fine fraction could potentially be utilized as compost material for non-edible plants or landfill cover material after assessing the geotechnical suitability. Some heavy metals such as Cr, Cu, Hg, Ni, and Pb were found to exceed the compost standards of India however; they were well within the USEPA limits (Kurian *et al.*, 2003).

The heavy metal analysis of Kodungaiyur dumpsite revealed the presence of Iron with the highest concentration of 20 gkg^{-1} , while the lowest metal concentration was found for cadmium 3 mgkg^{-1} (Esakkuet *et al.*, 2005). Furthermore, the bio-availability of zinc was found to be the highest while chromium the least in soil fraction of Kodungaiyur dumpsite. Based on the average of absolute values for the three depth levels (0 to 3m), the bioavailability order of metals was found as - $\text{Zn} > \text{Mn} > \text{Pb} > \text{Ni} > \text{Cu} > \text{Fe} > \text{Cr} > \text{Cd}$ (Esakku *et al.*, 2005). Nagendran *et al.* (2006) studied the potential of phytoremediation in sustainable landfill management in Kodungaiyur and Perungudi dumpsites near Chennai. They highlighted the potential of plants in removing the toxic metals from the dumpsites.

Few studies have been conducted to examine the characteristics of the legacy waste, including the level of contamination. The soil in Ghazipur dumpsite in Delhi was studied by Swati *et al.* (2017) which indicated the presence of inorganic contaminants as well as high cytotoxic and genotoxic compounds such as phthalates, benzene derivatives, halogenated aliphatic compounds, and PAHs derivatives. Hence, it is essential to conduct thorough sampling and analysis of the mined fractions before recycling. Maillacheruvu and Asolekar (2017) highlighted the need for dumpsite reclamation and legacy waste management to curb the hazardous impacts of the dumpsites such as those encountered in the dumpsites at Deonar in Mumbai and Pirana in Ahmedabad. The preliminary site investigation at Pirana dumpsite in Ahmadabad revealed that more than 50% of the solid waste comprises of inert material (soil or silt-like material) having size <10mm (Maillacheruvu and Asolekar, 2017). It has been observed that the fine inert fraction is in the range of 50-60% in all the dumpsites in India. The composition of legacy wastes from various dumpsites in India is presented in **Table 1**.

For the management of the fine material, many authors have suggested microbial remediation for the

reclamation of the solid waste dumpsites in India; such as Annepu (2012) had discussed the excavation and reuse

TABLE 1. Composition of legacy wastes from various dumpsites in India

Parameter	Perungudi Dumpsite in City of Chennai	Kodungaiyur Dumpsite in City of Chennai	Deonar Dumpsite in City of Mumbai	Mumbai Dumpsite in City of Ahmedabad
Approximate daily quantities received at the dumpsite (TPD)	2,400 to 2,600	2,600 to 2,800	6,826	3,200
Number of sampling points	12	46	not available	5
Combustible waste fraction	39.4%	3.5%	2.1%	19%
Stones and large fraction (>20mm)	18.5%	28.3%	31.5%	17%
Inert finefraction	40.1%(<20mm)	67.8%(<20mm)	63.5%(<8 mm)	50%(<6mm)
References	URL of Greater Chennai Corporation; Kurian <i>et al.</i> (2003)	URL of Greater Chennai Corporation; Kurian <i>et al.</i> (2003)	Joshi <i>et al.</i> , (2013); Kurian <i>et al.</i> (2003)	Maillacheruvu & Asolekar (2017)

of mined waste for producing compost in Autonagar, Hyderabad. The process involved mixing, spraying the bio-culture, turning, and aerating the waste. However, it is recognized that biological methods could be time taking as well as possibly not so efficient for application in the field considering the scale of the problem in India.

The aged dumpsites are believed to be the potential source of greenhouse gas emissions (GHG). In the study conducted for Ghazipur landfill area of Delhi (Ranjan *et al.*, 2014), it was estimated that the methane emission flux was 18 mg/m²/h (lowest in winter) and 264 mg/m²/h (highest in summer). The study recommends bio-mining of landfill gas from biodegradable fraction and processing of refuse-derived fuel (RDF) from polymeric waste and combustible waste fraction.

For an efficient landfill mining operation, the capital cost and the associated benefits should be estimated. Dubey *et al.* (2016) had presented an overview of the resource recovery potential from the dumpsites located in major metro cities as well as state capitals in India. Different factions of waste in the Indian cities were identified as biodegradables, combustibles, recyclables, and inerts. Dubey *et al.* (2016) reported that the dumpsites in cities

like Coimbatore (Vellalore), Delhi (Okhla), Lucknow (Moti Jheel and Barikalan Dubagga), Madurai (Vellaikkal) and Varanasi (Ramnagar Road) are more suitable for landfill mining operations as they are located strategically within the densely populated areas. Whereas, dumpsites in Asansol, Dehradun, Panjim, and Vadodara were claimed to be non-profitable sites for landfill mining as they are located on the outskirts of the respective cities, which makes the transportation cost on a higher side (Dubey *et al.*, 2016). However, this might change with time, as these areas become more populated, and the same operation might very well turn out to be beneficial and revenue generating. Landfill mining can help in reducing the carbon emissions and earning carbon credits, which could serve as environmental benefit (Annepu, 2012)

In all the studies conducted in the Indian context, it has been stated in many papers that landfill mining can be considered as a sustainable and innovative technology for the management of the humungous volume of legacy waste and recovery of land and resources from the old stockpile of wastes. It can be argued that engaging in a circular economy approach as compared to the linear 'take, make and dispose model, the landfill mining reveals its true potential by urban mining of end-of-Life products.

Landfill mining of legacy wastes has the prima-facie idea of resource recovery and mitigating unnecessary dependence on virgin resources from nature. However, there is a lack of any demonstrated project being undertaken at the national level. Also, there is lack of sufficient studies based on systematic sampling and analysis.

4. Proposed Technologies and Benefits from Utilization of Excavated Waste Fractions

Presently there are more than a thousand dumpsites - which have been causing a great environmental and health hazard. As reported by CPCB (2017), there are nearly 1300 dumpsites which have been officially identified for remediation. The continuous pressure from the Government is compelling the municipalities and the local bodies to address the various technological interventions - which can be potentially adopted to solve the problem of dumpsites and the hazards associated with them. Reclamation of dumpsites through landfill mining not only clears lands underneath but also presents the opportunities for subjecting various fractions to gainful utilization and thereby generates revenue (as shown in the **Figure 3**). Various benefits from landfill mining are listed below

a) Energy Recovery: As discussed in the previous section, the two major fractions obtained from the mining of the dumpsites are the inert fraction and the scrap polymeric and combustible fraction. The polymeric waste fraction obtained from the excavation of the old dumpsites can be utilized for energy recovery. One of the ways could be the shredding of the waste followed by the pelletization – the product is referred to as the “refuse-derived fuel.” Reportedly, RDF has the calorific value of 3100/ kcal/kg and moisture content less than 15% (Rana *et al.*, 2015) which can be further utilized by the intensive energy industries as a substitute of virgin fuel. The shredded polymeric waste can also be utilized in co-processing cement plants as an alternative fuel. Singh and Basak (2018) reported that one tonne of RDF could replace 560/ kg of coal considering the calorific value of RDF 12.9 GJ/tonne and coal 23 GJ/tonne. This can contribute potentially in the reduction of the GHGs. Another application could be the conversion of the polymeric waste into oil. However, the contamination of the excavated waste should be considered while arriving

at the best-suited treatment alternative for the excavated polymeric and combustible wastes.

b) Recycled Aggregates: There have been efforts worldwide to utilize the alternative construction materials as a substitute to traditional construction materials such as bricks, blocks, tiles, aggregates, ceramics, cement, lime, soil, timber and paint to minimize natural resource depletion (Pappu *et al.*, 2007). The inert fraction which constitutes the major fraction of the legacy waste consists of the C&D waste such as broken bricks, masonry, tiles, soil, etc. This fraction of waste could be beneficially recycled and used in the construction industry for the manufacturing of the so-called ‘green construction plant.’ It is important to note here that the bigger particles (size ≥ 20 mm) can be used as a substitute of the coarse aggregates while the one which is smaller in size (< 4.75 mm) can be used as a substitute of fine aggregates. There are several examples where wastes have been used to make construction products. This would not only help in getting rid of the huge stockpile of the aged old waste but also creates business avenues for the entrepreneurs.

Reportedly, the coarser material recovered from the excavation of the landfills such as broken bricks, tiles masonry, etc. can be used as “recycled aggregates” (RA). Evangelista and Brito (2007) evaluated the potential of fine recycled concrete aggregates to partially replace natural fine aggregate content in concrete works. It was observed that up to 30% replacement of natural aggregate with recycled. If recycled aggregates are accepted, then there is a huge re-use market for the aggregates derived from waste inert recovered from old dumpsites which can be potentially used in road construction, drainage, paver block manufacturing, fillers, and other construction projects.

The recycled aggregates and recycled concrete aggregates can be used in the sub-base layers of road construction, capping the landfills, filling the drains and land on which new construction is to be done.

c) Fine Fractions: It is observed that a large proportion of waste recovered from the old dumpsites is of fine fraction (< 10 mm). The fine fraction may account for

40-80 mass% of excavated material (Parodi *et al.*, 2018). The fine fraction typically composed of soil like materials derived from the decomposed organic matter or weathered mineral fraction. The main chemical compound of fine fractions is SiO_2 , mostly present as quartz and minor amounts of sheet silicates, followed by CaO and may also contain other impurities in the form of heavy metals. These fractions can be utilized as soil cover in landfill

operations. Also, as fillers and substitute of fine fraction in the construction activity.

- d) **Land Clearing:** Planning Commission Report on Waste to Energy (2014) speculated that, by 2031, the urban centers will generate 165 million tons of waste annually and by 2050 it could reach 436 million tons per year. According to Joshi and Ahmad (2016) “to accommodate this amount of waste generated by 2031,

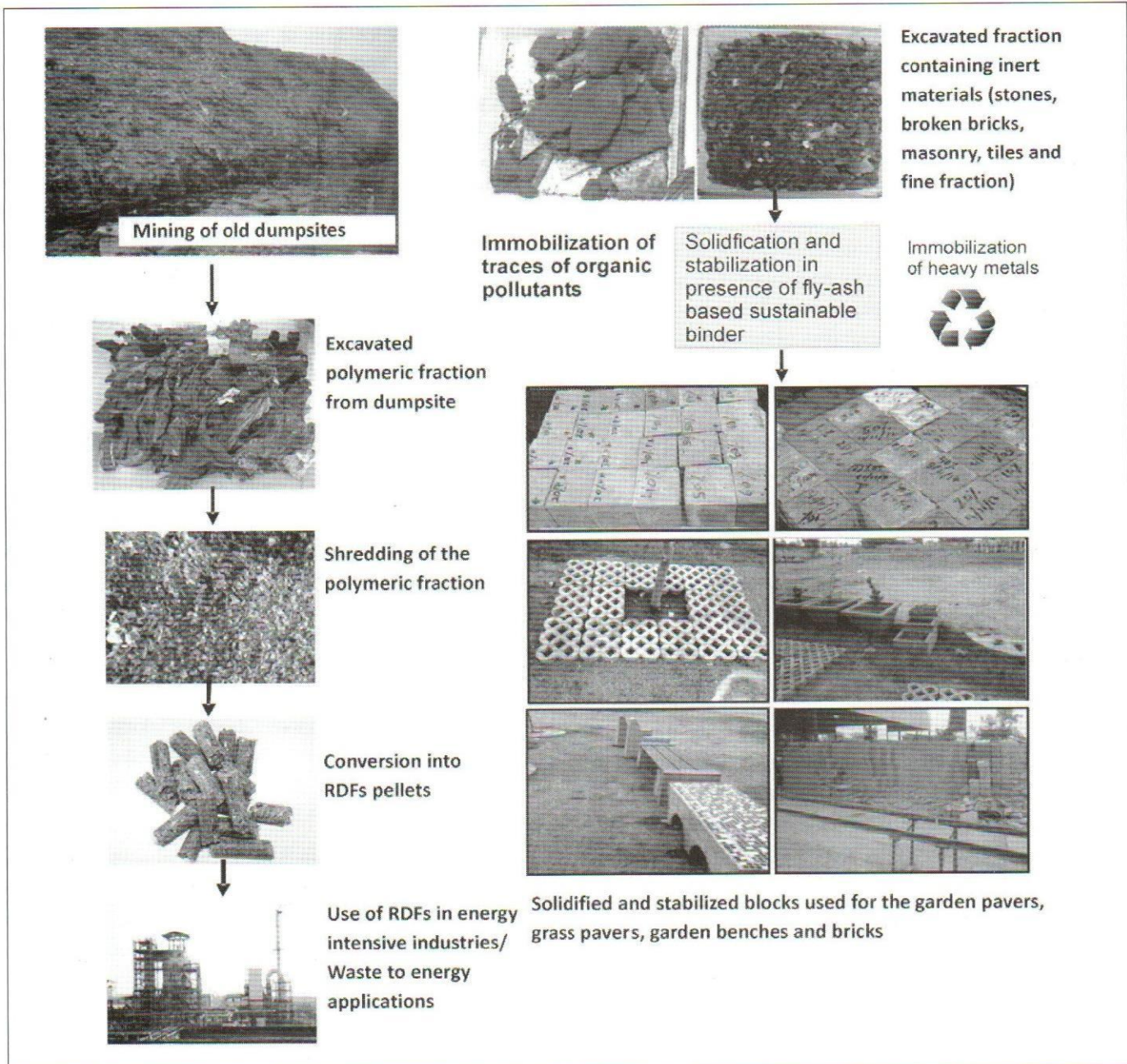


Fig. 3. Various fractions typically obtained after mining of a legacy waste dumpsite

about 235 million m³ of landfill space will be required every year, and in terms of the area, it would be 1,175 hectares of landfill footprint per year. The area required from 2031 to 2050 would be 43,000 hectares for landfills piled in 20-meter height". Therefore, it is argued by the authors that the most practical method of clearing land occupied by the prevailing legacy dumpsites would be to undertake systematic landfill mining operations in a phase-wise manner.

Clearly, the land footprint cleared after landfill mining would prove to be the most significant benefit in terms of monetary value of the land-resource in urban locations. Alternately, the free land could be used for constructing scientific landfill cells – that are equipped with composite liner system and leachate collection facility. Thus, for sustainable management of municipal solid wastes, the issue of abandoned municipal dumpsites needs to be addressed in a systematic manner.

5. Summary and Discussion

With accelerated urbanization and concurrent population growth, there has been a remarkable increase in generation rates of solid wastes in Indian cities. As a result, municipal corporations and urban local bodies are facing increased pressure of disposal of solid wastes due to environmental and health hazards posed by non-scientific management of these wastes. Recently, the Government of India has launched the *Swachh Bharat Abhiyan* – in which the urban local bodies are expected to manage their solid wastes in an environmentally sound manner. The Solid Waste Management Rules (2016) and *Swachh Bharat Abhiyan* have laid down the guiding principles for the proper management of solid waste in India. However, a major portion of un-segregated solid waste continues to be disposed of in dumpsites.

For efficient management of solid wastes, the end-of-life materials should be managed based on the so-called '9R framework' of the circular economy *namely*, refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover. It is evident from the '9R framework' that the actions leading to recycle and recover appear in the end of hierarchy of options. Clearly, efforts should be made to implement the first seven R.

This paper argues for integrating the circular economy approach with solid waste management strategies to generate value-added products and minimize

resource depletion. For example, polymeric wastes, paper, glass and metals should be segregated at source and subjected to a variety of gainful applications. The first seven R-based strategies must be explored before subjecting them to conventional recycling.

Having explored the strategies inspired by the '9 R framework', the remaining combustible fraction should be subjected to waste to energy technology – because the thermal processes assume the lowest position in thermodynamic hierarchy. Clearly, not even a small fragment of polymeric waste should be disposed of in landfill. It would be best to subject the remaining polymeric wastes to pyrolysis to obtain gaseous and liquid fuels after exploring the '9 R framework'.

Finally, it is recommended that the circular economy approach has to be integrated with the waste management policies in India to minimize the burdens on environment and support environmentally defensible consumption of resources and strengthen the economy. Thus, Material Recovery Facilities (MRF) should be installed at the solid waste management facilities. Appropriate technologies and management system should be based on the population size, economic activity and the land use in and around the given urban settlements.

It is interesting to note that all these efforts alone cannot solve the problem of waste management in India. It has to be understood that the problem of dumpsites and the management of aged wastes or legacy wastes has to be addressed along with the fresh solid wastes. It has been recognized that the hazard caused by the open dumpsite in India can be brought under control only by adopting appropriate strategies for management of legacy waste. This can be achieved by processing the waste so that various fractions obtained after excavation can be gainfully utilized. However, so far, the management of the legacy waste buried in the old dumpsites has not been incorporated in the integrated solid waste management strategies. There exists a knowledge gap in understanding the characteristics and composition of the so-called legacy waste, which is essential for decision-makers to choose the best available technology for the treatment of the legacy waste.

Reportedly, few studies conducted on the dumpsites in Chennai, Mumbai and Ahmedabad revealed the presence of polymeric and combustible materials as well as inert material consisting of C&D waste (broken bricks, tiles, masonry, etc), street sweepings, soil cover, and

decomposed organic waste. It is suggested that the polymeric and combustible material could be potentially utilized for waste to energy applications. On the other hand, the inert material can be used for alternative construction material typically referred to as “green construction materials”.

The coarser materials such as stones, gravels, and broken bricks could be used for the manufacturing of recycled aggregates – a substitute for the natural aggregate. While, the fine fraction (soil or sand like material) could be used as a filler material and in the manufacturing of paver blocks in the construction industry. This will not only help in getting rid of the huge stockpiles of the waste but also minimize the use of virgin raw material.

Clearly, there is a great potential to recover land and materials from legacy waste dumpsites. The main benefits of the reclamation are the minimization of the risk of pollution from substandard or un-engineered landfills or dumpsites, reclaiming the soil, extending the life of the landfill facility and creating a sustainable business model through value-added products manufactured from the excavated legacy wastes.

References

- Andersen, M.S.** (2007). An introductory note on the environmental economics of the circular economy. *Sustainability Science*, 2(1), pp.133-140.
- Asolekar, S.R. and Gopichandran, R.** (2005). Preventive Environmental Management - An Indian Perspective, Foundation Books Pvt. Ltd., New Delhi, India.
- Canopoli, L., Fidalgo, B., Coulon, F. and Wagland, S.T.** (2018). Physico-chemical properties of excavated plastic from landfill mining and current recycling routes. *Waste Management*, 76, pp.55-67.
- CPCB.** (2017). Consolidated annual report on implementation of solid wastes management rules, 2016, Central Pollution Control Board, Ministry of Environmental, Forest & Climate Change, Parivesh Bhavan, Delhi.
- Dubey, A., Chakrabarti, M. and Pandit, D.** (2016). Landfill mining as a remediation technique for open dumpsites in India. *Procedia Environmental Sciences*, 35, pp.319-327.
- Esakku, S., Selvam, A., Joseph, K. and Palanivelu, K.** (2005). Assessment of heavy metal species in decomposed municipal solid waste. *Chemical Speciation and Bioavailability*, 17(3), pp.95-102.
- Evangelista, L. and De Brito, J.** (2007). Mechanical behaviour of concrete made with fine recycled concrete aggregates. *Cement and concrete composites*, 29 (5), pp.397-401.
- FICCI.** (2009). Survey on the current status of municipal solid waste management in Indian cities and the potential of landfill gas to energy projects in India, Federation of Indian Chambers of Commerce and Industry (FICCI), New Delhi.
- Flyhammar, P.** (1997). Estimation of heavy metal transformations in municipal solid waste. *Science of the total environment*, 198(2), pp.123-133.
- He, P., Chen, L., Shao, L., Zhang, H. and Lü, F.** (2019). Municipal solid waste (MSW) landfill: A source of microplastics?- Evidence of microplastics in landfill leachate. *Water Research*, 1, pp.38-45.
- Hogland, W., Marques, M. and Nimmermark, S.** (2004). Landfill mining and waste characterization: a strategy for remediation of contaminated areas. *Journal of Material Cycles and Waste Management*, 6(2), pp.119-124.
- Homrich, A.S., Galvão, G., Abadia, L.G., Carvalho, M.M.** (2018). The circular economy umbrella: trends and gaps on integrating pathways. *Journal of Cleaner Production*, 175, pp.525-543.
- Kurian, J., Esakku, S., Palanivelu, K. and Selvam, A.** (2003). Studies on landfill mining at solid waste dumpsites in India. In Proceedings Sardinia, Ninth International Waste Management and Landfill Symposium, 6 – 10 October, 3, pp.248-255.
- Joshi, M.P., Patil, S.B. and Mourya, K.** (2013). Solid waste management on dumping ground in Mumbai region – A study. *International Journal of Computer Applications*, 975, p.8887.
- Joshi, R. and Ahmed, S.** (2016). Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science*, 2(1), pp.1-18.
- Kirchherr, J., Reike, D. and Hekkert, M.** (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, pp.221-232.
- Korhonen, J., Nuur, C., Feldmann, A. and Birkie, S.E.** (2018). Circular economy as an essentially contested concept. *Journal of Cleaner Production*, 175, pp.544-552.
- Krook, J., Svensson, N. and Eklund, M.** (2012). Landfill mining: A critical review of two decades of research. *Waste management*, 32(3), pp.513-520.
- Lacoste, E. and Chalmin, P.** (2007). From Waste to Resource: 2006. World Waste Survey. From waste to resource in the: Economica Editions – 49, rue Héricart, 75015 Paris, France.
- Maillacheruvu, K.Y. and Asolekar, S.R.** (2017). Effective Management of Aged Stockpiled Solid Wastes in India. In *Geo-environmental Practices and Sustainability*, Springer, Singapore, pp.107-115.
- McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., Kemp, R. and Doménech, T.** (2017). Circular economy policies in China and Europe. *Journal of Industrial Ecology*, 21(3), pp.651-661.
- Millar, N., McLaughlin, E. and Börger, T.** (2019). The Circular Economy: Swings and Roundabouts?. *Ecological Economics*, 158, pp.11-19.

- Moraga, G., Huysveld, S., Mathieux, F., Blengini, G.A., Alaerts, L., Van Acker, K., de Meester, S. & Dewulf, J.** (2019). Circular economy indicators: What do they measure?. *Resources, Conservation and Recycling*, 146, pp.452-461.
- Nagendran, R., Selvam, A., Joseph, K. and Chiemchaisri, C.** (2006). Phytoremediation and rehabilitation of municipal solid waste landfills and dumpsites: A brief review. *Waste Management*, 26(12), pp.1357-1369.
- Pappu, A., Saxena, M. and Asolekar, S.R.** (2007). Solid wastes generation in India and their recycling potential in building materials. *Building and environment*, 42(6), pp.2311-2320.
- Parrodi, J.C.H., Vollprecht, D., Pomberger, R.** (2018). Fine fractions from landfill mining: Potential and main challenges to overcome. In 4th International Symposium on Enhanced Landfill Mining, 4 - 6 February, 2018, Mechelen, Belgium.
- Peng, Y.** (2017). Perspectives on technology for landfill leachate treatment. *Arabian Journal of Chemistry*, 10, pp.S2567-S2574.
- Potting, J., Hekkert, M.P., Worrell, E. and Hanemaaijer, A.** (2017). Circular economy: measuring innovation in the product chain (No. 2544). PBL Publishers, The Hague, the Netherlands.
- Quaghebeur, M., Laenen, B., Geysen, D., Nielsen, P., Pontikes, Y., Van Gerven, T. and Spooren, J.** (2013). Characterization of landfilled materials: screening of the enhanced landfill mining potential. *Journal of Cleaner Production*, 55, pp.72-83.
- Raghab, S.M., El Meguid, A.M.A. and Hegazi, H.A.** (2013). Treatment of leachate from municipal solid waste landfill. *HBRC Journal*, 9(2), pp.187-192.
- Rana, R., Ganguly, R. and Gupta, A.K.** (2015). An assessment of solid waste management system in Chandigarh city, India. *Electronic Journal of Geotechnical Engineering*, 20, pp.1547-1572.
- Ranjan, M.R., Ramanathan, A.L., Tripathi, A. and Jha, P.K.** (2014). Landfill mining: a case study from Ghazipur landfill area of Delhi. *International Journal of Environmental Sciences*, 4(5), pp.919.
- Razza, F., D'Avino, L., L'Abate, G. and Lazzeri, L.** (2018). The role of compost in bio-waste management and circular economy. In *Designing Sustainable Technologies, Products and Policies* Springer, pp.133-143
- Renou, S., Givaudan, J.G., Poulain, S., Dirassouyan, F. and Moulin, P.** (2008). Landfill leachate treatment: review and opportunity. *Journal of Hazardous Materials*, 150(3), pp.468-493.
- Report of the Task Force on Waste to Energy.** (2014). Planning Commission, New Delhi. Available at < http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf>.
- Rodic, L. and Gupta, S.K.** (2012). Closure and rehabilitation of waste dumpsites in Indian megacities Delhi and Mumbai. In *ISWA World Solid Waste Congress 2012*, 17-19 Sept. 2012, Florence, Italy.
- Scheu Manfred and Bhattacharyya.** (1997). Reuse of Decomposed Waste, In: Coad, Adrian (Ed). *Lessons from India in Solid Waste Management*. Department of International Development, UK Government.
- Schroeder, P., Anggraeni, K. and Weber, U.** (2019). The relevance of circular economy practices to the sustainable development goals. *Journal of Industrial Ecology*, 23(1), pp.77-95.
- Sharholly, M., Ahmad, K., Mahmood, G. and Trivedi, R.C.** (2008). Municipal solid waste management in Indian cities - A review. *Waste management*, 28(2), pp.459-467.
- Simon, F.G. and Müller, W.W.** (2004). Standard and alternative landfill capping design in Germany. *Environmental Science & Policy*, 7(4), pp.277-290.
- Singh, A. and Basak, P.** (2018). Economic and environmental evaluation of municipal solid waste management system using industrial ecology approach: Evidence from India. *Journal of Cleaner Production*, 195, pp.10-20.
- Swati, Ghosh, P. and Thakur, I.S.** (2017). An integrated approach to study the risk from landfill soil of Delhi: Chemical analyses, in vitro assays and human risk assessment. *Ecotoxicology and environmental safety*, 143, pp.120-128.
- Vaccari, M., Vinti, G. and Tudor, T.** (2018). An analysis of the risk posed by leachate from dumpsites in developing countries. *Environments*, 5(9), p.99.
- Winterstetter, A., Wille, E., Nagels, P. and Fellner, J.** (2018). Decision making guidelines for mining historic landfill sites in Flanders. *Waste Management*, 77, pp.225-237.
- Xiaoli, C., Shimaoka, T., Xianyan, C., Qiang, G. and Youcai, Z.** (2007). Characteristics and mobility of heavy metals in an MSW landfill: Implications in risk assessment and reclamation. *Journal of Hazardous Materials*, 144(1-2), pp.485-491.

Web References:

- Banerjee, P., 9 February**, 2016. Gone to Waste: How India is drowning in garbage. In *Hindustan Times*, <http://www.hindustantimes.com/india/india-s-cities-are-faced-with-a-severe-waste-management-crisis/story-vk1Qs9PJT8I1bPLCJKsOTP.html> Accessed on 22nd May, 2019.
- Sambyal, S.S. and Agarwal, R., 18 October**, 2018. Is Swachh Bharat Mission ensuring waste segregation systems?

In Down To Earth, <https://www.downtoearth.org.in/blog/waste/is-swachh-bharat-mission-ensuring-waste-segregation-systems—61885> Accessed on 22nd May, 2019.

Bhattacharya, S. and Yadav, P., 2 September, 2017. Two killed as 50 tonnes of waste hurtles down Ghazipur landfill. In Times of India, <https://timesofindia.indiatimes.com/city/delhi/two-killed-as-50-tonnes-of-waste-hurtles-down-ghazipur-landfill/articleshow/60332295.cms> Accessed on 28th May, 2019.

Pinto, R., 27 March, 2018. Fire breaks out at Mumbai's Deonar dump, spreads and rages on. In Times of India, <https://timesofindia.indiatimes.com/city/mumbai/fire-breaks-out-at-deonar-dump-spreads-rages-on/articleshow/63472468.cms> Accessed on 28th May, 2019.

Greater Chennai Corporation, Solid Waste Management <http://www.chennaicorporation.gov.in/departments/solid-waste-management/index.htm> Accessed on 22nd May, 2019.

Central Pollution Control Board, Solid waste management Rules, 2016 <http://cpcb.nic.in/displaypdf.php?id=aHdtZC9TV01fMjAxNi5wZGY> Accessed on 29th May, 2019.

“We are recycling not only to protect the environment, but for economic reasons as well. Disposal is simply too costly and too dangerous. The challenge is to redirect the flow of raw materials going to landfill into strengthening our declining local economies. The solution to pollution is self-reliant cities and counties..”

– Neil Seldman

Conversion of Marble Waste into a Value Added Composite Materials for Civil Infrastructure

ASOKAN PAPPU, RANJAN CHATURVEDI, PRASHANT TYAGI, ANAM KHAN, RAVI PATIDAR AND EDWARD PETERS

During marble processing, cutting and polishing, more than 12 MT (million tons) of marble waste per year has been produced only in the state of Rajasthan, India. Safe disposal of such huge quantity of marble wastes become a major environmental issue. In the present study, attempt have been made to recycle marble waste collected from Makrana marble processing industries, Rajasthan, as raw materials, for making composite materials. Characterisation studies showed that the major mineral present in marble waste are Calcite (CaCO_3), Dolomite ($\text{CaMg}(\text{CO}_3)_2$) and Quartz (SiO_2). Composite materials were made using marble waste reinforced with jute textile fibres in epoxy resin system.

The findings of the study showed that marble waste composites reinforced with jute textile have resulted about 50% higher flexural strength (48.48 MPa) than the commercially available MDF (medium density fibre) board (24.23 MPa). It also showed very low water absorption (24 hour immersion) and thickness swelling. The microstructure of fractured surface of marble waste composite showed very good bonding between the marble waste, fibre and the matrix.

The composite materials have multifunctional applications in civil construction sector, transport system as doors, false ceilings, architectural wall panels, partition and furniture etc. The marble waste composite materials are stronger than teak wood and other traditional materials such as medium density board, particle board, and rice husk board. Commercial realisation of this composite technology would significantly contribute to Nation program on clean India, make in India and advanced manufacturing missions. Efforts are being made to ease the commercialisation of this technology.

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INTRODUCTION

Inorganic waste generated during different industrial processes in abundance is of greater concern due to depletion of natural resources, environment degradation and global warming. About 16 MT of marble waste has been generated annually in India and improper management of industrial waste led to environmental contamination at a great extent (Pappu and Thakur, 2017). Innovative research on solid waste management results in newer technologies and create opportunities to use solid wastes a raw materials for the making an alternative construction materials and substitute to traditional materials such as bricks, tiles, aggregates, ceramics, cement, and timber (Asokan *et al.*, 2007).

Marble powder also known as calcite tailing is a residual material resulting from the cutting and polishing of marble stone. In the recent years marble industries in many countries reached a new level of popularity and thus volume of marble waste powder and scrap produced has been increasing manifold annually. On the other hand use of natural fibres have been encouraged in composite industry to replace synthetic fibres such as glass fibre due to low cost and abundant availability and environmental friendly nature (Bajpai *et al.*, 2012; Pappu *et al.*, 2015; Singh and Palsule, 2014).

Usage of traditional synthetic fibres are now getting limited to few applications because of their hazardous nature and environmental point of view (Pappu *et al.*, 2016). Marble waste has been used for many applications such as geotechnical, building materials, environmental applications like chemical adjuvant for acid mine (Barros *et al.*, 2009) and soil amendment to neutralize the acidic soil (Tozsin *et al.*, 2014a), soil treatment which in turn improved the yield of the hazelnut field (Tozsin *et al.*, 2014b).

Marble stone slurry waste and large marble stone waste has been utilised primary aggregate in concrete (André *et al.*, 2014) also marble sludge powder waste as a substitutes for natural sand in concrete (Hameed and Sekar, 2009). Marble waste has also been used to replace part cement, with an increase in compressive strength (Singh *et al.*, 2015), as an additive in composite cement production (Aruntaş *et al.*, 2010). In another research the waste pieces of marble was used as crushed stone instead of limestone in self-consolidating concrete (SCC) (Uygunoglu *et al.*, 2014).

Marble waste has been used to produce composite products, using different type of matrix and filler amount (Borsellino *et al.*, 2009). The marble waste was processed and mixed in polymer matrix without any fibre reinforcements to make composite as artificial stones (Gomes Ribeiro *et al.*, 2017). Artificial stones were made with density closed to marble and some properties better than the marble (Souza *et al.*, 2017). Marble was used with fibre reinforcement to make hybrid composites with about 31% better flexural strength (Borazan and Gokdai, 2017). Review of the work done showed that considerable work has been done for marble waste utilisation, especially in Italy, Turkey and Brazil.

Little work has been done on use of marble waste for making polymer matrix composite under compression moulding, vacuum bagging, and vacuum vibro compression for the high density composites (Souza *et al.*, 2017). Recycled PET and marble waste was used to make composite using extrusion system followed by injection moulding, which showed good mechanical properties (Çinar and Kar, 2018). Micro marble particles along with glass fibre were used to make composite tiles using recycled PET as the binder matrix (Icduygu *et al.*, 2012). Mechanical property of composite with high marble waste contents (60% - 80%) and with different polymer system (Epoxy / PE) was evaluated and it was found that composites with PE and marble waste showed better flexural property than composites with epoxy and marble waste (Borsellino *et al.*, 2009).

Marble waste production has also increased in India in recent years mainly in Rajasthan (Department of Industries, 2015). Many hectares of land have been occupied for disposal and storage of waste marble slurry which now became a serious environmental problem in this state. There is considerable scope for developing environment friendly and cost effective materials using solid wastes for civil construction applications (Pappu *et al.*,

2007). One of the study showed that granite and marble waste was mixed with epoxy resin with glass fibre to make high performance composite (Rout and Satapathy, 2015). In another study Rajasthan marble waste along with jute fibre mat and epoxy resin was used to make composites with varying filler contents (Sharma and Patnaik, 2018).

Coal combustion residue were already being used for various applications such as bricks, concrete, and wood substitute materials (Asokan *et al.*, 2005), similarly marble waste has also potential to utilize as a potential raw materials in these areas of research. Earlier study showed that the use of marble slurry waste along with natural jute fibre in making polyester resin composites (Saxena *et al.*, 2010). The Taj Mahal is known to be one of the world seven wonders, which was constructed using white marble obtained from Makrana, Rajasthan, India. The Present study deals with the use of marble waste collected from marble slurry dumping sites in Makrana, Rajasthan and to produce a new class of composite materials and create new opportunities for entrepreneurship development.

Materials and methods

Materials

The marble waste used in the present study was collected from major marble waste slurry dumping sites, located in Makrana, Rajasthan, India. The commercially available jute textile fibre, was used in this study as a reinforcement materials in composite. Epoxy resin (Lapox B-11) having epoxy value 5.25 – 5.45 and specific gravity 1.16 was used. Hardener (K-48) in combination with epoxy having pot life 20 minutes, used as a matrix material in composites sample preparation.

Sample preparation

The marble waste underwent many treatments like grinding, drying in oven at 70 degree C for 72 hrs. The Epoxy and Hardener was used at the ratio of 1:0.10 for the preparation of composites and different specimens were casted using natural fibre i.e. jute textile with addition of treated marble waste of varying percentage, under compression moulding system at 120 ± 5 degree C at a pressure 5 PSI for 10 min and were cured at 36 ± 2 degree C for 8 h.

Testing

Various tests were conducted on marble waste for the determination of its properties, X-ray diffraction was done using RigakuMiniflex-II desktop X-ray Diffractometer. Thermogravimetric analysis was done using Metler Toledo

TGA/DSC-1 star system. For determination of conductivity and pH of the marble waste LABMAN Conductivity meter LMCM-20 and LABMAN pH meter 5 point calibration LMPH-12 was used respectively. For particle size analysis Horiba LA95052 particle size distribution analyser was used. Various tests were also conducted on the prepared composites for the determination of the mechanical and physical property. For the evaluation of tensile properties, samples were prepared according to the ASTM D638 – 14 and the test was conducted on Instron 8800 UTM. For the determination of the flexural properties of the composites the three point bend samples were prepared according to the ASTM D790 – 17 and test was done on Lloyd Instrument LRX Plus UTM. The breaking force and extension at maximum load of the fabric used in this study was calculated according to ASTM 5053-11 using Lloyd Instrument LRX Plus UTM. The 24 hour water absorption test of the polymer composites was determined in accordance with the ASTM D 570 - 8 and the thickness swelling was

also calculated from rectangular strips immersed in water for 24 hrs at the room temperature.

Results and Discussion

Characterisation of marble waste

X-Ray Diffraction

Figure 1a shows XRD pattern of the marble waste collected from Makrana district of Rajasthan, it was observed that marble waste has three major minerals namely Calcite (CaCO_3), Dolomite ($\text{CaMg}(\text{CO}_3)_2$) and Quartz (SiO_2). Based on their relative intensity, it was confirmed that dolomite concentration in this sample is slightly high as compared to calcite and quartz. However, no peak corresponds to actinolite phase. The mineralogical studies of marble waste sample showed dolomite as major mineral which might be reason for higher bulk density as compared to the published work by (Rajgor *et al.*, 2013).

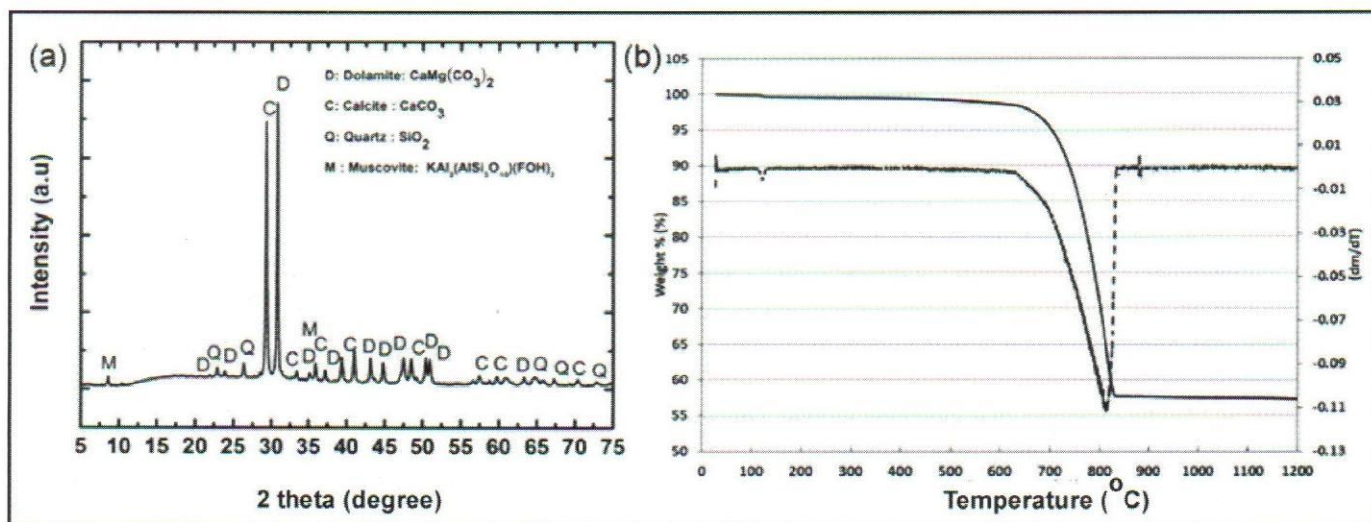


Fig. 1. TGA analysis and XRD analysis of Makrana marble sample

Thermogravimetric Analysis

From the obtained TGA data illustrated in figure 1b, showed similar thermal profile as that of a typical pure marble.

The samples underwent a high decomposition, reaching approximately 42%. A smooth and steady decomposition was observed with a single distinct peak and well defined deflection point.

Physical Properties

The bulk density of the samples was 1.49 g/cc. specific gravity is 2.59 of the collected marble waste. 43.52 was

the obtained experimental Porosity of the collected samples. Mean particle size of the marble waste was 65.8 μm with D_{10} and D_{90} values 29.56 μm and 101.53 μm respectively. Electrical conductivity was 0.30 mS/cm and pH of the marble waste was 7.83 which indicates the equal concentration of hydroxide and hydrogen ions in the sample. The work carried out by (Arunta⁹ *et al.*, 2010) showed almost similar value of specific gravity (2.60) while (Ercikdi *et al.*, 2015) showed slightly higher value of specific gravity (2.62-2.72). Work done by (Fernández-Caliani and Barba-Brioso, 2010) showed highly alkaline pH which indicates that the sample was fresh and less exposed to

environment or contaminated. Research done by (Moreno-Barriga *et al.*, 2017) showed electrical conductivity of 2.20 mS/cm which is higher than present work. The value of electrical conductivity is directly proportional to the concentration of anions or cations in the sample.

FTIR analysis

The FTIR spectrum of marble waste collected from Makrana is presented in figure 2.

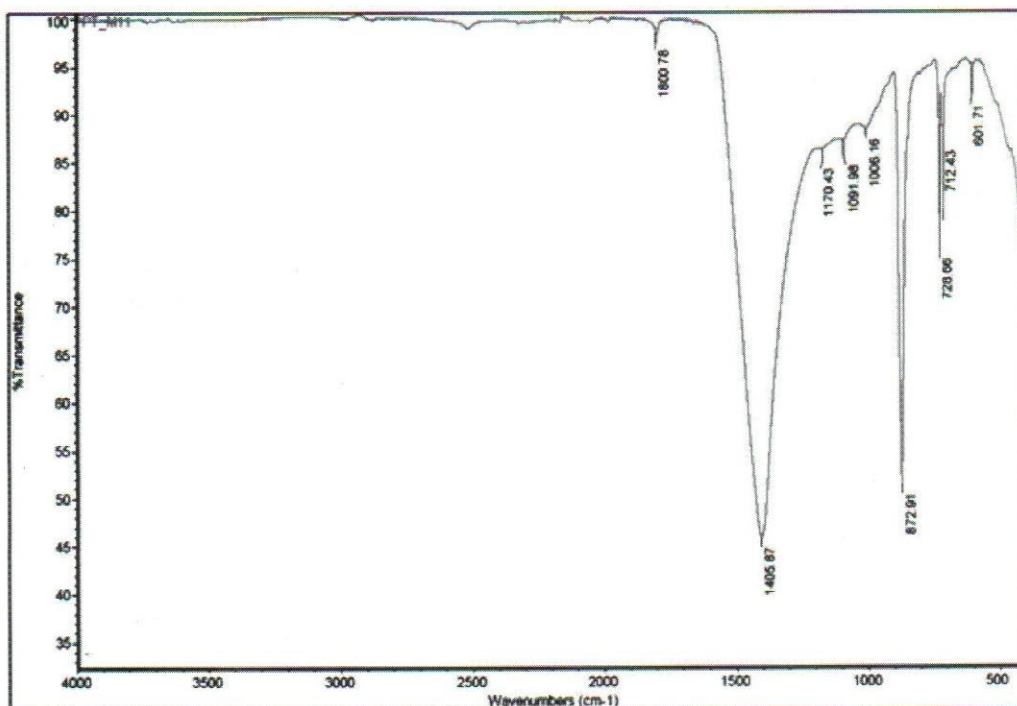


Fig. 2. FT-IR spectra of the marble waste

It was observed that absorption bands of Calcite mineral dominate the spectrum as reported in other works (Toschi *et al.*, 2013) (Şahbaz and Acikgoz, 2017). The absorption band at 1092 cm⁻¹ can be attributed to symmetric stretching of carbonate group. The sharp bands at 873 cm⁻¹ and 712 cm⁻¹ arose due to out-of-plane bending and in-plane bending respectively. The strong and large band observed at 1406 is due to asymmetric stretching of carbonate. A small band observation detected at 1801 cm⁻¹ can be further attributed to a combination of both symmetric stretching and in-plane bending.

Characterisation of marble waste composites:

Tensile properties

Composites made with jute textile fibre (EPC-J) have showed a tensile strength of 20.59 ± 1.56 MPa with the maximum strain of 0.78 % (Figure 3). The tensile modulus was 4.42 ± 0.61 GPa which is lower than the composite with marble waste. The composite made of marble waste

alone has showed a tensile strength of 12.85 ± 2.36 MPa and tensile modulus 6.27 ± 1.06 GPa which is more than any other cases of composites (Figure 4). The maximum strain achieved was 0.43%. Further, breaking strength and elongation at break of the jute textile fabric was 213.03 N and 4.00 mm respectively (Table 1).

Flexural properties

The 3 point bend test conducted on the composite specimen with jute, marble waste and epoxy resin showed the flexural strength of 48.48 ± 3.66 MPa which is similar to the composite with only marble waste (Figure 5). Flexural modulus was 6.31 ± 0.21 GPa and maximum strain was 1.38 %. Composite with only marble waste and epoxy showed a flexural strength of 48.05 ± 1.19 MPa and the flexural modulus of 7.12 ± 0.43 GPa, the strain was only 0.8% (Figure 6). Earlier researches have showed a Flexural strength of 22.2 MPa using marble waste content (Borsellino *et al.*, 2009).

TABLE 1. Breaking strength and elongation of the textile fibres

Textile Fibres	Sample ID	Maximum Load (N)	Extension at Max. Load (mm)	Weight (GSM)
Jute	J1	249.83	3.53	241.9
	J1	187.53	4.40	250.1
	J3	201.72	4.07	242.1
	Mean	213.03	4.00	244.7
	SD	32.65	0.44	4.7

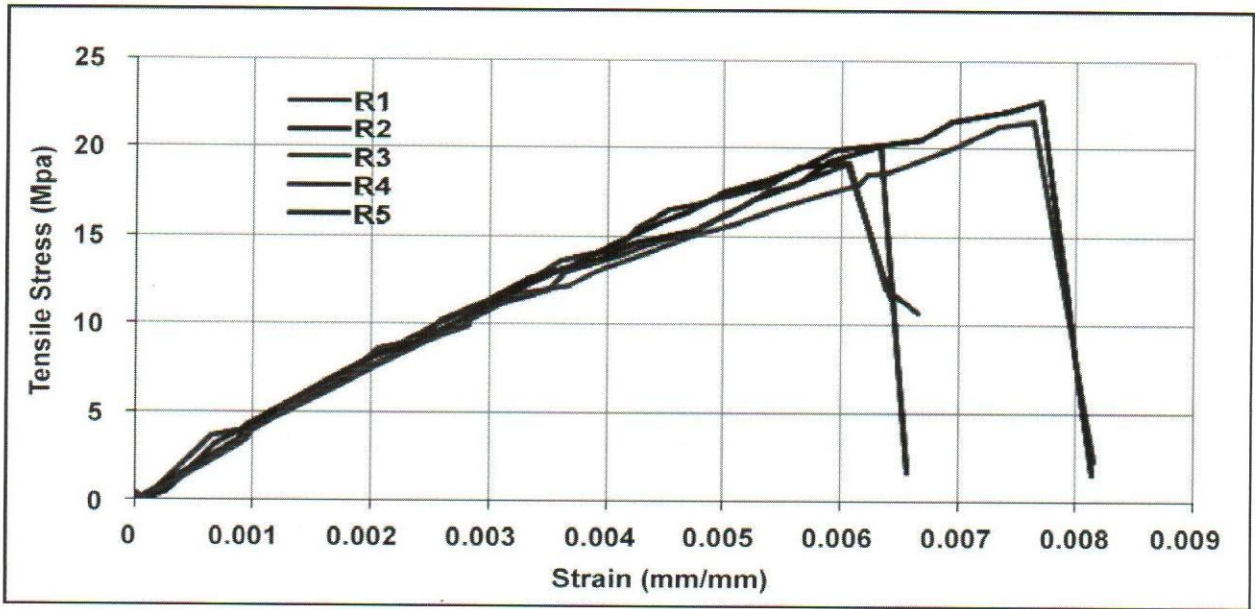


Fig. 3. Tensile test results of the EPC – J composite sample

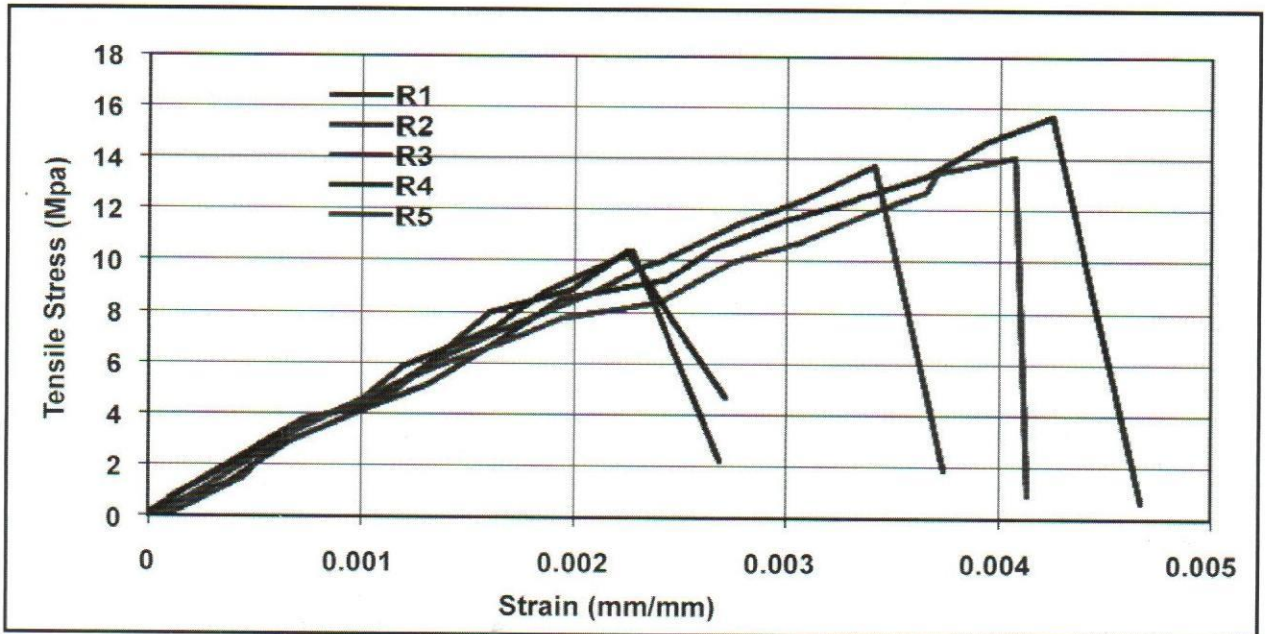


Fig. 4. Tensile test results of the EPC – MW composite sample

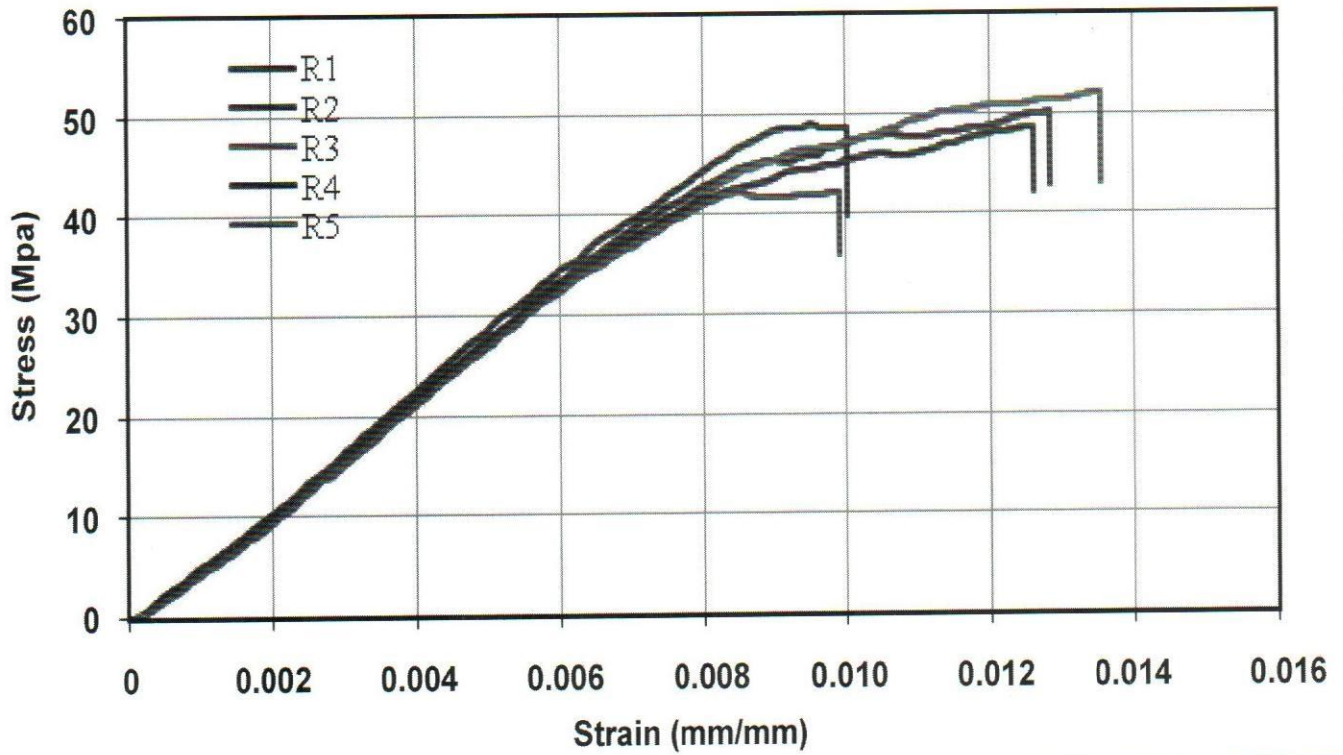


Fig. 5. Three point bending test results of the EPC - J composite sample

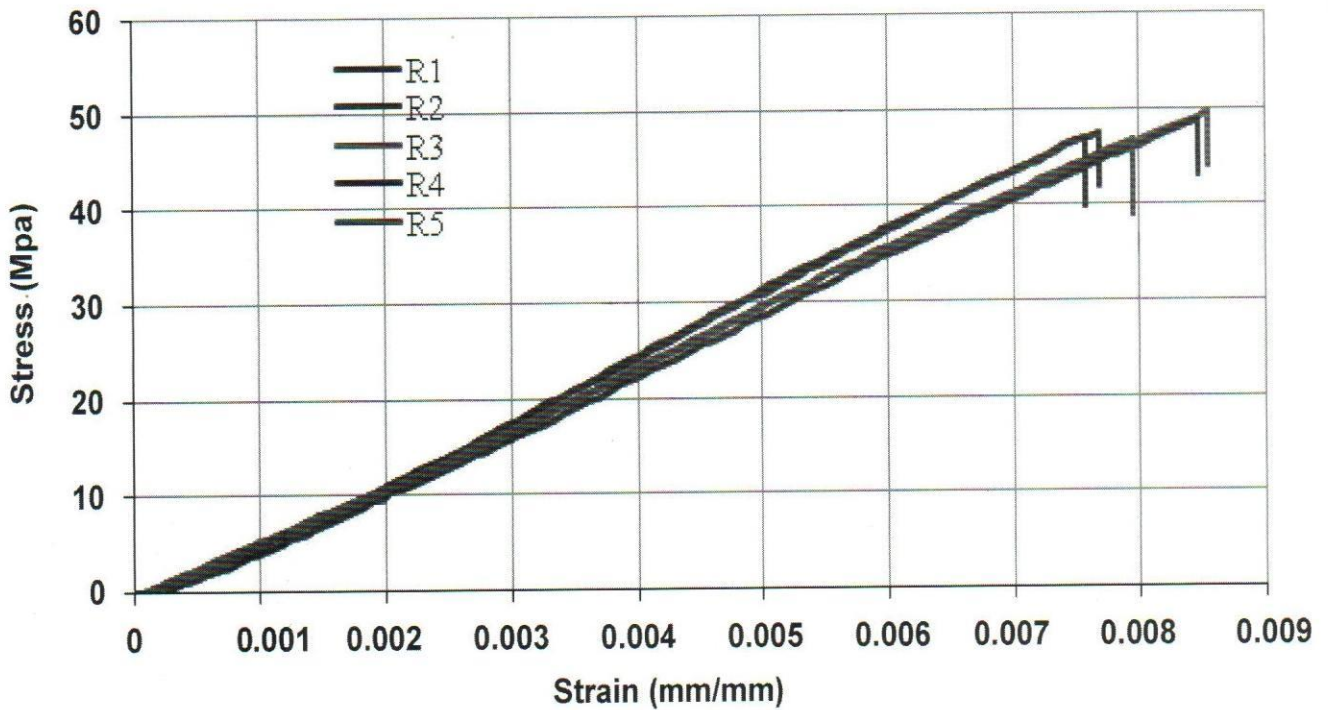


Fig. 6. Three point bending test results of the EPC - MW composite sample

TABLE 2. Comparison of mechanical and physical properties of different materials

S. No.	Material	T S (MPa)	TM (GPa)	F S (MPa)	FM (GPa)	W A (%)	Th S (%)	Density (g/cm ³)
1	EPC-MW	12.85	6.27	48.05	7.12	0.09	2.02	1.565
2	EPC-Jute	20.59	4.42	48.48	6.31	0.56	0.00	1.557
3	Teak	57.47	6.73	65.99	6.53	48.02	-	0.521
4	MDF*	13.33	2.84	24.23	2.23	87.74	18.42	0.694
5	PB*	20.80	2.08	16.15	1.95	43.37	30.39	0.652
6	Ply*	54.02	4.29	57.19	3.78	62.87	9.96	0.525
7	Tipwood®	80.00	-	70.00	6.00	1.20	-	1.150
8	MDF Grade -I ^a	-	2.8	28	-	30	4	0.6-0.9
9	HD PB BWR Grade ^b	34.32	-	44.13	-	10	-	0.9-1.2
10	Plywood BWR Grade ^c	-	4.5	36	-	-	-	-

TS: Tensile Strength; **TM:** Tensile Modulus; **FS:** Flexural Strength; **FM:** Flexural Modulus; **IS:** Impact Strength; **WA:** Water Absorption; **Th.S:** Thickness Swelling; **ρ:** Density

All the hybrid green composite materials showed better flexural and tensile modulus value than the convention wood products like MDF, PB and Ply wood.

Water absorption and thickness swelling

The density of the composites is more than 1.5 g/cm³ while the other conventional wood product showed the

density of 0.52 – 0.69 g/cm³ Table 2. The increase in the density of the composites is due to the high bulk density value of marble waste which is 1.8 g/cm³. However, density of composites and other mechanical properties can be customised using different sandwich materials to meet the customer requirement and as per the specific applications and more details have been reported

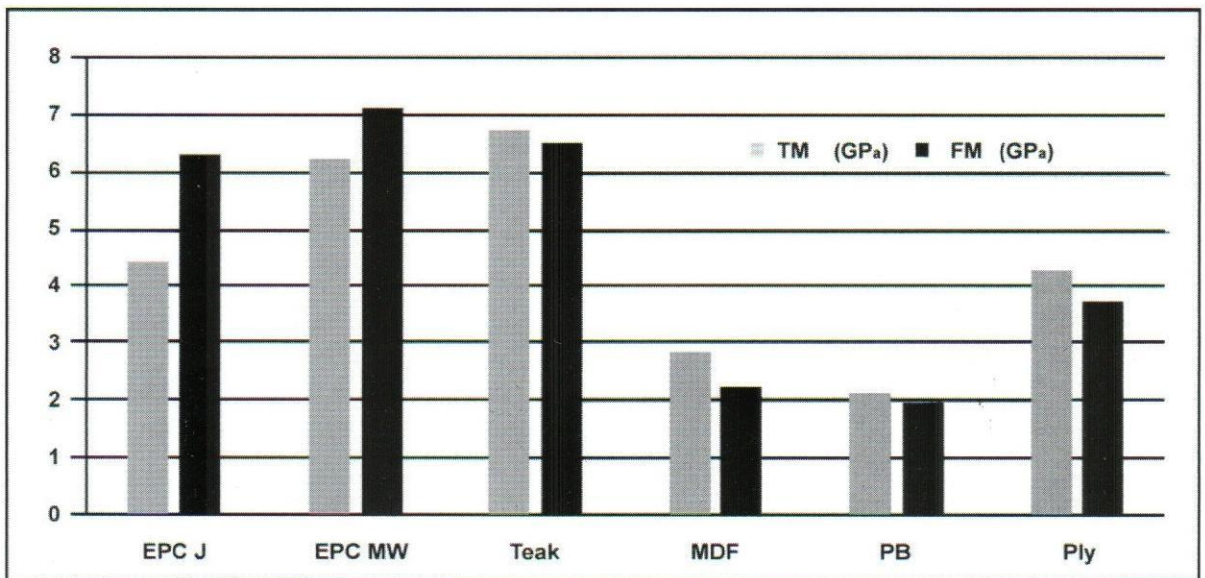


Fig. 7. Comparison of tensile modulus and flexural modulus of the composite samples with commercial products

elsewhere (Asokan Pappu *et al.* 2019). The water absorption of composites was higher with the jute fabric and glass fabric, may be because of the porosity. The present study revealed that there is negligible thickness swelling in the composite which indicates, there would not be any swelling or shrinkage in the material which are considered as important parameter to be used in possible applications in door and panel products. No such studies have been reported so far by other researchers except, work reported by Borsellino *et al.*, 2009.

FTIR analysis

The FT-IR spectra of the epoxy composites are presented in the figure 7. Since ATR technique characterize only the surface, it is not possible to identify band appearing due to Jute fibres embedded within layers. Nevertheless, following bands can be assigned that are common in all spectra (Nikolic *et al.*, 2010)(CAÑAVATE *et al.*, 2000). 3320-2270 cm^{-1} represents O-H stretching. 3062-3036 cm^{-1} represents stretching of C-H of oxirane ring. 2961-2865 cm^{-1} bands represent stretching of C-H and CH aromatic and aliphatic. 1717 cm^{-1} band represents stretching in C=O bond. 1606-1581 cm^{-1} is the stretching in C=C aromatic ring from epoxy. 1507 cm^{-1} is the stretching in C-C of aromatic ring from epoxy. 1032-1104 cm^{-1} represents the stretching in C-O-C of ethers. 873 cm^{-1} represents out of plane bending of carbonate group from marble 826 cm^{-1} represent the stretching C-O-C of oxirane group. 768 cm^{-1} represent rocking CH_2 group.

SEM Micrographs

The FESEM of the composite samples was done. The proper bonding between the fibres and the matrix along with the marble waste particles were observed (Figure 8a). The results showed that the bonding of marble particle and the fibre covered in polymer matrix. It is shows that good adhesion between the filler particles and the reinforcement fibres. There is not much gap between the fibre and matrix was observed in figure 8b.

Opportunities for marble waste recycling and entrepreneurship development

Composite materials have been manufactured, generally, using synthetic fibres such as glass, aramid, carbon and not renewable and biodegradable. Making glass fibre and synthetic fibres are energy intensive and not easy handling as it causes hazards to human health. The present study, revealed that marble waste particulates and renewable jute fibres are promising raw materials in manufacturing composites, which would be sustainable, cost effective and environmental friendly.

The technology processes know-how for manufacturing marble waste composite materials are now ready for commercial scale production. The technology package includes (i) Detailed specifications of raw materials requirement, (ii) Process of casting and fabrication of hybrid composites, (iii) Performance evaluation of the developed hybrid composite materials,

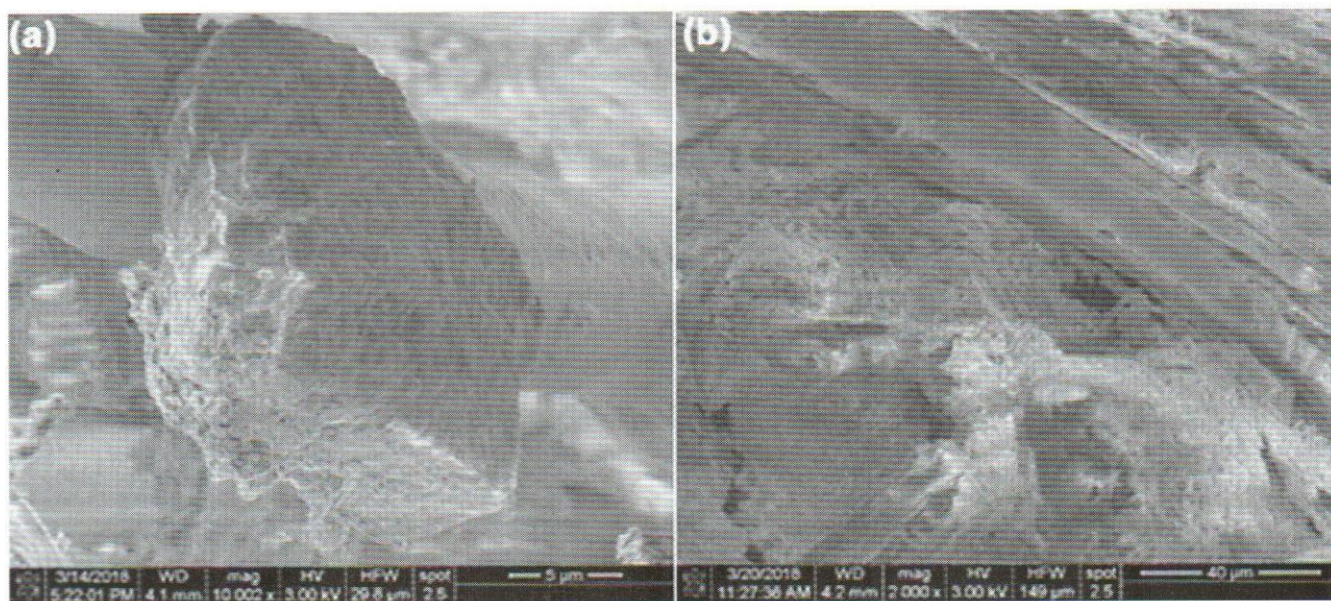


Fig. 8. Microstructure of marble waste composites

TABLE 3. Mechanical and physical properties of the hybrid composites

S. No.	Sample ID	TS (MPa)	TM (GPa)	FS (MPa)	FM (GPa)	Density (g/cm ³)	WA (%)	Th.S (%)
1	EPC-Jute R-1	19.15	4.50	49.10	6.62	1.684	0.546	0.000
	R-2	20.23	4.07	50.35	6.39	1.581	0.565	0.000
	R-3	21.61	4.50	52.01	6.12	1.406	0.575	0.000
	R-4	22.75	5.33	48.54	6.31	-	-	-
	R-5	19.22	3.71	42.38	6.10	-	-	-
2	EPC-MW R-1	13.75	7.84	47.24	7.44	1.442	0.097	2.075
	R-2	10.36	5.96	47.55	7.70	1.707	0.090	2.007
	R-3	15.67	5.56	49.67	6.90	1.546	0.092	1.977
	R-4	14.07	5.2	48.91	6.69	-	-	-
	R-5	10.42	6.81	46.87	6.89	-	-	-
	Mean	12.85	6.27	48.05	7.12	1.565	0.093	2.020
	SD	2.36	1.06	1.19	0.43	0.109	0.004	0.050

TS: Tensile Strength; **TM:** Tensile Modulus; **FS:** Flexural Strength; **FM:** Flexural Modulus; **IS:** Impact Strength; **WA:** Water Absorption; **Th.S:** Thickness Swelling; **ñ:** Density

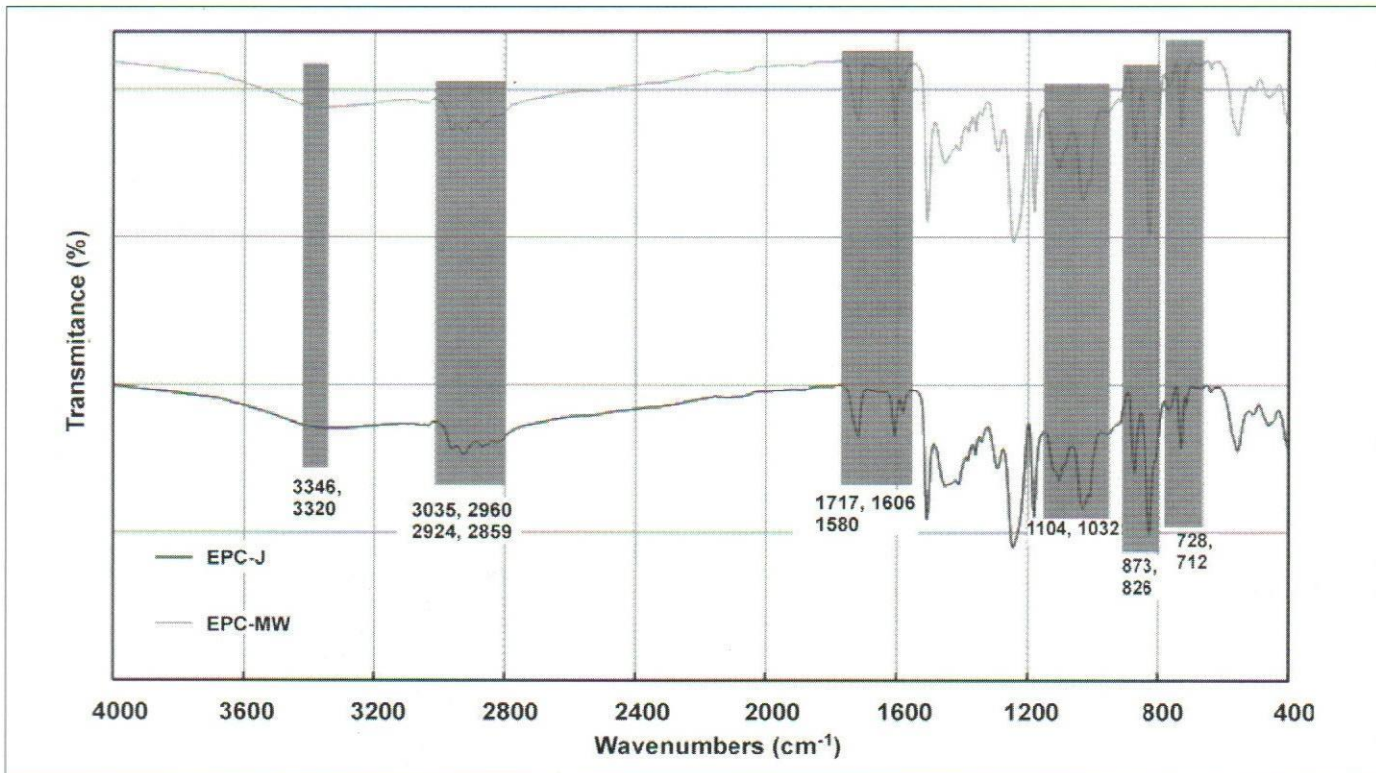


Fig. 9. FT-IR spectra of cross-sections of marble waste composite

(iv) Potential applications (v) Requirement of major equipment and machineries and (vi) requirement of land, building and investment for setting-up of industry for the production of marble waste composite materials in commercial scale. Interested entrepreneurs, start-ups and industries are welcome for licensing the technology.

Acknowledgement

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References

- Ahmetli, G., Dag, M., Deveci, H., Kurbanli, R. (2012a). Recycling studies of marble processing waste: Composites based on commercial epoxy resin. *J. Appl. Polym. Sci.* 125, 24–30. <https://doi.org/10.1002/app.34548>
- Ahmetli, G., Kocak, N., Dag, M., Kurbanli, R. (2012b). Mechanical and thermal studies on epoxy toluene oligomer-modified epoxy resin/marble waste composites. *Polym. Compos.* 33, 1455–1463. <https://doi.org/10.1002/pc.22274>
- André, A., De Brito, J., Rosa, A., Pedro, D. (2014). Durability performance of concrete incorporating coarse aggregates from marble industry waste. *J. Clean. Prod.* 65, 389–396. <https://doi.org/10.1016/j.jclepro.2013.09.037>
- Aruntaş, H.Y., Gürü, M., Dayi, M., Tekin, I. (2010). Utilization of waste marble dust as an additive in cement production. *Mater. Des.* 31, 4039–4042. <https://doi.org/10.1016/j.matdes.2010.03.036>
- Asokan, P., Saxena, M., Asolekar, S.R. (2005). Coal combustion residues - Environmental implications and recycling potentials. *Resour. Conserv. Recycl.* 43, 239–262. <https://doi.org/10.1016/j.resconrec.2004.06.003>
- Bajpai, P.K., Singh, I., Madaan, J. (2012). Comparative studies of mechanical and morphological properties of polylactic acid and polypropylene based natural fiber composites. *J. Reinf. Plast. Compos.* 31, 1712–1724. <https://doi.org/10.1177/0731684412447992>
- Barros, R.J., Jesus, C., Martins, M., Costa, M.C. (2009). Marble stone processing powder residue as chemical adjuvant for the biologic treatment of acid mine drainage. *Process Biochem.* 44, 477–480. <https://doi.org/10.1016/j.procbio.2008.12.013>
- Borazan, A.A., Gokdai, D. (2017). Polymer Composites Reinforced With Waste Marble Dust and Fibers From Chicken Feathers As an Alternative Material. *Fresenius Environ. Bull.* 26, 2095–2103.
- Borsellino, C., Calabrese, L., Di Bella, G. (2009). Effects of powder concentration and type of resin on the performance of marble composite structures. *Constr. Build. Mater.* 23, 1915–1921. <https://doi.org/10.1016/j.conbuildmat.2008.09.005>
- Cañavate, J., Colom, X., Pagès, P., Carrasco, F. (2000). Study of the Curing Process of an Epoxy Resin by FTIR Spectroscopy. *Polym. Plast. Technol. Eng.* 39, 937–943. <https://doi.org/10.1081/PPT-100101414>
- Çinar, M.E., Kar, F. (2018). Characterization of composite produced from waste PET and marble dust. *Constr. Build. Mater.* 163, 734–741. <https://doi.org/10.1016/j.conbuildmat.2017.12.155>
- Ercikdi, B., Külekcı, G., Yılmaz, T. (2015). Utilization of granulated marble wastes and waste bricks as mineral admixture in cemented paste backfill of sulphide-rich tailings. *Constr. Build. Mater.* 93, 573–583. <https://doi.org/10.1016/J.CONBUILDMAT.2015.06.042>
- Fernández-Caliani, J.C., Barba-Brioso, C. (2010). Metal immobilization in hazardous contaminated minesoils after marble slurry waste application. A field assessment at the Tharsis mining district (Spain). *J. Hazard. Mater.* 181, 817–826. <https://doi.org/10.1016/j.jhazmat.2010.05.087>
- Gokdai, D., Borazan, A.A., Acikbas, G. (2017). Effect of Marble: Pine Cone Waste Ratios on Mechanical Properties of Polyester Matrix Composites. *Waste and Biomass Valorization* 8, 1855–1862. <https://doi.org/10.1007/s12649-017-9856-6>
- Gomes Ribeiro, C.E., Sanchez Rodriguez, R.J., Carvalho, E.A. d., (2017). Microstructure and mechanical properties of artificial marble. *Constr. Build. Mater.* 149, 149–155. <https://doi.org/10.1016/j.conbuildmat.2017.05.119>
- Gürü, M., Tekeli, S., Akin, E. (2007). Manufacturing of Polymer Matrix Composite Material Using Marble Dust and Fly Ash. *Key Eng. Mater.* 336–338, 1353–1356. <https://doi.org/10.4028/www.scientific.net/KEM.336-338.1353>
- Hameed, M.S., Sekar, A.S.S. (2009). Properties of green concrete containing quarry rock dust and marble sludge powder as fine aggregate. *J. Eng. Appl. Sci.* 4, 83–89.
- Icduygu, M.G., Aktas, L., Altan, M.C. (2012). Characterization of composite tiles fabricated from poly(ethylene terephthalate) and micromarble particles reinforced by glass fiber mats. *Polym. Compos.* 33, 1921–1932. <https://doi.org/10.1002/pc.22332>
- Moreno-Barriga, F., Díaz, V., Acosta, J.A., Muñoz, M.Á., Faz, Á., Zornoza, R. (2017). Organic matter dynamics, soil aggregation and microbial biomass and activity in Technosols created with metalliferous mine residues, biochar and marble waste. *Geoderma*, 301, 19–29. <https://doi.org/10.1016/j.geoderma.2017.04.017>
- Nikolic, G., Zlatkovic, S., Cakic, M., Cakic, S., Lacnjevac, C., Rajic, Z. (2010). Fast Fourier Transform IR Characterization of Epoxy GY Systems Crosslinked with Aliphatic and Cycloaliphatic EH Polyamine Adducts. *Sensors*, 10, 684–696. <https://doi.org/10.3390/s100100684>
- Pappu, A., Patil, V., Jain, S., Mahindrakar, A., Haque, R., Thakur, V.K. (2015). Advances in industrial prospective of cellulosic macromolecules enriched banana biofibre

resources: A review. *Int. J. Biol. Macromol.* 79, 449–458. <https://doi.org/10.1016/j.ijbiomac.2015.05.013>

- Pappu, A., Saxena, M., Asolekar, S.R.** (2007). Solid wastes generation in India and their recycling potential in building materials. *Build. Environ.* 42, 2311–2320.
- Pappu, A., Saxena, M., Thakur, V.K., Sharma, A., Haque, R.** (2016). Facile extraction, processing and characterization of biorenewable sisal fibers for multifunctional applications. *J. Macromol. Sci. Part A Pure Appl. Chem.* 53, 424–432. <https://doi.org/10.1080/10601325.2016.1176443>
- Pappu, A., Thakur, V.K.** (2017). Towards sustainable micro and nano composites from fly ash and natural fibers for multifunctional applications. *Vacuum*, 146, 375–385. <https://doi.org/10.1016/j.vacuum.2017.05.026>
- Rajgor, M.B., Patel, N.C., Pitroda, J.** (2013). A Study On Marble Waste Management: Opportunities And Challenges In Current Age For Making Value Added Bricks, In: Proceedings Of National Conference Crdce13. SVIT, Vasad, Vasad, pp. 20–21.
- Ribeiro, C.E.G., Rodriguez, R.J.S.** (2015). Influence of Compaction Pressure and Particle Content on Thermal and Mechanical Behavior of Artificial Marbles with Marble Waste and Unsaturated Polyester. *Mater. Res.* 18, 283–290. <https://doi.org/10.1590/1516-1439.372314>
- Rout, A.K., Satapathy, A.** (2015). Study on mechanical and erosion wear performance of granite filled glass-epoxy hybrid composites. *Proc. Inst. Mech. Eng. Part L J. Mater. Des. Appl.* 229, 38–50. <https://doi.org/10.1177/1464420713499483>
- Şahbaz, D.A., Acikgoz, C.** (2017). Cross-linked chitosan/marble powder composites for the adsorption of Dimozol Blue. *Water Sci. Technol.* 76, 2776–2784. <https://doi.org/10.2166/wst.2017.447>
- Saxena, M., Mehrotra, P., Pappu, A.** (2010). Innovative building materials developed from natural fibres and industrial waste. *PDF. L. Contam. Reclam.* 18, 355–363. <https://doi.org/10.2462/09670513.1016>
- Sharma, A., Patnaik, A.** (2018). Experimental Investigation on Mechanical and Thermal Properties of Marble Dust Particulate-Filled Needle-Punched Nonwoven Jute Fiber/Epoxy Composite. *Jom* 70, 1–5. <https://doi.org/10.1007/s11837-018-2828-x>
- Singh, A.A., Palsule, S.** (2014). Thermal Properties of Jute Fiber Reinforced Chemically Functionalized High Density Polyethylene (JF / CF- HDPE) *Composites Developed by Palsule Process 2*, 97–108.
- Singh, R., Bhutani, M., Syal, T.** (2015). Strength Evaluation of Concrete Using Marble Powder and Waste Crushed Tile Aggregates. *Int. J. Sci. Emerg. Technol. with Latest Trends* 20, 18–28.
- Souza, F., Eduardo, C., Ribeiro, G., Jesus, R., Rodriguez, S.** (2017). Physical and mechanical characterization of artificial stone with marble calcite waste and epoxy resin. *Mater. Res.* 21, 1–6. <https://doi.org/10.1590>
- Toschi, F., Paladini, A., Colosi, F., Cafarelli, P., Valentini, V., Falconieri, M., Gagliardi, S., Santoro, P.** (2013). A multi-technique approach for the characterization of Roman mural paintings. *Appl. Surf. Sci.* 284, 291–296. <https://doi.org/10.1016/J.APSUSC.2013.07.096>
- Tozsin, G., Arol, A.I., Oztas, T., Kalkan, E.** (2014a). Using marble wastes as a soil amendment for acidic soil neutralization. *J. Environ. Manage.* 133, 374–377. <https://doi.org/10.1016/j.jenvman.2013.12.022>
- Tozsin, G., Oztas, T., Arol, A.I., Kalkan, E., Duyar, O.** (2014b). The effects of marble wastes on soil properties and hazelnut yield. *J. Clean. Prod.* 81, 146–149. <https://doi.org/10.1016/j.jclepro.2014.06.009>
- Uygunoglu, T., Topçu, I.B., Çelik, A.G.** (2014). Use of waste marble and recycled aggregates in self-compacting concrete for environmental sustainability. *J. Clean. Prod.* 84, 691–700. <https://doi.org/10.1016/j.jclepro.2014.06.019>

“Uncommon thinkers reuse what common thinkers refuse”

— JRD Tata

Hospitals - Enormous Waste Powerhouses: Leapfrog to Environmental Sustainability

VIKRAM SANDHU, HARLEEN KAUR AND HEENA ATWAL

Every living thing, be it a single cell to as large as blue whale, takes in nutrient and excretes waste. Most of the machinery is based on this simple biological model of nutrients in and wastes out. The main aim of research conducted for this paper is to study the present actions related to the various waste management techniques and various practices taken by the healthcare organisations for the disposal of the waste. Waste management requires dire need for alteration to proffer sustainable practices in the anticipation of offering the waste management sector a more economically feasible and socially admissible answer to the current waste management predicament. It is necessary to consider explanation of the costs of different disposal practices and not just the cost of the recycling process but also the worth of the domesticated material. Making note of the quantum of common waste as well as bio-waste produced and managing routine observation of health care waste organization tradition, the hospitals can help in preserving the environment.

INTRODUCTION

There are few things definite in life – death, change and waste. Hence solid waste can be defined as “Organic or inorganic waste matter generated from different activities, which have defunct in the eyes of the first owner but holds usefulness to somebody else.” (Robinson, W.D.1986). Generally, waste is defined as the end product of life cycle and is incinerated in landfills. About 27.8 percent of India’s entire population (as per Census 2001) dwells in urban areas. The estimated urban population is 33.4 percent by the year 2026. The amount of waste produced in urban India is rising day by- day because of its increasing population. The annual quantum of solid waste produced in urban India has risen from six million tons in 1947 to 48 million tons in 1997 and showcasing an annual growth rate of 4.25 percent, what more, it is expected to increase to 300 million tons by 2,047 (CPCB, 1998). Stacks of waste are bought to discarding ground in developed nations.

However, in developing nations, refuse mainly is found on the roads and empty expanse. Rising pollution is resulting to environmental variations and fiscal cost coupled to litter in provision to health peril and off-putting effect on organisations have distorted the way establishments view it. Hospital litter mooted to biologic or non- biologic waste that is surplus and not projected for further use. The creator of waste is liable for guarantying apt disposal. Hospitals are generally obligated to society to uphold a hygienic environment and organize litter in order to shun pollution and contagion within and in the vicinity of the hospital (Nosheen Arshad, *et al.*, 2011). Waste minimisation mainly remunerates the waste generator costs for both the attainment of goods and for waste handling resulting

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in reduction in disposal and the responsibility concerning the disbarment of hazardous litter is reduced. Medical and related equipment used in a health-care industry can be reused if it is planned for the same and will endure the sterilization process. All healthcare employees have a responsibility to take part in this process and hence be guided in waste reduction and the categorisation of hazardous matters (WHO report, 1992). All of the hospital personnel are appointed as the panel for waste management. As WHO said, superior health care waste management practices in a hospital subject to devoted waste handling team, fitting supervision, tactful arrangement, responsible union, nurturing legislation, ample funding, and complete involvement of the trained staff (Maryam Maroufi, *et al*, 2012). Government regulatory machineries, the public and the healthcare bringer brush aside bio medical waste organization entente of various major hospitals which are generating quantum of litter than legalized according to International guidelines by WHO for countries. In discrepancy to the beneficial side of hospitals as medical facility contributor, the other side of the bio-medical waste management has been forsaken which is measured to be likely perilous (Rajeswari, B. 2012).

Classification of hospital waste

A classification scheme comes from The World Health Organization. The WHO classifies medical waste into:

- Sharps- sharps include the objects that can puncture or lacerate the skin; including needles, syringes, etc.
- Infectious- Describes waste that has the likelihood of causing infections. It includes human as well as animal tissues, blood-drenched bandages, used surgical gloves, cultures, stocks, or swabs.
- Pathological- It encompasses recognizable tissues, organs, and body parts obtained from animals and humans. If the waste came from a living organism, it is pathological waste: Material discarded from the body in surgery including the fluids and solids excreted in autopsies is pathological waste, with the exception of teeth.
- Radioactive- can be produced from nuclear medicine treatments, cancer therapies and medical equipment that utilize radioactive isotopes.
- Pharmaceutical- This category of waste comprises expired, unused, and contaminated pharmaceutical products containing vaccines and biological products

used for therapy. Over-the-counter drugs end up as pharmaceutical waste as does paraphernalia used in pharmacies: gloves, masks, bottles, etc

- Others (often sanitary waste produced at hospitals)- makes up at least 85% of all litter engendered at medical services, which is diverse from basic household or workplace waste, and includes paper, plastics, liquids and any other materials.

Segregation of waste

The risk waste should be segregated at the point of production from non-risk waste. It is convenient for safe disposal of risks waste.

For all the types of waste separate containers are required i. e. risk waste sharps and non-risk waste. All the different coloured containers lined with plastic bags are positioned in each department.

Sharps – Red container

- Needles
- Ampules
- Broken glass
- Blades
- Razors
- Staples
- Trocars
- Guide wires
- Other sharps

Biohazardous waste – Red container lined with a red bag

- Infectious waste
- Blood products (albumin, etc)
- Contaminated PPE (personal protective equipment)
- IV tubing
- Cultures, stocks

Trace Chemotherapy – Yellow container

- Empty vials and ampules
- Empty syringes, needles
- Empty IVs
- Gowns
- Gloves
- Tubing
- Aprons
- Wipes
- Packaging

RCRA Hazardous Waste – Black container

- Hazardous medications (RCRA)
- P-listed drugs and their packaging

- Half or partial doses (RCRA)
- Hazardous bulk medications
- (incineration only)
- Bulk chemo
- Pathological waste

Pharmaceutical Waste – Blue and white container

- Pills
- Injectables
- Antibiotics

THE FOUR R'S

Reduce. Reuse, Recycle, Recover. The answer to bringing down entire waste cost is to optimize institution's waste management.

A. Reduce

The triumph of a strategy to help reduce waste is largely relied upon the implementation of a philosophy to grip resource maintenance efforts. In all aspects of life acceptance of environmental sustainability is our responsibility. Growing on the Resource maintenance policy a plan for recycle strategy should be pursued, to not only reduce excess waste in the initial steps but to also provide feasible end product. Dealing with the equilibrium of the waste with a segregation and surmount strategy. This will help us in reducing the disparity into bits and pieces.

B. Reuse

The 4R's Reuse Group comprises the quantum of used thing from Collectables, antiques and memorabilia to general material. Trading in used items typically involves the recoup of used items and segregation into components. Beyond reclaiming and enhancing reuse in the industry repair and refurbish is enthused.

C. Recycle

The primitive recycling industry has been basically a scrap trading industry with the focus on the efficient and effective cost of freight and material management. Now a day recycling industry has changed largely into a service industry comprising of compilation, categorization, handing and moving of waste material and by-products. Recycling promotes compilation and arrangement of recyclable materials

D. Recover

The alteration of waste matters for the recuperation of the energy standards contained within the waste matter such as BTUs or protein. The recovery of the complex matters which cannot be recycled is proving to be advantageous because of the energy value they provide. This is only possible if waste is managed by recognizing and diverting matters from discarding to recovery.

The value of waste

Recycling is helpful for the performance of healthcare industry and maintaining environmental sustainability..

- Depending on matters market, recycling can in fact add money to your bottom line.
- The potential savings related to the estimated 50% of waste that can be reduced, reused or recycled is noteworthy.
- Waste Management's significant national presence, infrastructure facility and supplier relationship gives a unique capacity to "make markets" where nothing earlier existed.

Training

Knowledge has shown the significance of guidance, stimulation and motivation of hospital staff to make certain that waste is properly segregated. Healthcare specialists have developed effectual plans that make this multifaceted subject understandable and simple to execute.

Working with hospital staff to build lithe and progressive educational strategies that make staff efficient in the skills essential to "put waste in its proper place" and reduce the quantum that goes into higher-cost waste grouping (waste.net, 2018).

Review of literature

An endeavour has been undertaken to present the review of literature based on the theoretical and empirical studies carried out at regional, national and international level over the years. It has apprised us to identify various aspects related to 'waste minimisation', "Biomedical waste", "Biomedical waste management", "Environmental sustainability", "Healthcare industry improvements over the time". Here are few of the studies that apprised us:-

World Health Organisation (1992) in their report on public health issues related to animal and human encephalopathy's stated that in regulating the

economic feasibility of recycling, it is necessary to consider explanation of the costs of different disposal practices and not just the cost of the recycling process but also the worth of the domesticated material.

Nosheen Arshad, et al. (2011) in their study on hospital waste disposal stated that appropriate compilation and isolation of waste is necessary. There isn't sufficient data on medical waste administration practices and its effect on public health and environment. The techniques of adequate medical waste discarding and segregation are also derisory. However, there is requirement for increasing awareness about medical waste and its associated matters.

Dr. B. Rajeswari (December, 2012) in his study on Procedural Bio-Medical Waste Management suggested that by making note of the quantum of common waste as well as bio-waste produced and managing routine observation of health care waste organization tradition, the hospitals can help in preserving the environment.

Anna Araba Mensah (December 2012) in his thesis on Solid Medical Waste Management Practices proposed that adequate waste management strategy is needed to make certain health and environmental protection from medical waste by formulating an environmental department. Segregation of medical waste should be done at the point of production.

Hunachew B. Mengesha, Biruck Y. Dessalegn (2014) in their paper on Solid waste Characterization and Recycling Potential in Hawassa University, Ethiopia stated that there is need to assign budget for the management of solid wastes; unremitting attentiveness creation for the community need to be made using the existing practices; in cooperation with the city administration to implement feasible management options for long-term solution. Moreover, motivating entrepreneurs to utilize the waste as raw materials for setting up business prospect is a different approach to minimize health risk to humans and decrease environmental hazards as a result of improper management and discarding of waste.

I. A. Joshua, S. Mohammed, J., G. Makama, W. I. Joshua, O. Audu, .A. G. Nmadu, J.B. Ogboi (April 2014) in their study on Hospital Waste Management

as a potential hazard stated that hospital waste if not appropriately managed has the impending proposition of posturing a serious threat to health and environment. Regardless of the significant percentages of the staff of the primary health care centres having awareness on waste management policy and plan, still a good quantity do not exercise hand washing, segregation and colour coding.

Dr. Raveesh Agarwal, Mona Chaudhary and Jayveer Singh (2015) in their research study on waste management initiatives in India for human well being propose that in order to be financially sustainable and achieve socio-economic and environmental goals in the field of waste management, the need of the hour is to systematically analysis the advancements and limitations of the practices involved in waste management, according to which an effective waste management system can be developed with the help of various stakeholders of India.

Dr. Asima Banu, et al, (January, 2015) in their study on challenges of hospital solid waste management stated that though a well operational system is in place still stress needs to be laid for guidance of waste handlers and drive them to bring behavioural change chiefly in wards' and emergency ward. Hospital administrators require devise and execute a plan for providing apt training to health care workers so as to tackle the deficiencies observed in this study.

Babajide Milton Macaulay and Frank Muhammed Odiase (January 2016) in their study on medical waste management practices in developing countries proposed that a plan should be formulated that offer medical waste pre-treatment options which are environmentally-sustainable such as autoclaving, microwaving, steam treatment, heat treatment and chemical treatment. The cheapest but harmless means of pre-treating waste is the use of bleaching agents which are within our means.

Ministry of Environment and Forests, (1998) in their report on Bio-Medical Waste stated that the rules laid for the primary healthcare centre should be applied for permission from the state pollution control board and put up with all the obligations and official procedure. The preparation and discarding options as well as their standards agreed upon in the rules ought to be examined with orientation to the needs

and capacities of primary health care system. 48 hours time edge for storing untreated biomedical waste imposes a specific constraint on management of waste produced in widely spread out and remote healthcare centres.

Quality Council of India (2005), in their report on Standards for hospital recommend that advancement of an accreditation system for hospitals slot in health care waste executive in itself is a big step forward for ensuring proper biomedical waste management. The constitutional provisions referred to in the standards for waste management have to be cleared in relation to various categories of health care units. Services recommended under the universal sterilization programme should also include accreditation system with proper standardisation criteria

Malcolm R Macleod, Susan Michie, Ian Roberts, Ulrich Dirnagl, Iain Chalmers, John P A Ioannidis, Rustam Al-Shahi Salman, An-Wen Chan, Paul Glasziou (January 2014) in their study on Biomedical research: increasing value, reducing waste commented that the present normalcy in biomedical research is based on the compound and inter-reliant activities of diverse actors, each functioning within their own systems of jeopardy and enticement. These activities can be comprehended as a consequence from the interaction of aptitude (the individual's logical and physical aptitude to connect with the activity in question), prospect (cause external to the individual that make activities likely), and inspiration (drivers that uplift and express behaviour).

Joshua Reno, (October 2015) in this study on waste and waste management it is stated by the author that Waste, in every assortment and intricacy, should serve as a cue that we can never fully seize the planetary progression to which we add, nor presume that they are easily handled. By decreasing waste to an all-too-human derivative in need of reasonable management, we exclude from reflection as to how waste may survive for nonhuman beings, how it is not simply something that occurs to them.

Emilia Asuquo Udofia, Julius N. Fobil and Gabriel Gulis (March 2015) in their review on solid medical waste management in Africa stated that the review shows that independent national hard work have made only sluggish progress in overseeing solid medical

waste, forcing authors to question whether or not a combined advance demands the grouping of specialist in solid medical waste management and amassed disciplines all over the continent to decipher and combine available technology, proficiency, funding and best activities to bear on solid waste management.

Moher, D et al. (2016) in his study on increasing value and reducing waste in biomedical research proposed that however, to avoid the well known difficulty of deteriorating to execute research information into practice, need is to use methodically designed knowledge conversion strategies together with the use of theory-based strategies to persuade research activities, actions, and policies of the different groups involved. A good initial point may be to re-consider the series' suggestions and mull over ways of observing progressing research value.

Satnam Singh & Vinit Prakash, (2007) in their review on toxic Environmental Releases from Medical Waste Incineration: A Review proposed that medical waste has been thought of as a division of hospital waste and important quantum of waste from other non-hospital places such as clinics, health-care organization, laboratories and research centres etc., is neglected as a medical waste.

Patience Aseweh Abor, (September 2007) in her study on medical waste management practice in a Southern African hospitals states that meagre segregation of medical litter pose serious health inferences to health workforce, clients and the community. Also, because of the toxic nature of medical waste, inappropriate management may direct to the annihilation of natural environment and concern the balance of ecosystems.

The review of literature has provided insight about the factors that affect the impact of biomedical waste, its future projections, practices, benefits and limitations considering the negative and positive aspects. After reviewing number of empirical and conceptual studies in the present paper, an attempt has been made to generate the likelihood of acceptance of biomedical waste management worldwide and observe its effectiveness in managing healthcare.

This study attempts to generate the likelihood of acceptance of biomedical waste management practices worldwide and observe its effectiveness in managing healthcare. The study will include reviews that stresses upon risks, issues and dwell on deficiencies in practices.

Research methodology

The methodology used for study has been explained below, after conducting extensive survey with the help of questionnaire and related secondary data. Research methodology is the systematic study into a subject in order to discover or revise facts, theories and applications. It is the way how we conduct the research. The broad objective of the present study is to understand biomedical waste management in the hospitals.

In order to understand the methodology used to compile this paper, this section is included in order to clarify how an effective methodological philosophy can contribute to the successful production of a un-bias and critical paper, as well as comprehend the process underwent to reach the pertinent conclusion. This also serves the purpose of justifying and authenticating the research procedures employed in order meet the set objectives and answers the main research question of this paper.

In this paper a study on the biomedical waste management in healthcare industry is done to check the effects, benefits and hazards. This study attempts to generate the likelihood of awareness of waste management worldwide and observe its effectiveness in managing healthcare. The study will include figures that stresses upon risks issues and dwell on deficiencies in waste management.

The exploratory study was used and after the extensive survey and the review of literature the factors mentioned were deciphered. This research focuses to gather preliminary information that will help define problems and suggest hypothesis.

Objectives of the study

The specific objectives of the study are as follows:

1. To study the awareness of the producer of waste on its effective management.
2. To analyze the positive and negative effect of present biomedical waste management practices.
3. To identify the factors influencing waste manager personnel's perception with regard to waste management techniques.
4. To examine the impact of identified factors on waste management.

Sources of the data collection

Primary Source

- Consumer Survey on the awareness of biomedical waste management in 50 hospitals in Amritsar, Batla, Jalandhar, Vallah and few other nearby cities.

Secondary sources were used to formulate this paper. The various published sources reviewed are:-

- WHO report, 1992
- CPCB report, 1998
- Ministry of Environment and Forests report, 1998.
- Quality Council of India report, 2005
- Waste.net, 2018
- Different research studies of researchers like Dr. Raveesh Agarwal, Mona Chaudhary and Jayveer Singh (2015) and many more.
- Libraries of leading B-Schools
- E-libraries and Information available on Internet
- Journals, Periodicals, Newsletters & Magazines; and
- Other online and offline sources of information related to mobile apps enabled system in healthcare.

Data Collection Tools

- Questionnaire Survey
- Books
- Internet

Universe of the Study

Cosmos of present research includes respondents from district Amritsar of Punjab who have knowledge and awareness regarding biomedical waste management; its issues; and challenges.

Research Analysis

Variables used in the Study

The study used both dependent and independent variables.

(i) **Dependent Variables (DV)**

1. Willingness to Train (WTT) more for waste management techniques (WMT)

This dependent variable was measured by using five point Likert scale ranging from 1 to 5 where 1 = Very Low, 2 = Low, 3 = Moderate, 4 = High and 5 = Very High.

The effect of key demographic variables such as age; income; qualification; occupation and gender was examined with the help of Chi-Square Test.

2. Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)

The statements used for this construct was measured with the help of five point Likert scale ranging from 1 to 5 where 1= Strongly Disagree (SD); 2= Disagree (D); 3= Neutral (N); 4=Agree (A); and 5= Strongly Agree (SA). It includes six statements i.e.

- a) I believe that the cost of waste management techniques effect the hospitals decision to use it.
- b) I believe that waste is segregated according to the guidelines in the hospital.
- c) Hospital believes in recycling and reusing the waste generated.
- d) I believe that the items of the waste described according to categorisation.
- e) I believe that the hospital makes it easy to calculate the total waste generated
- f) I trust the hospital's waste management guidelines.

The mean score of the total responses of these six statements was treated as dependent variable. The impact of independent variables was examined on dependent variable with the help of Multiple Regression Analysis.

3. Sustainable waste management behaviour (SWMB)

The statements constituting this dependent variable was measured with the help of five point Likert scale ranging from 1 to 5 where 1= Strongly Disagree (SD); 2= Disagree (D); 3=Neutral (N); 4=Agree (A); and 5= Strongly Agree (SA). It includes five statements

- a) The expectations meet regarding the waste management in the hospital

- b) Recycling of the segregated waste is done
- c) The waste which can be used again is used
- d) The information relating to waste management is provided clearly
- e) I was satisfied with my decision to join this hospital as waste management staff

The mean score of the total responses of these five statements was treated as dependent variable. The impact of independent variables was examined on this variable with the help of Multiple Regression Analysis.

(ii) Independent Variables (IDV)

● Key Demographic Variables

The study adopted qualification; occupation; and designation as independent variables for achieving the first objective of the study to measure their impact on users.

a. **Qualification** - It was measured in five categories i.e., below 10th standard, senior secondary, professional degree, graduate, postgraduate. These categories were coded in SPSS as 1 for below 10th standard; 2 for senior secondary; 3 for graduate; 4 for post-graduate and 5 for professional degree.

b. **Designation** – it was measured in four categories i.e., doctor, nurse, laboratory staff, support staff. These categories were coded 1 for doctor, 2 for nurse, 3 for laboratory staff and 4 for support staff.

- The second and third objectives of the study were achieved with the help of following independent variables:

'Recycling (RC); 'Green disposal' (GD); 'Reuse' (RU). These variables were measured with the help of five point Likert scale ranging from 1 to 5 where 1 = Strongly Disagree (SD); 2 = Disagree (D); 3 = Neutral (N); 4 = Agree (A); and 5 = Strongly Agree (SA).

- The fourth objectives of the study, following independent variables were taken into consideration:

'Disposal Knowledge' (DK); 'Segregation Concern' (SC); 'Social Influence' (SI); 'Governmental Initiative' (GI); and 'Waste disposal Knowledge & Information' (WKI). These variables have been measured taking five point Likert scale ranging from 1 to 5 where

1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A) and 5 = Strongly Agree.

Formation of Hypothesis –

To achieve the objectives of the study following hypotheses were framed and tested.

1. Hypotheses related to Effect of Key Demographic Variables of users on Willingness to Train (WTT) more for waste management techniques (WMT)

- **H01:** There is no significant effect of Users education on their, willingness to Train (WTT) more for waste management techniques (WMT)
- **H02:** There is no significant effect of Users designation on their, willingness to Train (WTT) more for waste management techniques (WMT)

2. Hypotheses related to Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)

- **H01:** There is no significant impact of Recycling (RC) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)
- **H02:** There is no significant impact of „Green Disposal (GD) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)
- **H03:** There is no significant impact of Reuse (RU) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

3. Hypotheses related to impact of various identified factors on Sustainable waste management behaviour (SWMB)

- **H01:** There is no significant impact of 'Disposal Knowledge' (DK) on users, Sustainable waste management behaviour (SWMB).
- **H02:** There is no significant impact of 'Segregation Concern' (SC); on users, Sustainable waste management behaviour (SWMB).

- **H03:** There is no significant impact of 'Social Influence' (SI); on users, Sustainable waste management behaviour (SWMB).
- **H04:** There is no significant impact of 'Governmental Initiative' (GI); on users, Sustainable waste management behaviour (SWMB).
- **H05:** There is no significant impact of 'Waste disposal Knowledge & Information' (WKI); on users, Sustainable waste management behaviour (SWMB).

Response rate- The questionnaire was distributed among 1500 respondents from 50 major hospitals of district Amritsar (30 respondents from each hospital) and 1500 were collected back. The study finally selected 1338 questionnaires which are comprehensively completed and 152 were seemed to be fit for statistical analysis. The study omitted 10 questionnaires as the respondents were not aware about the biomedical waste management. Hence, 1490 questionnaires which were found to be usable for statistical analysis, representing a response rate of 99 per cent.

Statistical techniques used in the study-

Following statistical techniques were used in the present research to analyze the collected data:

- **Descriptive Analysis :** The present study used frequencies, ranks and percentages to examine the demographic variables i.e. gender; age; marital status; education; geographical area; annual income; and occupation of the respondents.
- **Chi-Square' Test and Cross Tabulation:** The effects of key demographic variables like education; occupation; and designation on willingness to Train (WTT) more for waste management techniques (WMT) were examined with the help of Chi-Square Test. Chi-Square test of Independence is used to test the degree of association between two variables. It is used to analyse whether user's willingness to Train (WTT) more for waste management techniques (WMT) is dependent on key demographic characteristics of consumers. Cross Tabulation is carried out based on different categories of consumer demographics and consumers willingness to Train (WTT) more for waste management techniques (WMT).

Research Analysis Report

- **FOR OBJECTIVE-1— Effect of Key Demographic Variables of users on Willingness to Train (WTT) more for waste management techniques (WMT)**

a. **H₀₁**: There is no significant effect of Users education on their, willingness to Train (WTT) more for waste management techniques (WMT).

HA1: there is significant effect of users education on their, willingness to Train (WTT) more for waste management techniques (WMT).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Below 10th	77 (98.17) [4.57]	154 (154.76) [0.00]	79 (57.08) [8.42]	24 (26.57) [0.25]	8 (5.41) [1.24]	342
Senior Secondary	85 (77.79) [0.67]	115 (122.63) [0.48]	55 (45.23) [2.11]	12 (21.06) [3.89]	4 (4.29) [0.02]	271
Graduate	78 (70.33) [0.84]	121 (110.87) [0.93]	23 (40.89) [7.83]	20 (19.04) [0.05]	3 (3.88) [0.20]	245 245
Post Graduate	87 (81.81) [0.33]	127 (128.97) [0.03]	39 (47.57) [1.54]	27 (22.14) [1.06]	5 (4.51) [0.05]	285
Professional degree	72 (70.90) [0.02]	112 (111.77) [0.00]	36 (41.23) [0.66]	25 (19.19) [1.76]	2 (3.91) [0.93]	247
Column Totals	399	629	232	108	22	1390 (Grand Total)

The chi-square value is 37.8687 and the p -value is .00158. The result is significant at $p < .05$.

Conclusion : there is a relationship between education and willingness to train more for waste management techniques.

- b. **H₀₂**: There is no significant effect of Users occupation on their, willingness to Train (WTT) more for waste management techniques (WMT).

H_{A2}: There is significant effect of Users occupation on their, willingness to Train (WTT) more for waste management techniques (WMT)

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Doctor	101 (132.13) [7.33]	205 (172.81) [6.00]	36 (41.54) [0.74]	74 (43.41) [0.62]	2 (3.17) [0.43]	401
Nurse	99 (111.70) [0.67]	115 (146.09) [0.48]	23 (36.36) [2.11]	20 (44.95) [3.89]	5 (2.68) [0.02]	339
Laboratory Staff	153 (115.65) [12.06]	152 (151.26) [0.00]	23 (40.89) [4.91]	20 (19.04) [13.85]	3 (2.78) [0.02]	351
Support Staff	105 (98.52) [0.43]	127 (128.97) [0.03]	39 (30.98) [2.08]	27 (38.29) [3.33]	1 (2.37) [0.79]	299
Column Totals	458	599	144	178	11	1390 (Grand Total)

The chi-square value is 87.5994 and the p -value is < 0.00001 . The result is significant at $p < .05$.

Conclusion : there is a relationship between designation and willingness to train more for waste management techniques.

● **FOR OBJECTIVE 2 and 3:- Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)**

a. H_{01} : There is no significant impact of Recycling (RC) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)

H_{A1} : There is significant impact of Recycling (RC) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Recycling	384 (350.10) [3.28]	805 (733.50) [6.97]	36 (45.00) [1.80]	24 (43.20) [8.53]	2 (79.20) [75.25]	1251
Non-recycling	5 (38.90) [29.54]	10 (81.50) [62.73]	14 (5.00) [16.20]	24 (4.80) [76.80]	86 (8.80) [677.25]	139
Column Totals	389	815	50	48	88	1390 (Grand Total)

The chi-square value is 958.3602 and the p -value is < 0.00001 . The result is significant at $p < .05$

Conclusion : There is significant impact of Recycling (RC) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

b. H_{02} : There is no significant impact of Green Disposal (GD) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)

H_{A2} : There is significant impact of Green Disposal (GD) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP)

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Disposal	274 (253.83) [1.60]	905 (839.95) [5.04]	79 (85.84) [0.55]	24 (41.54) [7.40]	1 (61.84) [59.86]	1283
Non-Disposal	1 (21.17) [19.22]	5 (70.05) [60.41]	14 (7.16) [6.54]	21 (3.46) [88.77]	66 (5.16) [717.74]	107
Column Totals	275	910	93	45	67	1390 (Grand Total)

The chi-square value is 967.1248 and the p -value is < 0.00001 . The result is significant at $p < .05$.

Conclusion: There is significant impact of, Green Disposal (GD) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

c. H_{03} : There is no significant impact of Reuse (RU) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

H_{A3} : There is significant impact of Reuse (RU) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Reuser	364 (341.10) [1.54]	698 (653.24) [3.07]	179 (180.36) [0.01]	57 (73.83) [3.84]	1 (50.46) [48.48]	1299
Non-Reuser	1 (23.90) [21.94]	1 (45.76) [43.78]	14 (12.64) [0.15]	22 (5.17) [54.75]	53 (3.54) [692.01]	91
Column Totals	365	699	193	79	54	1390 (Grand Total)

The chi-square value is 869.6609 and the p -value is < 0.00001 . The result is significant at $p < .05$.

Conclusion: There is significant impact of, Reuse (RU) on Staffs' Perception (SP) with regard to Sustainable waste management Practices (SWMP).

● **FOR OBJECTIVE 4:- Impact of various identified factors on Sustainable waste management behaviour (SWMB)**

a. **H₀₁:** There is no significant impact of 'Disposal Knowledge' (DK) on users, Sustainable waste management behaviour (SWMB).

H_{A1}: There is significant impact of 'Disposal Knowledge' (DK) on users, Sustainable waste management behaviour (SWMB).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Knowledgeable	274 (247.50) [2.84]	754 (680.40) [7.96]	184 (173.70) [0.61]	36 (99.00) [40.09]	3 (50.40) [44.58]	1251
Ill-informed	1 (27.50) [19.22]	2 (75.60) [60.41]	9 (19.30) [6.54]	74 (11.00) [360.82]	53 (5.60) [40.21]	139
Column Totals	275	756	193	110	56	1390 (Grand Total)

The chi-square value is 960.7905 and the *p*-value is < 0.00001. The result is significant at *p* < .05.

Conclusion: There is significant impact of 'Disposal Knowledge' (DK) on users, Sustainable waste management behaviour (SWMB).

b. **H₀₂:** There is no significant impact of 'Segregation Concern' (SC); on users, Sustainable waste management behaviour (SWMB).

H_{A2}: There is significant impact of 'Segregation Concern' (SC); on users, Sustainable waste management behaviour (SWMB).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Concern for Segregation	362 (344.72) [0.87]	734 (699.88) [1.66]	154 (161.44) [0.34]	67 (88.32) [5.15]	3 (25.64) [19.99]	1320
No Concern	1 (18.28) 16.34]	3 (37.12) [31.36]	16 (8.56) [6.46]	26 (4.68) [97.02]	24 (1.36) [376.98]	70
Column Totals	363	737	170	93	27	1390 (Grand Total)

The chi-square statistic is 556.165. The *p*-value is < 0.00001. The result is significant at *p* < .05.

Conclusion: There is significant impact of 'Segregation Concern' (SC); on users, Sustainable waste management behaviour (SWMB).

c. **H₀₃:** There is no significant impact of 'Social Influence' (SI); on users, Sustainable waste management behaviour (SWMB).

H_{A3}: There is significant impact of 'Social Influence' (SI); on users, Sustainable waste management behaviour (SWMB).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Influenced	275 (257.80) [1.15]	755 (709.41) [2.93]	184 (190.10) [0.20]	67 (92.73) [7.14]	8 (38.95) [24.59]	1289
Non-influenced	3 (20.20) [14.65]	10 (55.59) [37.39]	21 (14.90) [2.50]	33 (7.27) [91.14]	34 (3.05) [313.84]	101
Column Totals	278	765	205	100	42	1390 (Grand Total)

The chi-square statistic is 495.5212. The *p*-value is < 0.00001. The result is significant at *p* < .05.

Conclusion: There is significant impact of 'Social Influence' (SI); on users, Sustainable waste management behaviour (SWMB).

d. **H04:** There is no significant impact of 'Governmental Initiative' (GI); on users, Sustainable waste management behaviour (SWMB).

HA4: There is significant impact of 'Governmental Initiative' (GI); on users, Sustainable waste management behaviour (SWMB).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Effective	295 (273.85) [1.63]	758 (710.54) [3.17]	179 (178.56) [0.00]	46 (66.61) [6.38]	8 (56.44) [41.57]	1286
Non-effective	1 (22.15) [20.19]	10 (57.46) [39.20]	14 (14.44) [0.01]	26 (5.39) [78.87]	53 (4.56) [514.03]	104
Column Totals	296	768	193	72	61	1390 (Grand Total)

The chi-square statistic is 705.0626. The *p*-value is < 0.00001. The result is significant at *p* < .05.

Conclusion: There is significant impact of 'Governmental Initiative' (GI); on users, Sustainable waste management behaviour (SWMB).

e. **H05:** There is no significant impact of 'Waste disposal Knowledge & Information' (WKI); on users, Sustainable waste management behaviour (SWMB).

HA5: There is significant impact of Waste disposal Knowledge & Information' (WKI); on users, Sustainable waste management behaviour (SWMB).

RESULTS						
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Row Totals
Significant	295 (276.62) [1.22]	750 (702.77) [3.17]	184 (191.58) [0.30]	67 (93.45) [7.49]	3 (34.58) [28.84]	1299
Non-significant	1 (19.38) [*] [17.43]	2 (49.23) [45.31]	21 (13.42) [4.28]	33 (6.55) [106.89]	34 (2.42) [411.65]	91
Column Totals	296	752	205	100	37	1390 (Grand Total)

The chi-square statistic is 626.587. The *p*-value is < 0.00001. The result is significant at *p* < .05.

Conclusion: There is significant impact of 'Waste disposal Knowledge & Information' (WKI); on users, Sustainable waste management behaviour (SWMB).

Suggestions and Recommendations

- Hospitals are generally obligated to society to uphold a hygienic environment and organize litter in order to shun pollution and contagion within and in the vicinity of the hospital.
- Medical and related equipment that are used in a health-care industry can be reused if it is planned for the same and will endure the sterilization process.
- Superior health care waste management practices in a hospital subject to devoted waste handling team, fitting supervision, tactful arrangement, responsible union, nurturing legislation, ample funding, and complete involvement of the trained staff.
- Growing on the Resource maintenance policy a plan for recycle strategy should be pursued, to not only

reduce excess waste in the initial steps but to also provide feasible end product.

- It is necessary to consider explanation of the costs of different disposal practices and not just the cost of the recycling process but also the worth of the domesticated material.
- Making note of the quantum of common waste as well as bio-waste produced and managing routine observation of health care waste organization tradition, the hospitals can help in preserving the environment.
- Segregation of medical waste should be done at the point of production.
- Motivating entrepreneurs to utilize the waste as raw materials for setting up business prospect is a

different approach to minimize health risk to humans and decrease environmental hazards as a result of improper management and discarding of waste.

9. Advancement of an accreditation system for hospitals slot in health care waste executive in itself is a big step forward for ensuring proper biomedical waste management.

Conclusion

Though there were limitations in the review that was conducted, but it allowed for some conclusions to be drawn on the basis of analysis. Guidance and regular check of the hospital staff on safe waste management and disposal practices can enhance waste minimization. There is need to obtain modern facilities for delivery of hospital waste such as modern trolley and wheel-dustbins by the administration. The hand gloves, chemicals and other shielding gears should be made accessible by the ministry of health for the utilization by the personnel in the hospitals. Medical personnel when encouraged to report cases of injuries from used objects especially sharp objects can help provide treatment at the apt time. The medical personnel's regular preparation on the theme of universal precaution and appropriate instructions on treatment of injury by sharps and post exposure prophylaxis should be provided. There is need is to use methodically designed knowledge conversion strategies together with the use of theory-based strategies to persuade research activities. There should be combined advanced demands for the grouping of specialist in solid medical waste management and amassed disciplines all over the continent to decipher and combine available technology, proficiency, funding and best activities to bear on solid waste management. All of these activities can be comprehended as a consequence from the interaction of aptitude (the individual's logical and physical aptitude to connect with the activity in question), prospect (cause external to the individual that make activities likely), and inspiration (drivers that uplift and express behaviour).

Scope of future study

- Further study on the prospect as to whether guidance and regular check of the hospital staff on safe waste management and disposal practices can enhance waste minimization.
- Further study on the need of new technology in relation to theory-based strategies can be enthused.

- Further study on the relation of advancement of an accreditation system for hospitals slot in health care waste executive for ensuring proper biomedical waste management is needed.

Limitations of the study

This study has the following limitations:

1. Due to time and sources constraint many of the research work around the world were not considered which could have made an impact on the study.
2. The factors identified affecting the mobile application usage is limited to the various studies considered.
3. The study conducted by various researchers may have limitations of their own which we could not be familiar with.

References

- Abor Patience Aseweh**, "Medical waste management practice in a Southern African hospital", *J. Appl. Sci. Environ. Manage.* Vol. 11(3) 91 – 96 ISSN 1119-8362, September 2007, www.bioline.org.br/ja.
- Arshad Nosheen, et al**, "Hospital Waste Disposal: A Review Article, Lahore, Pakistan". Nosheen Arshad et al *J. Pharm. Sci. & Res.* Vol.3 (8), 1412-1419, 2011.
- Central Pollution Control Board of India (CPCB)**, "Status of solid waste management in metro cities", CPCB, 1998.
- Dr. Rajeswari B.** "Procedural Bio-Medical Waste Management – A Comparison with International Standards" *Bonfring International Journal of Industrial Engineering and Management Science*, Vol. 2, No. 4, December, 2012.
- Dr. Banu Asima, et al**, "Challenges Of Hospital Solid Waste Management; Case Study In A Tertiary Care Hospital" *International Journal of Current Research* Vol. 7, Issue, 01, pp. 12099=1210, January, 2015.
- Dr. Agarwal Raveesh, et al**, "Waste management initiatives in india for human well being" **European Scientific Journal** June 2015 /SPECIAL/ edition ISSN: 1857 – 7881 (Print) e - ISSN 1857- 7431, 2015.
- Joshua I. A., et al**, "Hospital Waste Management as a Potential Hazard in Selected Primary Healthcare Centres in Zaria, Nigeria" *Nigerian Journal of Technology (NIJOTECH)* Vol. 33. No. 2, University of Nigeria, Nsukka, ISSN: 1115-8443 pp 215-221 April 2014, <http://dx.doi.org/10.4314/njt.v33i2.11> www.nijotech.com
- Ministry of Environment and Forests**, "Bio-Medical Waste (Management and Handling) Rules", New Delhi, 1998.
- Maroufi Maryam, et al**, "Function of nurses and other staff to minimize hospital waste in selected hospitals in Isfahan" *Iran J Nurs Midwifery Res.* 2012 Sep-Oct; 17(6): 445–450. 445-450, PMID: PMC3733291 PMID: 23922587, 2012.

- Mensah Anna Araba**, "Solid Medical Waste Management Practices: A Case Study at TheSefwi – Wiawso Government Hospital", kwame nkrumah university of science and technology, institute of distance learning, department of environmental science, December 2012,.
- Macleod Malcolm R, et al**, "Biomedical research: increasing value, reducing waste", pages 156, 166 and 176, January 8, 2014 [http://dx.doi.org/10.1016/S0140-6736\(13\)62329-6](http://dx.doi.org/10.1016/S0140-6736(13)62329-6)
- Mengesha Hunachew B., Dessalegn Biruck Y.**, "Solid waste Characterization and Recycling Potential in Hawassa University, Ethiopia", World Academy of Science, *Engineering and Technology International Journal of Environmental and Ecological Engineering* Vol:8, No:2, 2014.
- Macaulay Babajide Milton and Odiase Frank Muhammed**, "Medical waste management practices in developing countries: A case study of health facilities in Akure, Nigeria" *Article in International Journal of Environment and Waste Management*, DOI: 10.1504/IJEW.2016.076756, January 2016, <https://www.researchgate.net/publication/303853575>.
- Moher, D, et al**, "Increasing value and reducing waste in biomedical research: who's listening?", University of Plymouth, <http://hdl.handle.net/10026.1/4917> 10.1016/S0140-6736(15)00307-4 LANCET, 2016.
- Quality Council of India**, "Standards for Hospital" National Accreditation Board for Hospitals and Healthcare Providers, 2005, <https://qcin.org/structure.php>
- Robinson W.D.**, "The Solid Waste Handbook: A Practical Guide", John Wiley and Sons, *Chichester*, 1986.
- Reno Joshua**, "waste and waste management", Anthropology Faculty Scholarship, October 2015, https://orb.binghamton.edu/anthropology_fac/1
- Singh Satnam Singh and Prakash Vinit**, "Toxic Environmental Releases from Medical Waste Incineration: A Review", *Environ Monit Assess* 132:67–81 DOI 10.1007/s10661-006-9503-3, 2007.
- Udofia Emilia Asuquo, et al.**, "solid medical waste management in Africa", *African journal of environmental science and technology*, Vol. 9(3), Doi: 10.5897/AJEST2014.1851, ISSN: 1996-0786, March 2015, pp. 244-254 <http://www.academicjournals.org/AJEST>
- World health organisation**, "report of a WHO consultation on public health issues related to animal and human encephalopathies". Geneva, World Health Organization, 1992.
- Waste.net**, "Reduce, reuse, recycle, recover The four R's" , 2018 <https://www.waste.net/4/recover/index.html>.

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– Claudia Black

Cost Benefit and Economic Return on Productivity of Reuse and Recycle in Ernakulam

T. DHANALAKSHMI

On an average 6000 tonnes/day of municipal solid waste is being generated in Kerala. Paper, glass, bottle, plastic, metal, cans and dry waste together comprise 60% - 85% of total material. In terms of revenue, these materials represent from 75 to 90% of total monthly income. Thus, given its importance the objectives are to arrive at average production, to get an estimated amount of resource recovered and to calculate cost benefit of reuse and recyclable waste. Both primary and secondary data were used. This study not only reduces waste production, but also initiates reuse of the materials considered waste.

INTRODUCTION

It is evident that in Kerala, there is a large informal sector of waste recycling and reuse within which various groups of workers have differential access to various types of waste. On an average 6000 tonnes/day of municipal solid waste is being generated in Kerala. Paper, glass, bottle, plastic, metal, cans and dry waste together comprise 60% - 85% of total material of MSW and, in terms of revenue, these materials represent from 75 to 90% of total monthly income. Resource recovery from waste is an important method of producing reuse and recycle waste. Given the existence of well-established informal and private sector systems of waste trading, it might seem that a city like Ernakulam is in no need of any intervention to support the productivity of reuse and recycle waste. It should be remembered; however, that Ernakulam, like so many of the thousands of cities in the developing world, is under great pressures of modernization and change. It is a city that is officially unaware of its traditions of waste recycling. Even though the municipalities have a relatively small amount of waste to deal with daily, they are not able to handle that efficiently.

Waste can become wealth if properly managed. One of the important steps emphasized in zero waste management is reduction of waste through productivity of reuse and recycle. Reuse includes using waste as fertilizer. Recycling turns waste materials into valuable resources. It also generates a host of financial, social and environmental benefits. Recycling involves collection, sorting and processing waste into new products. Upon recycling, waste becomes an "asset" and its value increases. It reduces and relieves the ecological burden from the earth's ecosystem and significantly enlarges the earth's "carrying capacity" (Sinha, 1996). Another way of

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recovering resources from waste is its conversion. Conversion is often associated with organic waste like vegetable or animal matter or organically decomposable materials. It is a process based on anaerobic digestion of organic matter in which microorganisms break down biodegradable material in the absence of oxygen. It produces methane and carbon dioxide rich biogas suitable for energy production.

1.1 Waste Generation

Ernakulam generates approximately 550 tonnes of residential and commercial solid wastes per day. Besides the above activities another important waste generating sector is the bio-medical unit. These are the medical treatment and health centers generating hazardous waste in the city. The total amount of waste generated by this activity is 9589.17 kg/day.

The residential waste, which contributes the maximum waste generation of 3.0 tonnes per day per ward in corporation and 0.3 to 0.5 tonnes per day per ward in other municipalities is the result of household with higher paying abilities living in the city centre generated more waste when compared to others.

The prominent commercial activities in a ward of Cochin Corporation generate more than 5 tonnes of waste per day and a ward in municipalities generate between 0.4 to 0.9 tonnes of waste per day.

The industrial and biomedical units in city contribute the hazardous waste generation. Among the industries the most polluting ones are oil refineries, electroplating and service stations. The waste generated by these industries is toxic and hazardous in characters. Ernakulam generated 45560.80 MTA of hazardous waste from industries. However, no proper disposal techniques are available for the industrial waste generation in the city. In the case of hazardous waste management with the initiative of the Kerala State Industrial Development Corporation and the Industries Department, the Government is planning to have a common facility at a central place in the State.

1.2 Productivity of Reuse and Recycle

International bodies and environmental movements now place emphasis on recycling as part of an environmental ethic for resource conservation and waste reduction (World Commission on Environment & Development, 1987, pp. 253-255). Most of the materials recovered through

recycling are traded through informal trading system like Waste pickers, waste buyers, small waste-trading shops, larger dealers, wholesalers and recycling enterprises (Furedy, 1990, pp.18-19). In spite of increase in waste materials the waste buyers believe that the trade in this has become more competitive recently. In addition, the waste buyers operate under the typical handicaps of informal work and enterprises (Samal, 1990).

The productivity of reuse and recycle in Ernakulam is supported by a small community of rag pickers, retail and wholesale dealers and recycling units. The present study briefly highlights the productivity of reuse and recycles at household level and the activity of rag picking community in resource salvaging. The methodology used to study the productivity of reuse and recycle in the study area is listed below.

2. Data Sources and Methodology

The study is based on primary and secondary data. The study assumes that each household generates an average amount of reuse and recyclable materials from waste per month (limitation). Data for the study were collected as follows

- The secondary data were collected from Cochin Corporation and Kalamassery, Aluva, Angamaly, Paravur, Thiruppunithura, Perumbavoor, Muvattupuzha, Kothamangalam, Eloor, Koothathukulam, Maradu, Piravam and Thrikakara municipalities.
- The primary data was collected from 25 units comprising retail and wholesale dealers from different parts of the city. This information is used to arrive at average production of reuse and recyclable waste from households in each municipality and the Corporation.
- The average renewable waste generated per month is multiplied by the household data for each municipality and the Corporation to get an estimated amount of resource recovered from waste.
- Reuse and recyclable rate of organic waste and its cost benefits are calculated based on the information collected from Cochin Corporation.
- Data collected from 30 households who were using biogas plants with kitchen waste as feeding materials relate to Kalamassery municipality.

3. Results and Discussions

Quality of Municipal Solid Waste in Ernakulam

The physical characteristics of solid wastes vary widely based on socio-economic, cultural and climatic conditions. The study on physical qualities of solid waste like bulk density, its moisture content etc., help to identify solid waste management practices like disposal, recycling and other processing methods. Information on the chemical composition of solid wastes is important in evaluating processing and recovery options. In addition, the study helps in adopting and utilizing proper equipment and techniques for collection and transportation. The chemical characteristics like pH, chemical constituents like carbon content and N, P, K micronutrients of municipal solid waste help the decision maker to select proper waste management technology.

3.1 Physical Composition of Municipal Solid Waste

The physical composition of municipal solid waste is important for deciding the prime management actions namely the reduction, reuse and recycling of waste. According to Kerala State Urban Development Programme, 2007, the composition consists of paper 4.87%, plastic-4.83%, Metal-0.35%. Glass-1.06%, Rubber and leather 1.5%, Inerts-1.74%, Ash and fine earth-1.68%, compostable organics 79.78%, Domestic hazard-0.28% and others-3.91%.

3.2 Chemical Characteristics of Municipal Solid Waste

The chemical characterization of waste is important to understand the utilization as well as the pollution potential of solid waste. According to Kerala State Urban Development Programme report the chemical characteristics of municipal solid waste in Kochi are as follows; density-267.81kg/m³, moisture content-55.29%, calorific value-1759K. cal/kg, pH-7.46, C-26.39%, N-1.25%, C/N-21.11%, P as P₂O₅-129.25%. The heavy metal content of municipal solid waste contains Ar-5.72Mg/kg, Ni-4.49ppm, Cd-0.38ppm, Pb-2.48ppm, Cu-47.53ppm, Zn-98.98ppm and Hg <0.1Mg/kg.

3.3 Reuse and Recyclable Waste - Households

The materials that are produced for reuse and recycling from the households are plastic, paper (news papers, magazines, etc.) metal and glass. These materials are considered as waste by households but are retained for selling. They are sold to retail or whole sale dealers.

The approximate amount of waste produced from households in each municipality and the Corporation is the average production per household. The average production of reuse and recyclable products per household is as follows.

Newspaper, Magazines and Books – 5 kg/ 3 months/ household

Plastics – 1 kg/ 3 months/ household

Metals – 1kg/3months/household

Glass – 1.5kg/3 months/household.

Table 1 shows the households 'productivity of reuse and recyclable materials/3 months. Ernakulam, the study area produces 1477.16 tonnes of paper, 296.20 tonnes of plastic, 296.20 tonnes of metal and 442.06 tonnes of glass.

Table 2 shows earnings per household through reuse and recyclable materials in lakhs and it indicates that the average earnings per household of Ernakulam is 395.09 lakhs

Table 3 shows waste bought and sold by dealers. The waste dealers bought at Rs. 10/-kg for paper and sold at Rs. 12/kg. For plastics, the waste dealers bought at Rs. 16/kg and sold at Rs. 20/kg. For metals, the buying price was Rs.30/kg and the selling price Rs. 40/kg. And for glass the buying price was Rs. 4/bottle and selling price of Rs. 6/kg.

On an average they have the profit margin of more than 20 percentage.

Besides recovery at household level, waste is also recovered from community bins, transfer stations and land fill sites by rag pickers.

3.4 Waste Recovery by Rag Pickers

The rag pickers play a very important role in the recovery process of solid waste. Solid Waste is recovered at 3 stages by rag disposed waste. Three groups of rag pickers can be identified based on collection, they are as follows:

- Primary collectors i.e. rag pickers collecting from community bins and the road sides, where the waste is discarded.
- Secondary collectors i.e. rag pickers collecting from transfer stations.
- Tertiary collectors i.e. pickers from the landfills.

The average amount of waste recovered by rag pickers per day from dumpsite is in table 4.

TABLE 1. Households' production of reuse and recyclable materials/3 months

Name of the Municipality/Corporation	Paper Tonnes	Plastic Tonnes	Metal Tonnes	Glass Tonnes
Perumbavoor	35.13	7.02	7.02	10.54
Angamaly	41.83	8.40	8.40	12.54
Aluva	28.03	5.60	5.60	8.41
Koothattukulam	21.56	4.31	4.31	6.46
Piravam	34.03	6.80	6.80	10.21
Paravur	39.37	7.90	7.90	11.81
Kochi	791.94	158.38	158.38	237.58
Maradu	55.80	11.10	11.10	16.76
Kalamassery	88.79	17.76	17.76	26.63
Thrikkakara	96.64	19.30	19.30	28.99
Eloor	41.83	9.20	9.20	13.77
Thrippunithura	115.68	23.13	23.13	34.70
Muvattupuzha	37.99	7.60	7.60	11.39
Kothamangalam	48.54	9.70	9.70	12.27
Total	1477.16	296.20	296.20	442.06

Source: Survey data

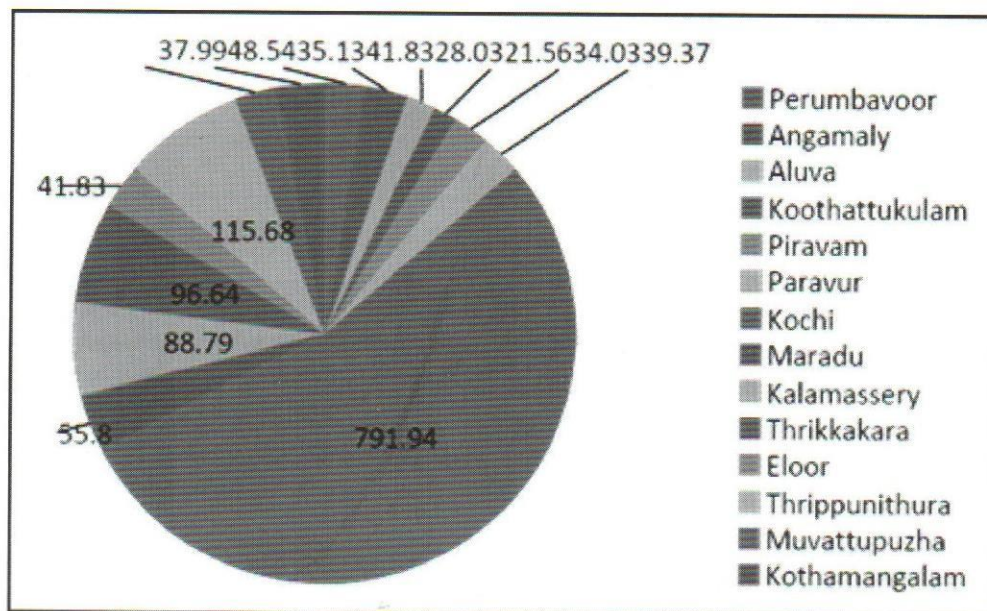


Fig. 1. Households production of reuse and recyclable material per 3 months

TABLE 2. Earnings per household through reuse and recyclable materials in lakhs (Average earnings/3 months)

Name of the municipality/Corporation	Average earnings/3 months
Perumbavoor	7.85
Angamaly	29.49
Aluva	7.06
Koothattukulam	10.33
Piravam	8.50
Paravur	9.93
Kochi	199.61
Maradu	14.03
Kalamassery	22.37
Thrikkakara	24.34
Eloor	11.16
Thrippunithura	29.08
Muvattupuzha	9.57
Kothamangalam	11.77
Total	395.09

Source: Survey data

TABLE 3. Waste bought and sold by dealers

Materials	Quantity Kg/day	Buying price Rs./kg	Selling Price Rs./kg
Paper	15	10	12
Plastics	5	16	20
Metals	5	30	40
Glass	25-50 bottles	4/bottle	6/bottle

Source: survey data

Rag pickers who collect wastes from streets earn rupees 20/kg/day from plastic, rupees 5/kg/day from paper, rupees 30/kg/week from metals and rupees 20/kg/week from glass. The waste collected is sold either to retailers or wholesalers.

3.5 Waste Dealers and Recycling Units

The reusable waste materials collected by the door-to-door waste collectors as well as street and dumpsite rag pickers

sell to middlemen, who, in turn, sell them to small recycling units. Waste recycling involves sorting, cleaning and processing of solid waste. The various recyclable materials from municipal solid waste in the study areas are discussed.

3.5.1. Plastics

Waste dealers cater to the demands of recycling units located in the same region. The plastic items used for recycling are bottles, scraps, containers, buckets, toys,

TABLE 4. Waste recovery by rag pickers in collection points (bins) and dumpsites.

Materials	Quantity	Selling Price
Paper	1kg/day	Rs. 5/kg
Plastics	3kg/day	Rs. 20/kg
Metals	1kg/week	Rs. 30/kg
Glass	1kg/week	Rs. 20/kg

Source: Survey data

polythene and PVC. There are well developed plastic recycling establishments in the city. The recycling units practice simple techniques of melting the plastic and molding it to new materials which the market can absorb. Some of the units convert the plastic into pellets and transport them to the units where they are molded into new products.

3.5.2 Paper

Paper recycling is an inter district and interstate activity. Besides recycling, paper is also sold for reuse. Recycled paper is an important part of the raw material used in the pulp and paper industry and is traded on a market that is global. The consumption and production is though fragmented globally and there are large differences in the consumption. The main use of recycled paper and cardboard is for the production of corrugated board, which in average contains as much as 91.8% recycled paper.

3.5.3 Metals

Most of the metal items include containers, utensils and parts of machines. These are usually sold for reuse. Other than reuse these are transported to other states for recycling purpose. The scrap merchants segregate all types of waste and send them for recycling units to Edayar (Iron & Steel Recycling Units), Perumbavoor (Plastic Recycling Units), Mettur, Salem (Iron & Steel Recycling Units), etc.

3.5.4 Glass

Recycling of glass in terms of cleaning and refilling of bottles as well as the use of broken glass in the production of new glass containers is well established in the glass industry. There are no glass manufacturing units in the city. The glass recovered from waste is transported mainly to other states.

3.6 Organic Waste Recovery in Ernakulam

The potentiality of organic waste is many. It can be processed and converted to manure or fuel pellets. The study of the nature of organic waste reveals that the fuel pellets have a calorific value of 3200 kilo calories per kg. With additives the value increases to 4000 calories per kg. Around 500 tonnes of organic waste can be converted to 100 tonnes of fuel pellets (Source:CMDA). Efforts have been made to convert organic waste to fuel pellets in cities like Baroda and Bangalore. In Ernakulam discussions are going on between the government and private organizations to set up pellets producing plants in Brahmapuram waste processing yard. It is a high capital intensive investment project. The establishment of such a project is an effective way of controlling solid waste pollution.

Another important way of utilizing organic waste is to convert it into manure. The Cochin Corporation is playing an important role in processing organic waste into manure. The technology used is simple. The process is called composting. Another technology is vermin-composting where earthworms are used to convert organic waste to manure. Many of the residential colonies in the Corporation and the Municipal areas are using this method to convert the organic waste into manure at the household level. Also the residential associations in the Cochin Corporation dug up eco-pits for collection of organic waste generated by residential colonies and its conversion to manure. These associations practice segregation of waste into organic and recyclable and reusable waste. However, these activity are restricted to a very few areas within the city. The regions (Cochin Corporation) process the organic waste for manure production, while a large quantity of organic waste generated by other municipalities is left unutilized at the dumpsites.

3.6.1 Cost and Economic Return on Productivity of Reuse and Recycle in Ernakulam

Households in the Cochin Corporation mostly segregate the organic waste and that is collected by the Corporation workers and transported to Brahmapuram processing plant. A nominal fee of Rs. 100/- per household is charged for this. The Cochin Corporation collected 200 tonnes/day of biodegradable waste and processed that into compost (100 tonnes/day). Earning from organic compost of Cochin Corporation is estimated to be Rs. 500000/day (Source: Cochin Corporation). Apart from that some households in the localities converted organic waste into compost at source and saved Rs. 30 per month the collection fee charged by the Corporation.

3.6.2 Material Recovery Rate

The percentage of waste stream recovered as usable secondary materials.

The generating pattern of solid waste in each municipality depends on activities generating waste. The generation rate for each ward is based on clearance of waste by local body. Ernakulam district generated a total waste of 550 tonnes per day. From that 412.5 tonnes of compostable organic waste is recovered per day. It has the potential of producing 206.25 tonnes of compost/day. It can be sold @ of Rs. 5/kg. On the basis of this the Corporation and municipalities in Ernakulam district can earn Rs. 1031250/- per day. However, a substantial amount or recyclable items such as plastic, glass, paper and metal along with household appliances are also disposed off along with the regular garbage in the municipalities. In some parts of the city, households make compost and biogas from organic waste.

In October 2000, the Ministry of Environment and Forest notified the Municipal Solid Waste (Management and Handling) Rules which require that all the cities should

$$\text{Material recovery rate \%} = 100\% \times \frac{\text{Amount of recyclable materials leaving the system}}{\text{Total amount of waste entering waste management system}}$$

Organic material recovery rate in Cochin Corporation

Total collected waste = 455 tonnes/day

Quantity of organic waste recovered for compost = 200 tonnes/day

Organic material recovery rate in % $\frac{200}{455} = 100\% \times 200$

= 43.95%

Production of compost from 200 tonnes of organic waste = 100 tonnes of compost

Cost of compost = Rs. 5/kg

Economic return from compost = Rs. 500000/day

set up suitable waste treatment and disposal facilities by 31st December 2001. The local bodies find it hard to acquire land, machinery, manpower and technology. This big challenge made them devise various solutions that include waste recovery and generation of energy from waste. Accordingly, organic wastes are to be converted into compost and biogas in the Corporation and municipalities. Some municipalities are trying to produce bricks and fencing poles from plastics with the help of National Small Industries Corporation. One tonne of plastic waste is supposed to produce 1000 bricks (Source:Kodungallur municipality)

An attempt has been made to study the feasibility for setting up of family type biogas plants in the study area to reuse and recycle the waste at source. The Asian Business Group has developed a new technology to treat the organic waste using bio technology method. The plant can be tailor made that depends upon the requirement of household.

3.6.3 Cost and Benefits of Biogas Plant

The main advantage of using organic waste as a feed for biogas plant is that its calorific value is higher when

compared to dung or excreta (www.arti-india.org).
Households make biogas from organic waste can save

Rs.4600/- per annum.

Production of bricks/tiles from 1 tonne of plastic waste (Size of the brick = 16inchX9inchX8inch)	=	8000 bricks
Cost of brick/tile	=	Rs.50/brick/tile
Production cost of 1 brick/tile	=	Rs.30/-
Total production cost for making 8000 bricks/tiles from 1 tonne of plastic waste (8000XRs.30)	=	Rs.240000/-
Market price for 8000 bricks/tiles(8000XRs.50)	=	Rs.400000/-
Revenue from bricks/tiles using plastic waste (Rs.400000-Rs.240000)	=	Rs.160000/- per tonne
(Ernakulam generated 550 tonnes of solid waste per day. This includes the plastic waste of 4.83% which amount to 26.56 tonnes of waste per day.)		
Therefore, the Economic return from 26.56 tonnes of plastic waste for Ernakulam	=	Rs.4249600/- per day.

TABLE 5. Cost and Benefits of Biogas Plant

Sl. No.	Description	Amount
1	Cost of construction of 1m ³ biogas plant	Rs. 20000.00
2	Operating cost (Repairs and Maintenance assumed at 3% of construction cost on a per annum basis)	Rs. 600.00
3	Annual cost on capital - Interest on capital investment @12%	Rs. 2400.00
4	Depreciation @4% per annum	Rs. 800.00
5	Total annual cost (Operating cost + Interest + Depreciation)	Rs. 3800.00
6	Annual gas production and replacement value of biogas plant Total gas production/ annum (365 x 0.250)	91.25kg
7	Assuming 12 LPG cylinders will be required for a household per annum(12 x700=8400) Replacement of biogas/annum (8400-3800)By using biogas, household can save Rs.4600/- per annum	Rs. 4600

3.6.4 Biogas Plant Impact Assessment

Biogas is a product of anaerobic fermentation of organic matters and consists of around 60-70% methane, 30-40% carbon dioxide. The input material for the biogas materials for biogas digesters are wastes that are found locally such as animal dung, agricultural residues and leaf litters from forests. The residues are introduced into a closed digester, where without the presence of free oxygen, the responsible microorganisms work successively to convert complex organic matter in to CH₄, CO₂, H₂, H₂S (Ramachandra, 2003).

According to the Appropriate Rural Technology Institute (ARTI) in Pune, a family size biogas plant has the potential to reduce the waste at source, which can be fed

with household organic waste. Users apply 1kg of organic waste daily and add 10 litres of water. In return the plant will produce around 250g of methane per day, enough to cook a full meal for a family of five. The gas could also be fed into a generator to provide around 1 kWh of electricity. One of the main advantages of using organic waste as the feedstock compared with dung or excreta is that its calorific value is considerably higher (www.arti-india.org). The various strengths and weaknesses of biogas using household waste in the study area are discussed in the following paragraphs.

4. Limitations of the Study

This study on productivity of reuse and recyclable waste material is completely based on average waste generation

data. It is also based on the assumption that all the households generated the average amount of recoverable waste.

5. Findings

The problems related to solid waste can be reduced to a great extent if a proper management system like reuse and recycle is practiced. An efficient management system not only takes into consideration environmentally safe disposal, but also salvaging of resources from waste. The reduction, reuse and recycling of waste are very efficient way of waste management. These techniques not only reduce the waste production, but also initiate reuse of the materials considered waste. Waste reaching the landfills is also reduced by a great quantity by practicing salvaging of resource from waste.

The potential of productivity of reuse and recyclable material in Ernakulam is: paper -1477.16 tonnes, plastic-296.2 tonnes, metal-296.2 tonnes and glass-442.06 tonnes from households/3 months in all the municipalities and the Corporation. This results in average earnings of Rs.395.09 lakhs during the reference period.

Waste bought and sold by the dealers generates a profit margin of more than 20%. Similarly, on an average the rag pickers collect waste from streets are plastic Rs.20/kg/day, paper Rs.5/kg/day, metals Rs. 30/kg/week and glass Rs.20/kg/week. The waste collected is sold to retail and whole sales.

Most of the metal items include containers, utensils and parts of machines which are usually sold for reuse. Other than reuse these are transported to other states for recycling purpose. The scrap merchants segregate all types of waste and send it for recycling units to Edayar (Iron & Steel Recycling Units), Perumbavoor (Plastic Recycling Units), Mettur, Salem (Iron & Steel Recycling Units), etc.

Since solid waste management involves the entire population, full cooperation from the public is to be ensured. Public awareness is essential to accept their role in terms of following the rules meticulously and payment of necessary taxes and service charges. Along with that public should initiate waste reduction at source. Though there are lot of activities in India in the field of source reduction, an important such activities are production of compost and biogas.

The organic waste recovery rate in Cochin Corporation is 43 per cent. Households in the Cochin

Corporation segregate the organic wastes which are collected and transported by the Corporation workers to Brahmapuram processing plant. It produces compost with an average of 50-100 tonnes per day. The compost is marketed at the rate of Rs.5/kg. Thus the organic waste recovery earns Rs.250000 to Rs.5,00,000 per day. It shows that Ernakulam has the potential of producing 206.25 tonnes of compost per day. It can earn revenue of Rs.1031250/- per day through organic waste recovery.

The disposal of plastic waste along with the municipal solid waste is the main problem for the urban local bodies. Recycling of plastic waste can resolve the issue. The study shows that Ernakulam generated 26.56 tonnes of plastic waste per day. It has the potential of producing brick/tiles from plastic waste and can earn revenue of Rs.4249600/- per day. It is experienced that bricks made from plastic waste improves the life of building and particularly the requirement of materials like sand, cement and aggregates is very much less when compared to other construction. This recyclable activity can minimize any harmful impact on environment especially to reduce the sand mining.

Some of the households in Ernakulam district produce biogas from kitchen waste. The replacement value of biogas for LPG is worked out to be Rs.4600/- per household per annum. Biogas plants provide several benefits. Organic waste is the most significant source of biofeed. By using kitchen waste as feed materials for biogas, 56.67% of the respondents get biogas only up to 1 hour. The study reveals that up to 50% savings in LPG is possible by using biogas. However, households did not have any clear idea on this as no measurement has been done or observations on this aspect. Cleanliness in the kitchen and environmental upgradation is an important benefit of biogas production. The user households have a positive feeling of realization of these benefits. More than 63% have reported that the biogas has reduced fuel expenses and 20% of the respondents reported that it reduced environmental pollution. Biogas is definitely an advantage as far as women are concerned. Female sex is more sensitive in operating of biogas than males. Forty percent of the biogas plant owners are very satisfied and 26.67%, satisfied. But 33.33% are dissatisfied about the performance of biogas plants. The reasons for dissatisfaction are due to inadequate waste quantity and thus reduce gas generation. This apart, society enjoys certain benefits in terms of environmental up gradation i.e. cleanliness in the absence of littered solid waste here

and there, conservation of land, water and air to maintain ecological balance etc.

6. Conclusions

Unfortunately, in Ernakulam the municipalities are not involved in waste recycling activity. The resource recovery practice is privately aided by community recycling units distributed within and outside the city. These units have been able to generate a demand resulting in employment opportunity for many as rag pickers. The waste is also recovered from the household level by the retail and wholesale units within the city. These small chains of activities are good source of resources recovery in the city. But the fact that large quantities of resources are lying unutilized in the landfills. Cochin Corporation took the initiative in separation of the organic waste and process into manure. A few households in Ernakulam segregate organic waste and process them into manure and energy by using vermicompost and biogas technology.

The enhancement of productivity of reuse and recycle can not only serve economic and social goals but also allows more effective use of the residual organic and inert wastes to achieve maximum recycling.

References

www.arti-india.org

Atasoylu, G., E.D. Evci, E. Kaya, F. Ergin, D. Tikir and E. Beser. (2007). "The household garbage in the western coast region of Turkey and its relationship with the socio-economic characteristics". *J. Environ. Biol.*, 28, P.225-229.

- Bijlani H.V. (1987). "Solid Waste Management", Arnold publications, New Delhi.
- Bridge water A.V., and Mumford C.J. (1979). "Waste Recycling and Pollution Control handbook", Reinhold Environmental series, New York.
- Dhanalakshmi R. & Shobha Iyer. (1999). "Solid Waste Management in Madras", Pudhuvazhvp Pathippagam (P) Ltd., Chennai.
- Furedy, C. (1990). 'Social Aspects of Solid Waste Recovery in Asian Cities', *Environmental Sanitation Review*, No. 30. Bangkok: Environmental Sanitation Information Centre.
- John R. Holmes. (1981). "Refuse Recycling and Recovery", John Wiley & Sons, New York.
- Mangalam News Paper. December 23 (2004). "Solid Waste Management Programme in Arppukara Panchayat".
- Samal, K.S. (1990). "Urban Informal Sector: Exploration of Informal sector in a small city of Orissa", Manak Publishing, New Delhi.
- Sinha, Rajiov K. (1996). "Environmental Crisis & Humans at Risk: Priorities for Action", INA Shree pub., Jaipur, pp.233-240.
- Tchobanoglous G. (2003). "Solid Waste Management in Environmental Engineering, (Ed. Salvato J.A., Nemerow N.L. and Agardy F.J), 5th Ed. John Wiley & Sons Inc, New Jersey.
- UNEP. (2005). *Solid Waste Management*, Compiled by Cal Recovery, Inc for United Nations Environment Programme. (www.unep.or.jp), p.558.
- World Commission on Environment and Development. (1987). 'Our Common Future', Oxford University press, Oxford.

We're all concerned about sustainable energy. If we could recycle waste heat to generate energy, we could use it for something useful."

– Mildred Dresselhaus

Identification of Factors Influencing Consumers thoughts on Green Marketing Practices: Application of Factor Analysis

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In the modern scenario of globalization, it has become a competitive one to keep the consumers in fold and even keep our natural environment safe. Green marketing is a phenomenon which has developed in the modern market and has emerged as an important concept in India as in other parts of the developing and developed countries which is seen as an important strategy of facilitating sustainable development. A majority of organizations around the world are making an attempt to reduce the harmful impact of production processes on the climate and other environmental conditions. They have comprehensively utilized the word green in marketing campaigns in the form of green marketing, green supply chains, green retailing, green consumers, green products, etc. hence the businesses and the marketers are taking the indication and are going green for the betterment of the entire society. This study is to analyze the thoughts of consumers on green marketing practices in Virudhunagar district. The researcher has used the factor analysis to identify the factors influencing the thoughts of consumers towards green marketing practices. The result reveals that advertisement and media, environmental protection, recycling of waste, green buying behaviour and preference of green products are the most influencing variables towards green marketing practices in Virudhunagar district.

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1. Introduction

In the emerging world, the concept of pollution free activity is given more importance in all the sectors and in all stages. The environmentalists are targeting the industrial sectors as the major contributors for depleting natural resources and environmental destruction. Hence, both production and marketing divisions of industries are stressed more to take utmost care in these areas along with fulfilling the market demands. To overcome these difficulties, a new concept has born in the present globalized world where production, consumption and also marketing of the products can be carried effectively ensuring environmental safety. This concept is named as 'Green Marketing' Rahul Singal et al.(2013).

Nidhi Aggarwal (2016), Green marketing is the marketing of products that are presumed to be environmentally safe. Thus, green marketing incorporates a broad range of activities, including product modification, changes to the production process, packaging changes, as well as modifying advertising. Today, Green marketing has moved from a trend to a way of doing business and that businesses should recognize the value of going green and incorporating this message into their marketing program and communicating the green concept to their consumers Shruti P Maheswari (2014).

Many global players in diverse businesses are now successfully implementing green marketing practices. Various studies by environmentalists indicate that people are concerned about the environment and are changing their behavioural pattern. The most of the consumers, both individual and industrial, are becoming more concerned about environment-friendly products. Majority of them feel that environment-friendly products are safe to use. As a result, green marketing has emerged, which aims at marketing sustainable and socially-responsible products and services.

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Now is the era of recyclable, non-toxic and environment-friendly goods. This has become the new mantra for marketers to satisfy the needs of consumers and earn better profits Yasmin Begum R.Nadaf et al. (2014)

Durgappa (2017) has reported that the corporate social responsibility has changed the role of marketing at large in India. In the social marketing concept, the long-term interests of the consumer and social welfare had taken a mainstream while profit making was expressed as a long-term objective. One of such CSR steps adopted by the corporate to show their green footprint was green marketing. There was a wide contradiction among marketing experts about the gap between attitude and behavior of the consumers regarding green consumption. The other group of experts was of opinion that while consumers were increasingly demanding environmental protection, their behavior did not really reflect this attitude. They were not aware of the damage being done to the environment out of their activities. Moreover, people were not knowledgeable of green alternatives and even if they were knowledgeable, they did not consider these green alternatives available and feasible. Many people thought that environmental protection was not their responsibility rather the fancy action should be taken not by them but by other institutional actors, mainly the state government and corporate. Therefore, this study is to examine the consumers' awareness on green marketing practices and to identify the factors influence the consumers' opinion

regarding green marketing practices in the study area.

Methodology

Objectives of the Study

- To examine the consumers awareness on green marketing practices.
- To identify the factors influencing of consumers thoughts towards green marketing practices.
- To offer suitable suggestions to enhance the practice of green marketing in the study area.

Method of Data Collection

This study covers both secondary data and primary data. The secondary data has collected from books, journals, records of the Government departments and the internet. The primary data has collected the pretested interview schedule from the sample respondents. There are totally 19,22,309 people living in Virudhunagar district as per 2010-2011 Census Report. The district has eight taluks such as, Aruppukottai, Kariapatti, Rajapalayam, Sattur, Sivakasi, Srivilliputtur, Tiruchuli, and Virudhunagar. Hence, the population is divided into eight strata according to the taluks. Then the samples are selected proportionately from each stratum by using **Judgement Sampling Method**. The Sample size i.e 384 has been identified by using online sample size calculator www.surveysystem.com and the details of sampling are shown in Table 1.

TABLE 1: Sample Design for Consumers

Sl. No.	Name of the Taluk	Total number of Population	Sample
1	Aruppukottai	2,46,186	49
2	Kariapatti	1,03,829	21
3	Rajapalayam	3,43,318	69
4	Sattur	1,66,659	33
5	Sivakasi	4,22,072	84
6	Srivilliputtur	2,89,895	58
7	Tiruchuli	1,01,568	20
8	Virudhunagar	2,48,782	50
	Total	19,22,309	384

Source: Census Report 2010–2011

Tools used for Analysis

The researcher has used **Percentage Analysis and Factor Analysis** with the help of Statistical Package for Social Sciences (SPSS). **Percentage Analysis** has been used throughout the study. In order to identify the factors influencing the customers' opinion regarding green marketing practices, the researcher has applied the **factor analysis**.

Results and Discussions

Consumers Awareness on Green Marketing Practices

Consumers provide real business opportunities. They are the present and future kingpins of business. Consumers are important drivers behind the move to save the environment. If consumers purchase eco-sensitive products and services, then manufacturers and service providers will be forced to put an end to non eco-friendly products. To know the awareness of the consumers on green marketing, some questions are asked and got the responses of the consumers. The responses are presented in the coming pages.

Concern about Green Practices

In general, consumer is a demand creator for the products. He/she is concerned about the price, quality and other

aspects of the products. Consumer's involvement on green practices is very important for this present situation. Table 2 displays consumers concern about green practices.

Table 2 discloses that out of 384 consumers, 279 consumers, accounting for 72.66 per cent, are concerned about the green practices and remaining 105 consumers (27.34%) are not concerned about the environment.

Reasons for not concerning about Green Practices

Normally consumers are having many reasons for not concerning about green practices. Table 3 shows the reasons for not concerning about green practices.

Table 3 exhibits that out of 105 consumers, those who are not concerned about green practices, 59 consumers accounting for 56.19 per cent, are not having awareness on green practices, 29 of them (27.62%) do not have interest on green practices and the remaining 17 of them (16.19%) don't have time to concern about green practices.

Opinion about Green Products

Opinion may vary from consumer regarding about the marketing practices. Table 4 furnishes the opinion of the consumers about green products.

Table 4 reveals that 162 consumers, constituting 42.19 per cent, are of the opinion that green products are

TABLE 2: Concern about Green Practices

S. No.	Particulars	No. of Consumers	Percentage to Total
1.	Concerned	279	72.66
2.	Not Concerned	105	27.34
	Total	384	100.00

Source: Primary data

TABLE 3: Reasons for Not Concerning about Green Practices

S. No.	Particulars	No. of Consumers	Percentage to Total
1.	No Awareness	59	56.19
2.	Not Interested	29	27.62
3.	No time	17	16.19
	Total	105	100.00

Source: Primary data

TABLE 4: Opinion about Green Products

Sl. No.	Particulars	No. of Consumers	Percentage to Total
1.	High Price	110	28.65
2.	Eco-friendly	162	42.19
3.	Not compatible	33	08.59
4.	Good for Health	79	20.57
	Total	384	100.00

Source: Primary data

eco-friendly in nature, 110 of them (28.65%) are of the opinion that green products price is high, 79 of them (20.57%) are opined that it is good for health and the remaining 33 of them (8.59%) are of the opinion that it is not compatible one.

Green Practices followed while shopping

Green practices means considering the environment while buying and using a product by the consumer. The details about green practices followed while shopping is presented in Table 5.

It is known from Table 5 that out of 384 consumers, 148 consumers accounting for 38.54 per cent, use the recyclable bags while shopping, 121 of them (31.51%) avoid the plastic bags while shopping, 91 of them (23.70%) prefer eco-friendly products while shopping and the remaining 24 of them (6.25%) avoid the packaged goods while making shopping.

Preferring Green Product Even at High Price

Some customers may prefer green products even at high price because he/she loves the nature. The information

TABLE 5: Green Practices followed while shopping

Sl. No.	Particulars	No. of Consumers	Percentage to Total
1.	Using Recyclable Bags	148	38.54
2.	Avoiding Plastic Bags	121	31.51
3.	Prefer Eco-friendly Products	91	23.70
4.	Avoiding Packaged Goods	24	06.25
	Total	384	100.00

Source: Primary data

TABLE 6: Preferring Green Product Even at High Price

Sl. No.	Particulars	No. of Consumers	Percentage to Total
1.	Prefer	261	67.97
2.	Do not prefer	123	32.03
	Total	384	100.00

Source: Primary data

regarding preference of consumers on green product even at high price by the customer is displayed in the Table 6.

Table 6 shows that out of 384 consumers, 261 consumers, constituting 67.97 per cent, prefer green product even at high price and the remaining 123 of them (32.03%) do not prefer green product when its price is high.

Awareness on Eco-Label

Some products are having product label along with special eco-care icons, such labels are green labels. The details of consumer awareness on eco-label are displayed in Table 7.

It is ascertained from Table 7 that, 256 consumers (66.67%) out of 384 consumers aware about eco-label and the remaining 128 of them (33.33%) are unaware about eco-label.

Opinion about Role of Government in Regulation of Green Marketing Practices Government’s role is very significant to regulate the green marketing practices. Central and state governments have taken some mandatory steps to sustain the nature. Table 8 presents the details of consumers’ opinion about government’s role in regulating green marketing practices.

The survey discloses that out of 384 consumers, 195 consumers, constituting 50.78 per cent, are not satisfied with the role of government in the regulation of green marketing practices and the remaining 189 of them (49.22%) are satisfied with the role of government in the regulation of green marketing practices.

Expectation of Consumers towards Role of Government with the Regulation of Green Marketing Practices

The researcher has further examined the expectation of consumers towards government’s role with the regulation of green marketing practices and the result is presented in Table 9.

Table 9 reveals that out of 195 consumers those who are expecting the role of Government in the regulation of green marketing practices, conducting awareness programme for development of green practices is expected by 42.05 per cent of the consumers, taking severe action against green violation is expected by 24.10 per cent of the consumers, giving cash awards to good followers is expected by 15.90 per cent of consumers, strict instruction for manufacturers/retailers to follow green practices is expected by 10.77 per cent of the consumers and banning of anti-green activities is expected by 7.10 per cent of consumers.

TABLE 7: Awareness on Eco-Label

Sl. No.	Particulars	No. of Consumers	Percentage to Total
1.	Aware	256	66.67
2.	Unaware	128	33.33
	Total	384	100.00

Source: Primary data

TABLE 8: Opinion about Role of Government in Regulation of Green Marketing Practices

Sl. No.	Particulars	No. of Consumers	Percentage to Total
1.	Satisfactory	189	49.22
2.	Not Satisfactory	195	50.78
	Total	384	100.00

Source: Primary data

TABLE 9: Expectation of Consumers towards Role of Government with the Regulation of Green Marketing Practices

S. No.	Particulars	No. of Consumers	Percentage to Total
1.	Instruct the manufacturers and retailers to follow green practices strictly	21	10.77
2.	Taking severe action against green violation	47	24.10
3.	Conducting awareness programme for development of green practices	82	42.05
4.	Giving Cash awards to good followers	31	15.90
5.	Ban anti-green activities	14	07.18
	Total	195	100.00

Source: Primary data

Consumers' Opinion towards Green Marketing Practices

During the survey, the consumers are given their opinion about the factors influencing the green marketing practices. The opinion is obtained for twenty three statements, which are related to the factors influencing the consumers' opinion regarding the green marketing practices by adopting scaling technique, namely, Likert Five Point Scale. Table 10 shows the details about consumers' opinion towards green marketing practices.

Table 10 discloses that majority of the consumers agree with all the factors in connection with the green marketing practices, the percentage is high for **"Agree"** and **"Strongly Agree"** scales.

Identification of Factors Influencing the Consumers Opinion Regarding Green Marketing Practices: Application of Factor Analysis

The researcher has used factor analysis to identify the factors influence the green marketing practices. There are several methods available for factor analysis. But the principle factor method with orthogonal varimax rotation maximizes the variance of the loadings within each factor. In the present study, the principal factor analysis method with orthogonal varimax rotation is used to identify the significance of different variable of consumer's thoughts on green marketing practices. The rotated factor loading received by factors F_1 , F_2 , F_3 , F_4 , and F_5 are presented in Table 11.

Factor I – Advertisement and Media

Consumers are the real assets of a business organization. Every business depends on its customers. Till a few years ago, consumers worried about the quality, quantity and price of products. But in the present scenario, consumers are also worrying about safeguarding the environment. So, consumers are important drivers behind the move to save the environment. Such consumers are called green consumers. Advertisement and Media make the consumers as green consumers. Table 12 displays the variables contributing to Factor - I.

Factor II - Environmental Protection

Green Marketing is a tool for protecting the environment for the present and future generations. It has a positive impact on environmental safety. Because of the growing concern of environmental protection, there is an emergence of a new market which is the green market. Table 13 exhibits the variables forming part of factor II.

Factor III - Recycling of Waste

Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. It can benefit our community and the environment. It reduces the amount of waste sent to landfills and incinerators and it also conserves natural resources. Table 14 portrays the variables forming part of Factor III.

TABLE 10: Consumers' Opinion towards Green Marketing Practices

S. No.	Particulars	VSA	SA	A	DA	SDA	Total
1	I know Green Products	139 (36.20%)	150 (39.06%)	85 (22.14%)	8 (2.08)	2 (0.52%)	384 (100%)
2	I am always using organic products	63 (16.41%)	149 (38.80%)	141 (36.72%)	30 (7.08)	1 (0.27%)	384 (100%)
3	I buy environmentally friendly products with my friends	69 (17.97%)	139 (36.20%)	133 (34.64%)	38 (9.89%)	5 (1.30%)	384 (100%)
4	I always share Information regarding eco- friendly products with my family Members	72 (18.75%)	138 (35.94%)	135 (35.16%)	35 (9.11%)	4 (1.04%)	384 (100%)
5	Supporting Environmental protection makes More	58 (15.10%)	150 (39.06%)	122 (31.77%)	42 (10.94%)	12 (3.13%)	384 (100%)
6	I am intended with switch over to other brand for ecological reasons	60 (15.63%)	128 (33.33%)	132 (34.38%)	60 (15.62%)	4 (1.04%)	384 (100%)
7	When I want to buy a product, I look at the ingredient label to see if it contains that are Environmentally Damaging	64 (16.67%)	131 (34.11%)	124 (32.29%)	48 (12.50%)	17 (4.43%)	384 (100%)
8	I prefer green products over non- green products Where their product qualities as similar	70 (18.23%)	127 (33.07%)	145 (37.76%)	37 (9.64%)	5 (1.30%)	384 (100%)
9	I buy green products even if they are more expensive than the non-green ones	54 (14.06%)	132 (34.38%)	126 (32.81%)	54 (14.06%)	18 (4.69%)	384 (100%)
10	I often urge my friends to use products that advertised as being Green	49 (12.76%)	137 (35.68%)	130 (33.85%)	57 (14.84%)	11 (2.86%)	384 (100%)
11	I would be willing to stop buying products from companies guilty of harming the environment even though it might be Inconvenient	67 (17.45%)	116 (30.21%)	133 (34.64%)	54 (14.06%)	14 (3.64%)	384 (100%)
12	I refuse to buy products from companies accused of being pollution	67 (17.45%)	127 (33.07%)	136 (35.42%)	39 (10.16%)	15 (3.90%)	384 (100%)
13	I buy products in refillable containers	68 (17.71%)	114 (29.69%)	133 (34.64%)	49 (12.76%)	20 (5.20%)	384 (100%)
14	I read labels to see if contents are environmentally safe	88 (22.92%)	113 (29.43%)	133 (34.64%)	42 (10.94%)	8 (2.08%)	384 (100%)
15	I avoid to buy the products in aerosol Containers	56 (14.58%)	134 (34.90%)	115 (29.95%)	60 (15.63%)	19 (4.94%)	384 (100%)
16	I believe recycling will reduce pollution	96 (25.00%)	109 (28.39%)	116 (30.21%)	51 (13.28%)	12 (3.12%)	384 (100%)
17	Recycling is important to save natural resources	108 (28.13%)	118 (30.73%)	104 (27.08%)	46 (11.98%)	8 (2.08%)	384 (100%)
18	I am always separating and Maintaining biodegradable Wastes from non-degradable	83 (21.61%)	108 (28.13%)	136 (35.42%)	45 (11.72%)	12 (3.12%)	384 (100%)
19	I don't throw non-biodegradable waste in the open areas Surroundings	99 (25.79%)	140 (36.46%)	104 (27.08%)	29 (7.55%)	12 (3.12%)	384 (100%)
20	I would like to watch green advertisements More	50 (13.02%)	147 (38.28%)	98 (25.52%)	82 (21.35%)	7 (1.83%)	384 (100%)
21	I know the most of the green companies	60 (15.63%)	96 (25.00%)	103 (26.82%)	94 (24.48%)	31 (8.07%)	384 (100%)
22	I am a dark green consumer (always buying green products or using Green Services)	67 (17.45%)	109 (28.39%)	119 (30.99%)	69 (17.97%)	20 (5.20%)	384 (100%)
23	I bring my own shopping bags instead of using plastic bags or paper sacks offered by Sellers	81 (21.09%)	124 (32.29%)	123 (32.03%)	37 (9.64%)	19 (4.95%)	384 (100%)

Source: Primary Data

Note: VSA – Very Strongly Agree; SA – Strongly Agree; A – Agree; DA – Disagree; SDA – Strongly Disagree.

TABLE 11: Rotated Factor Matrix with Communalities for Consumers' Thoughts on Green Marketing Practices in Virudhunagar District

S. No.	Statement	Number of Factors					Communality (h ²)
		F1	F2	F3	F4	F5	
1	I would like to watch green advertisements More	0.745	0.128	0.130	0.041	0.086	0.598
2	I know the most of the green companies	0.719	0.222	-0.079	0.112	-0.028	0.586
3	I am a dark green consumer (always buying green products or using Green Services)	0.668	0.016	0.212	0.084	0.243	0.558
4	Supporting Environmental protection makes More	0.018	0.660	0.062	0.239	-0.048	0.499
5	I buy environmentally friendly products with my friends	0.254	0.612	0.014	0.013	0.072	0.445
6	When I want to buy a product, I look at the ingredient label to see if it contains that are Environmentally Damaging	0.083	0.609	0.104	0.163	-0.077	0.421
7	I know Green Products	0.183	0.585	0.069	-0.149	0.233	0.457
8	I believe recycling will reduce pollution	-0.103	0.169	0.695	0.047	0.075	0.530
9	I am always separating and Maintaining biodegradable Wastes from non-degradable	0.117	-0.087	0.652	0.021	0.134	0.465
10	Recycling is important to save natural resources	-0.049	-0.045	0.542	0.339	-0.006	0.413
11	I bring my own shopping bags instead of using plastic bags or paper sacks offered by Sellers	0.375	0.138	0.504	0.119	-0.114	0.441
12	I buy products in refillable containers	0.102	-0.003	0.000	0.727	0.089	0.547
13	I avoid to buy the products in aerosol Containers	0.023	0.095	0.249	0.646	0.145	0.510
14	I would be willing to stop buying products from companies guilty of harming the environment even though it might be Inconvenient	0.024	0.376	-0.045	0.514	-0.138	0.427
15	I often urge my friends to use products that advertised as being Green	-0.095	-0.063	0.100	-0.134	0.601	0.402
16	I prefer green products over non-green products Where their product qualities as similar	0.237	-0.116	-0.035	0.104	0.555	0.390
17	I am intended with switch over to other brand for ecological Reasons	0.253	0.181	0.045	0.155	0.508	0.381

Source: Computed data

Note: The Principal Factor Method with Orthogonal Varimax Rotation is used to Extract Factors

Factor IV - Green Buying Behaviour

Green Consumerism must be encouraged by educating or creating awareness about eco-friendly buying behaviour. Finally consumers also have the ability to pressure organizations to integrate the environment into their corporate culture and thus ensure all organizations minimize the detrimental impact of their activities. It is

possible when using green buying behaviour. Table 15 shows the variables forming part of Factor IV.

Factor V - Preference of Green Products

Green Product means a product made from any eco-friendly raw material and it do not give any negative impact on the environment. Consumers prefer a product when its

TABLE 12: Factor I – Advertisement and Media

S. No.	Variables	Factor Loading	Communality (h ²)	Percentage of Variance
1	I would like to watch green advertisements More	0.745	0.598	11.016
2	I know most of the green companies	0.719	0.586	
3	I am a dark green consumer (always buying green products or using Green Services)	0.668	0.558	

Source: Computed Data

TABLE 13: Factor II – Environmental Protection

S. No.	Variables	Factor Loading	Communality (h ²)	Percentage of Variance
1	Supporting Environmental protection makes More	0.660	0.499	10.054
2	I buy environmentally friendly products with my friends	0.612	0.445	
3	When I want to buy a product, I look at the ingredient label to see if it contains that are Environmentally Damaging	0.609	0.421	
4	I know Green Products	0.585	0.457	

Source: Computed Data

TABLE 14: Factor III – Recycling of Waste

S. No.	Variables	Factor Loading	Communality (h ²)	Percentage of Variance
1	I believe recycling will reduce pollution	0.695	0.530	9.001
2	I am always separating and Maintaining biodegradable Wastes from non-degradable	0.652	0.465	
3	Recycling is important to save natural resources	0.609	0.421	
4	I bring my own shopping bags instead of using plastic bags or paper sacks offered by Sellers	0.504	0.441	

Source: Computed Data

environmental benefits are tangible and can be clearly and simply communicated. Table 16 shows the variable contributions the variable forming part of Factor-V.

Highest factor loadings under the dimensions namely: Advertisement and Media (F1), Environmental Protection (F2), Recycling of Waste (F3), Green Buying Behaviour

(F4) and Preference of Green Products (F5) respectively. Hence, these are the identified dimensions (factors), which influence the thoughts of consumers towards green marketing practices. Figure 1 shows that the consumers' thoughts on green marketing practices.

TABLE 15: Factor IV – Green Buying Behaviour

S. No.	Variables	Factor Loading	Communality (h ²)	Percentage of Variance
1	I buy products in refillable containers	0.727	0.547	7.24
2	I avoid to buy the products in aerosol Containers	0.646	0.510	
3	I would be willing to stop buying products from companies guilty of harming the environment even though it might be Inconvenient	0.514	0.427	

Source: Computed Data

TABLE 16: Factor V – Preference of Green Products

S. No.	Variables	Factor Loading	Communality (h ²)	Percentage of Variance
1	I often urge my friends to use products that advertised as being Green	0.601	0.402	7.698
2	I prefer green products over non- green products where their product qualities as similar	0.555	0.390	
3	I am intended with switch over to other brand for ecological Reasons	0.508	0.381	

Source: Computed Data

IDENTIFICATION OF FACTORS INFLUENCING CONSUMERS THOUGHTS ON GREEN MARKETING PRACTICES: APPLICATION OF FACTOR ANALYSIS

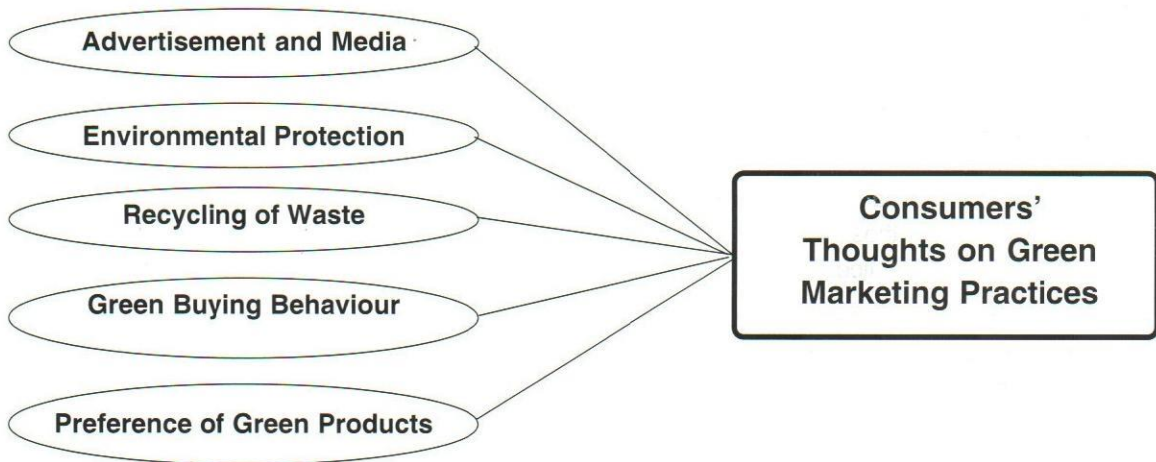


Fig. 1. Consumers' Thoughts on Green Marketing Practices

From the factor analysis, it is evident that all the factors that have been identified are important but they have all been rated differently. By incorporating these factors in the best proportion which all consumers of the study area having

more thoughts on green marketing practices. If all such green thoughts must bring in to action regularly by themselves then it helps to save our nature and also influences the attitude of sellers to sell green products more.

Suggestions of the Study

The researcher has given some suggestions for the government and consumers, based on the findings of the study.

- It is understood from the study that still many of the consumers are not having awareness on green marketing. In order to increase the awareness on green marketing practices among themselves, government and NGOs may conduct many awareness programmes like street plays, TV programmes, debates etc., Further it must give awareness to retailers, manufacturers and others by conducting orientation programmes, award recognition for best green sales, etc.,
- Government should initiate the mandatory action for banning the use of plastic bags in the study area. They should inspect the market frequently to the usage of plastic bags and they must take some penalty action against the consumers, retailers, manufactures and others those who are using such bags. Suppose it is unavoidable one, they made with more than 14 microns.
- Concerned with factor analysis, green consumer is the main factor for the development of the green marketing practices in Virudhunagar District. So, Government may recognize the award for 8 best consumers (each one from each taluk) those who are following green marketing practices continuously in the study area for every year under the title on "Best Green Consumers of the year" with cash prize and their performance must be published in the all local TV channels and other media. So, the publicity may encourage others also to follow green marketing practices seriously. At the same time government should initiate punishment for those who are completely violating green marketing practices in the study area.
- It is suggested that consumers are asked to buy green products voluntarily even though the price of green product is high for saving our nature. Because, the costs of green raw materials and green technology are high and they are imported from the other countries.

- It is suggested that consumers make a promise by themselves to strictly avoid the use of plastic bags for shopping and better to bring recyclable and reusable bags for shopping. Consumers must deny receiving plastic bags from the retailers or any other marketers.
- Consumers are suggested to use the resources optimally by different ways like switched off of electronic appliances when they are not needed; reduce, recycle and reuse of e-wastes, use refillable containers for purchase of liquid nature of products, completely eat or use products without waste like food items, medicines, fruits and vegetables, cosmetics and other products.
- It is suggested that consumers are asked to buy eco labeled green products for their use like star labeled electronic home appliances, green icon labeled products such as papers, garments and other products.

References

- Aggarwal Nidhi.** (2016). "Green Marketing – Challenges and Best Practices". *Indian Journal of Applied Research*, 6(6): 579-582.
- Chawala Deepak and Sondhi Neena.** (2014), "Research Methodology Concepts and Cases". *Vikas Publishing House Private Limited*, New Delhi.
- Durgappa.** (2017). "Status of Green Marketing and its Relevance India: A Descriptive Study". *International Journal for Innovative Research in Multidisciplinary Field*, 3(3): 59-64.
- Rahul Singal, Anuradha Garg and Sanjay Singla.** (2013). "Green Marketing Challenges and Opportunities". *International Journal of Innovations in Engineering and Technology*, 2(1): 470-474.
- Shruti P Maheswari.** (2014). "Awareness of Green Marketing and Its Influence on Buying Behaviour of Consumers: Special Reference to Madhya Pradesh, India". *AIMA Journal of Management and Research*, 8(1/4): 1-14.
- Tiwari J.** (2014) "Green Marketing in India: An Overview". *JOSR Journal of Business and Management*, 33-40.
- Yasmin Begum R.Nadaf and Shamshuddin M.Nadaf.** 2014. "Green Marketing: Challenges and Strategies for Indian Companies in 21st Century". *IMPACT: International Journal of Research in Business Management*, 2(5): 91-104.

"I only feel angry when I see waste. When I see people throwing away things we could use."

– Mother Teresa

sector found the platform with the support of the environmentalist. It became a challenging task for the government to fulfil the demand for electricity along with addressing the environmental concerns. The use of renewable energy is a viable solution for generating more power with reduced or no emissions. Out of the options available for renewable energy, solar energy and wind energy are considered to be feasible. However, solar energy is considered to be suitable and massive investments are made in this sector. A target of 100 GW of solar power generation by 2022 is to be set up by India.

Economic growth and social development will require more electrical power. Increased power demand will cause an effect on the environment resulting in soil erosion, air and water pollution along with damage to forests and vegetation. This damage to the environment will cause a threat to ecology and human health. Significant progress is observed in the power sector since Independence. The installed capacity of electrical power has increased from 1360 MW in 1947 to 356 GW in 2019 (CEA, 2019). With such a vast increase in the installed capacity, the concern towards the environment is also a debated issue. The share of fossil fuel has been 65% as compared to the renewable energy share of 35%. Global CO₂ emission was 33.1 Gton 2018. The average transmission and distribution losses are reported to be 23%. Thus, approximately 23% of power gets wasted due to these losses, and the damage to the environment without any economic or social gain is tremendous. Enhancing the share of renewable energy exponentially can reduce the dependency on fossil fuels. Policies are already formulated to increase the share of renewable energy, but heavy reliance on fossil fuels especially coal is continued. The high cost of installation of renewable energy power generation equipment is acting as a hindrance for the universal adoption of renewable energy sources. If the cost factor is brought to an affordable limit, renewable energy sources can help to fulfil the supply-demand gap of electricity requirement sustainably.

Literature Review

According to the resource-based theory, the main sources of sustainable competitive advantage are the high cost of imitation and unique capabilities (Barney and Arkan, 2005). Unique resources, which are difficult to copy by the competitors, support the sustainable competitive advantage. These unique resources

comprise financial and physical assets, skills of employees and specific organisational system. A firm can create a competitive advantage through its efforts in accomplishing unique value-added tasks through the use of resources acquired by them. The resource-based view draws attention to resources, which enhances the unique capabilities of a firm, which are difficult to imitate. It is difficult to imitate these resources as they are intangible assets, which are acquired through vast experience over a long period through hands-on learning (Hart, 1995).

The firms also acquire capabilities like the engagement of the majority of employees who can support coordinated activities. Sustainable competitive advantage will be attained by only those firms, which can develop resources supporting their unique capabilities (Christmann, 2000; Russo and Fouts, 1997). Environmental strategies like “pollution prevention, product stewardship, and sustainable development” facilitated by the firm’s capabilities are mentioned in the natural-resource-based conceptual framework by Hart (1995). According to Hart (1995), firms developing these unique capabilities by adopting environmental strategies acquire competitive advantage through improved efficiency, enhanced market reputation, raising costs of competitors through revised benchmarking by way of environmental standards. It is difficult for the majority of the firms to develop these capabilities and reap the benefits of competitive advantage due to high-cost involvement and failure in the development of unique and superior managerial capabilities. Few studies analysed through survey based methodology, the outcome of the resource-based theory of the firms. The link between “environmental strategies, firm-specific capabilities, and competitive benefits arising from these capabilities” has also been explored (Sharma and Vredenburg, 1998). They observed the correlation of “environmental strategies of the firms, organisational capabilities, and economic benefits” through a survey of 90 oil and gas companies based in Canada as prophesied in the resource-based view of the firm. Klassen and Whybark (1999) studied the effect of environmental commitment on manufacturing and environmental performance. “A firms’ environmental commitment (measured by an index score assessed from the survey) is directly related to cost, product quality, and on-time delivery”, was observed by them through a survey of managers from 66 furniture plants. Christmann (2000) observed that “environmental strategies create competitive cost advantages and firm’s capability for

process innovation and implementation affects its ability to benefit from implementing environmental strategies”.

Christmann (2000) analysed through a survey of 88 chemical companies, the capability of a firm in process and product innovation is a “rare, valuable, non-substitutable, and imperfectly imitable asset”. Through proactive environmental strategies, some firms acquired competitive cost advantage as explained through the diversity of this capability across the various firms. Through archival data, many empirical studies that analysed the proposition that “it pays to be green” (Klassen and McLaughlin, 1996), using event study methodology, analysed the link between environmental and financial performance. Through their study, they investigated the reaction of the market towards positive and negative environmental events. The study mentions that investors punished negative environmental events and appreciated the firm with positive environmental events. They concluded that a favourable market response is the result of positive environmental events.

(Hart and Ahuja, 1996) examined the role of emission reduction on the firms’ operational and financial performance in the present and future period. They surveyed 127 S&P 500 firms to conclude that enhancement in financial performance in 1990-1992 is related to a reduction in emissions during 1988-1989. Thus the economic benefits of becoming green were observed one to two years down the line. Dowell et al. (2000) analysed the relationship between the adoption of a single stringent global standard and less stringent environmental standards by multinational firms. The analysis was carried out in countries having less than \$8000 per capita GDP, where 89 multinational S&P firms have their plants. Through a survey carried out during the period 1994–1997, they created an environmental performance indicator.

The survey was conducted by asking the respondents’ opinion regarding their firms’ adoption of most stringent internal environmental norms in the US or compliance with environmental norms in the countries where plants are installed. It was observed that firms’ Tobin Q (a ratio of the total market value of the firm to its total asset value) had a positive relationship with more stringent environmental standards.

The Power Sector in India

India’s present power generation capacity is 356.10 GW. Out of this, the share of renewable energy is 22%

(excluding large hydro) (CEA, 2019). Table 1 shows the installed capacity (in MW) as on 31st March 2019.

The power sector in India requires substantial investment along with long-term planning. Regulatory decisions significantly influence the investment strategies as the Indian power sector is highly regulated and impacted by the regulatory authority. There is a need to arrive at the right balance between the security of supply, environmental impact, and costs involved, for the power sector to be sustainable. The companies must be highly proactive and ambitious towards environmental strategies and make consistent efforts to ensure the reduction of CO₂ emissions by switching over to renewable energy from fossil fuels. Efforts should be made to increase the performance of the existing thermal power plants by way of increased thermal efficiency, ability to use biomass, co-generation, and reliable coal sourcing.

With the entry of the private firms in the power generation sector which was considered to be the domain of the state, the entire scenario has transformed. The private sector has been able to ensure the minimisation of losses and supply of electricity at very competitive prices. The private power supply companies are also proactive towards environmental conservation. Annual environmental reports published by these private firms ensure the adoption of proactive environmental strategies. The state power sector regulators decide the tariff over a period. Solar energy has become a critical source of energy, which is showing a promising future for the power sector. With rising competition, the state sector is forced to relook at their performance. They have initiated serious efforts in reducing transmission and distribution losses. Some state power sectors have succeeded in lowering the T&D losses to less than 15% as compared to 30-35% earlier. Even the quality of coal is better due to the import of coal from the overseas market, which is superior to Indian coal having lower ash content and high calorific value.

Use of nuclear power has also added to clean sources of power. The government is commissioning several new nuclear power plants with the help of countries who are expert in the field of nuclear energy. The fuel for the nuclear power whose availability was an issue is now readily available due to excellent diplomatic relations with nuclear fuel producing nations. The government has set up an ambitious target for the generation of electrical power from the new and renewable sources of energy. Subsidies are being provided to encourage the installation of such facilities.

TABLE 1: Installed Capacity (in MW) (as on 31.03.2019)(CEA, 2019)

Region	Sector	Energy Source wise breakup of Installed Capacity							Renewable Energy	Grand Total
		Thermal Power Generation Capacity					Nuclear	Hydro		
		Coal	Lignite	Gas	Diesel	Total	Sources			
Northern Region	State	16344.00	250.00	2879.20	0.00	19473.20	0.00	8697.55	699.56	28870.31
	Private	21680.83	1080.00	558.00	0.00	23318.83	0.00	2514.00	13120.46	38953.29
	Central	12335.37	250.00	2344.06	0.00	14929.43	1620.00	8496.22	379.00	25424.65
	Sub Total	50360.20	1580.00	5781.26	0.00	57721.46	1620.00	19707.77	14199.02	93248.25
Western Region	State	21560.00	1040.00	2849.82	0.00	25449.82	0.00	5446.50	547.89	31444.21
	Private	34745.67	500.00	4676.00	0.00	39921.67	0.00	481.00	21864.76	62267.43
	Central	16502.95	0.00	3280.67	0.00	19783.62	1840.00	1620.00	666.30	23909.92
	Sub Total	72808.62	1540.00	10806.49	0.00	85155.11	1840.00	7547.50	23078.94	117621.55
Southern Region	State	19932.50	0.00	791.98	287.88	21012.36	0.00	11774.83	586.88	33374.07
	Private	11874.50	250.00	5322.10	273.70	17720.30	0.00	0.00	37491.40	55211.70
	Central	11235.02	2890.00	359.58	0.00	14484.60	3320.00	0.00	541.90	18346.50
	Sub Total	43042.02	3140.00	6473.33	561.58	53217.26	3320.00	11774.83	38620.18	106932.27
Eastern Region	State	6240.00	0.00	100.00	0.00	6340.00	0.00	3537.92	275.11	10153.03
	Private	6387.00	0.00	0.00	0.00	6387.00	0.00	399.00	1116.37	7902.37
	Central	14836.64	0.00	0.00	0.00	14836.64	0.00	1005.20	10.00	15851.84
North Eastern Region	Sub Total	27463.64	0.00	100.00	0.00	27563.64	0.00	4942.12	1401.48	33907.24
	Sub Total	770.02	0.00	1775.81	36.00	2581.83	0.00	1427.00	324.29	4333.11
Islands	Sub Total	0.00	0.00	0.00	40.05	40.05	0.00	0.00	17.73	57.78
ALL INDIA	State	64076.50	1290.00	7118.71	363.93	72849.13	0.00	29878.80	2347.93	105075.86
	Private	74688.00	1830.00	10580.60	273.70	87372.30	0.00	3394.00	73661.40	164427.70
	Central	55680.00	3140.00	7237.91	0.00	66057.91	6780.00	12126.42	1632.30	86596.63
	Sub Total	194444.50	6260.00	24937.22	637.63	226279.34	6780.00	45399.22	77641.63	356100.19

Figures at decimal may not tally due to rounding off

Pollution from Power Generation

India primarily depends on thermal power produced from thermal power plants based on coal, oil and natural gas. These plants are old and inefficient and are hence the primary source of greenhouse gas (CO₂) emission. There is a significant potential for reduction of greenhouse gas emissions. The emissions from the Indian thermal power plants is 50% to 120% more as compared to the thermal power plants situated in the European Union (IEA, 2011). The government has decided to shut down the thermal

power plants, which are older than two decades and replace them with more significant sized plants based on super-critical pressure technology (The Economic Times, 2015). Poor quality of Indian coal causes higher emissions due to the high ash content. Regulation is in place for using the beneficiated coal whose ash content is 34% or lesser. The consumption of coal on account of low calorific value has also resulted in emissions as Indian thermal power plants consume 0.7 Kg of coal to generated 1 kWh of electricity as compared to thermal power plants

in the USA which consume only 0.45 Kg per kWh of electricity generated. The Gross Calorific Value (GCV) of Indian coal is 4500 Kcal/kg as compared to the GCV of Australian coal which is 6500 Kcal/kg. Coal having high ash content and high sulphur is banned by several countries along with coal with high contamination with trace metals to reduce pollution.

Renewable Energy Sources

Solar energy and wind energy are the primary renewable energy sources in India, which is one of the most active players in the utilisation of renewal energy. The grid-connected non-conventional renewable technology based electricity capacity of India is 77.64GW, which is 22%

(excluding large hydro) of the total capacity and more than the total of major hydroelectric capacity. Table 2 shows the installed capacity of renewable energy as on 31st March 2019.

Hydro Power

India has some of the oldest hydroelectric power plants which are more than century old. The typical load factor of hydroelectric power plants in India is 60%. The total hydroelectric power potential of India is 94000 MW including small hydroelectric plants (CEA, 2019). The government owns the majority of the hydroelectric power generation.

TABLE 2: Installed Capacity of Renewable Energy Sources in India in MW (as on 31.03.2019)(CEA, 2019)

Small Hydro	Wind	Bio-Power Plants		Solar	Total Installed Capacity
		Biomass/ Cogeneration	Waste to Energy		
4593.15	35625.97	9103.50	138.30	28180.71	77641.63

Solar Power

Due to its geographical location, India receives abundant sunlight. Approximately 5000 trillion kWh of solar radiation is incident on its land per year having a solar power generation potential of 0.25 kWh per square metre of the area used. The solar energy installed capacity as on 31st March 2019 was 28GW. Commissioning of several significant projects are already in the pipeline and is expected to be completed within the next five years. India plans to generate 100 GW of solar power by 2022. Land area requirement for solar power plants is similar to coal-based thermal power plants, i.e., 2.4 hectares (0.024 km²) land per MW capacity. The area required includes consumptive water storage & ash disposal areas. If only 1% of the land (32000 Sq. km.) is deemed to be barren, it can install solar power plants having a capacity of 1.33 million MW. The exciting part is that solar power tariff has reduced to less than Rupees three per unit in the year 2019. There is enormous potential to replace the pollution oriented thermal power plants with solar plants, which is nevertheless the cleanest source of power. This way India can reduce significant emissions from the thermal power plants.

Wind Power

India stands fifth regarding wind power capacity in the world. As per Table 2 mentioned above the total wind power capacity of India was 35625 MW in 2019. The development of wind power initially started in southern India, and later on, it spread to other parts of the country. India has set up a target of 60GW of wind power capacity by 2022 (CEA, 2019).

Similarly, other sources of renewable energy like geothermal and tidal power are also under consideration, but their full-scale utilisation will take some time. However, with the synergy going towards the renewable energy sources it will not be very long when these power sources are available commercially.

Discussion

The power sector is considered to be the major contributor to greenhouse gas emissions. The pollution from the thermal power plants due to the burning of fossil fuels not only damages the natural environment within the vicinity of the plant but also adds to the overall environmental damage over an extended period. The environmental

regulators have been fighting with the polluters for a long time. The environment has become a serious issue at the international level. Several countries specifically in the developing region are being targeted to reduce their emissions. Incentives like carbon credits are already in place to encourage emission cuts. Strategic environmental assessment has been adopted by the industries actively over the last decade (Nilsson and Dalkmann, 2001; Partidario et al., 2008; Retief, 2007). (Bigland-Pritchard and Prebble (2010) identified the requirement of guiding the development of the power sector through long-term strategic planning. Liou et al. (2006) and Noble (2004) observed that practitioners, as well as decision makers, face significant challenges from systematic methodological flexibility in environmental assessment. The renewable energy sources are abundantly available as compared to fossil fuels which may exhaust over a period.

The government must provide affordable electricity to all. However, this requires accomplishment without causing any harm to the environment. Waste reduction has also been a crucial issue with the government. Coal-based thermal power plants generate environmentally hazardous fly ash as waste. With the regulations in place, the fly ash from the thermal power plants has become the raw material for the cement manufacturing sector by way of blending. Thus the waste from thermal power plants is utilised efficiently by the cement sector. Large solar power plants are being installed by the private sector to take advantage of the environment-friendly policies of the government. With the adoption of the Electricity Act-2003, the state sectors have to look forward to survival, as the power sector has been thrown open to private players. The restriction of availing power only from the only licensed power supply company has ended, and consumers now have the choice to select their electricity provider. These private players have set a benchmark by way of transparent environmental reporting. The T & D losses are at par with the best in the sector.

Several initiatives are being taken to minimise the ecological damage caused by way of afforestation. Energy efficient equipment are introduced in the market to ensure effective utilisation of the power at a minimal cost. The government has set up a Bureau of Energy Efficiency to rate the equipment depending on their efficiency and power consumption. The power generation and power supply companies are working in cohesion to prevent environmental damage. The power supply companies are

going beyond the extant laws to adopt proactive environmental strategies. The factors responsible are stiff governmental regulations, competitions, long-term profit and stakeholder pressure. As disruption to the production process can cause loss of profit, the power sector is ensuring the adoption of proactive environmental strategies. Some companies are going beyond regulations and have invested heavily to ensure the generation of clean energy. Renewable energy sources will dominate the energy scenario shortly when the availability of fossil fuels becomes scarce and economically non-viable. The emissions due to fossil fuel burning will also play an important role in switching over to renewable energy on a vast scale. For reducing carbon footprints, the government institutions are encouraging zero energy buildings. Use of energy efficient products has also increased considerably over a period. The stakeholders have become conscious enough to oppose any attempt which causes or has the potential to cause environmental damage. The power supply companies are encouraging the generation of power through renewable energy sources. Policies are in place for the use of solar power through self-generation by the consumers and feeding back the excess power to the grid enabling them to reduce their electricity bills. With such mass scale adoption and encouragement of renewable energy use, the effect of greenhouse gas emission can be reduced or reversed. The support of government is very much necessary to ensure sustainable growth of the power sector so that adoption of cleaner energy continues so that affordable power is available to all without any damage to the environment.

References

- Barney, J., Arikan, A.** (2005). The resource-based view: origins and implications. In: Hitt, M., Freeman, R.E., Harrison, J.S. (Eds.), *Handbook of Strategic Management*. Blackwell Publishing.
- Bigland-Pritchard, M., Prebble, P.** (2010). Transforming Saskatchewan's electrical future, Part One: Sustainability is achievable, but how do we get there? Regina, SK: Canadian Centre for Policy Alternatives.
- Central Electricity Authority**, Ministry of Power, Govt. of India. All India Installed Capacity of Utility Power Stations. Retrieved 09 May 2019.
- Christmann, P.** (2000). Effects of "best practices" of environmental management on cost advantage: the role of complementary assets. *Academy of Management Journal*, 43 (4), 663–680.
- Dowell, G., Hart, S., Yeung, B.** (2000). Do corporate global environmental standards create or destroy market value? *Management Science*, 46 (8), 1059–1074.

- Hart, S.** (1995). A natural-resource-based view of the firm. *Academy of Management Review*, 20 (4), 986–1014.
- Hart, S., Ahuja, G.** (1996). Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance. *Business Strategy and the Environment*, 5 (1), 30–37.
- International Energy Agency, France.** (2011). "CO₂ emissions from fuel combustion highlights, 2011 Edition".
- Klassen, R., Whybark, D.** (1999). The impact of environmental technologies on manufacturing performance. *Academy of Management Journal*, 42 (6), 599–615.
- Klassen, R., McLaughlin, C.** (1996). The impact of environmental management on firm performance. *Management Science*, 42 (8), 1199–1214.
- Liou, ML, Yeh, S.C., and Yu, Y.H.** (2006). Reconstruction and systemization of the methodologies for strategic environmental assessment in Taiwan. *Environ. Impact Assess. Rev.* 26(2), 170–184.
- Nilsson, M., Dalkmann, H.** (2001). Decision making and strategic environmental assessment. *Journal of Environmental Assessment Policy and Management*, 3 (3), 305–327.
- Noble, B.F.** (2004). Strategic environmental assessment quality assurance: some principles and guidelines on the use of assessment panels. *Environ. Impact Assess. Rev.* 24, 3–25.
- Partidario, M.R., Paddon, M, Eggenberger, M, Minh Chau, D., and Vanuyen, N.** (2008). Linking strategic environmental assessment (SEA) and city development strategy in Vietnam. *Impact Assess. Project Appraisal*. 26 (3), 219–227. Taylor & Francis Online.
- Retief, R.** (2007). A performance evaluation of strategic environmental assessment (SEA) processes within the South African context. *Environ. Impact Assess. Rev.* 27(1): 84–100.
- Russo, M., Fouts, P.** (1997). A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal*, 40 (2), 534–559.
- Sharma, S., Vredenburg, H.** (1998). Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. *Strategic Management Journal*, 19 (8), 729–753.
- The Economic Times.** (2015-09-16). "Government to pump in Rs. 70,000 crore in replacing old thermal power plants". Retrieved 2015-09-16.

"When you put the whole picture together, recycling is the right thing to do."

– Pam Shoemaker

Social Inclusiveness of National Food Security Bill: Issues and Concerns

DILIP DIWAKAR G, NITIN TAGADE AND SANDEEP SHARMA

The National Food Security Bill (NFSB) came at a point when nutrition based deprivation of not only poor, but also majority of the marginalised communities, especially the SCs is at peril. The main thrust of the bill is built on the existing ICDS, MDM and PDS programmes, however, the existing macro level data and literature clearly shows that nutrition level of children has not improved much in the last two decades. Especially, under nutrition is high among certain social groups such as SCs and STs. But there is no specific mention in the NFSB on addressing the concerns of the marginalised communities. This paper examines the existing utilisation gaps among SC and ST, using the available NFHS and NSSO data. This paper also studies the caste based discrimination in utilising the ICDS, MDM and PDS programmes and proposes measure to bring in social inclusiveness in the NFSB.

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1. Background

The issue of food security has so much priority concern in India that a bill was made to pass in the parliament in 2013 to ensure food entitlement to its citizens. The concern is relevant for the reason that more than one-fifth of its population was poor in 2011-12. In fact, poverty ratio increases substantially if compared with the international standard of two dollars. In addition to this, about half of the children below six years of age are undernourished with wide variation across states in 2005-06. These alarming figures rationalize the efforts of the then Government in bringing the bill to ensure food security in India (Gulati A. et. al., 2012). The Public Distribution System (PDS) has the major responsibility to supply subsidised food. A number of studies have critically examined the efficiency and efficacy of the same. However, subsidised food supply depends on the production and procurement of the food grains. While looking at the production of the food grains, it is observed that food grain production increased from 196.8 million tonnes to 264.4 million tonnes during 2000-01 to 2013-14 (BE) at the rate of 2 per cent per annum. Even the production of rice and wheat has increased from 85 to 106.3 million tonnes at the rate of 1.82 per cent and 69.7 to 95.8 tonnes at the rate of 2.65 per cent per annum, respectively during the same period (GoI, 2014). Similarly the procurement of cereals has been increasing from 19.3 per cent to 29.8 per cent during 2000-01 to 2012-13 (Sinha, 2013). Since the production and procurement are not the concern for food supply, we are left with the distribution problem and its discussion.

With major changes in the economic policy in 1991, universal PDS has been made target based. The studies have shown a number of problems even related to the

Targeted Public Distribution System (TPDS) such as high leakages and targeted errors, increasing economic cost and thereby subsidy. The NSSO based estimates indicate substantial decline in the share of leakages from 54 per cent in 2004-05 to 35 per cent in 2011-12 (Sinha, 2013, p. 33). Similar evidences are drawn from the field survey conducted in nine states in 2011 to assess PDS (Khera, 2011). Jha and Acharya (2013) argue that the share of food subsidy to Gross Domestic Product is less than 1 per cent, and it is declining over the period from 0.8 per cent to 0.74 per cent during 2004-05 to 2012-13 (BE). Thus, some of the problems that were debated during the last two decades are not of much concern to that extent now. However, inclusion and exclusion errors still get space in the discussion. In 2004-05, about 63 per cent of the poor households were not covered under PDS indicating substantially high exclusion errors, and about 62 per cent of all BPL and AAY cards were in the hands of non-poor households suggesting a large systematic inclusion error (Svedberg, 2012, p.56).

Despite these positive changes in the production and procurement front, poverty and under nutrition is substantially high among SCs and STs and rate of decline in poverty across social groups in both rural and urban areas is not similar, but it is relatively less for SCs and STs as compared to Non-SC/STs during 1993-94 to 2009-10 (Diwakar, 2014; Thorat & Dubey, 2012, p. 45). It is being evident that the social exclusion and discrimination are still evident in different forms in various spheres such as economic, political, social, educational etc. (Thorat, 2014). As a result of this, SCs and STs are not able to accrue the benefits of the positive changes occurring in the economy, food grain production and its distribution at par with non-excluded counterparts. These groups lag behind in improvement in poverty reduction over the time despite the fact that it prioritised the policy agenda as a part of inclusive growth trajectory. SCs and STs are not only lacking behind economically, but they also face challenges in utilising basic government services like ICDS, MDM and JSY. The discriminatory access to MDM and JSY (Sabharwal et al., 2014a; Sabharwal et al., 2014b); and ICDS (Diwakar, 2014) has hampered the development of the SCs. The consequences of these are clearly evident from the varying rate of changes in poverty decline across social groups. Poverty among SCs declined at the rate of 2.4 per cent in rural areas and 2.1 per cent in urban areas. Among STs, it declined at the rate of 2.1 per cent in both rural and urban areas while among Non-SC/STs, it declined

at the rate of 2.7 per cent and 2.4 per cent per cent respectively during 1993-94 to 2009-10.

Similarly, there has not been much improvement in the nutritional status among children during the last two decades (IIPS and ORC Macro 1995, 2000, 2007; Hungama, 2007; NNMB, 2012). India is the home for most of the undernourished in the world. It is even worse than some of the Sub-Saharan African countries (Horton, 2001). The NFHS data shows that the share of underweight among children below three years of age during 1998-99 and 2005-06 was very high for SC. Moreover, the rate of reduction was relatively low as compared to others (Diwakar, 2014).

In this context, it is necessary to examine the relevance of the National Food Security Bill from inclusive policy perspective as it has been argued that it is a right based approach and provides entitlement to food to 67 per cent of the population in India and helps to clear the social disparity that exists in poverty and under nutrition. In fact, the bill is constantly praised for bringing various existing programmes such as ICDS, MDM and PDS under its umbrella (Mishra, 2011). However, it failed to make necessary changes and was incorporated as it is with the existing limitations. There is a complete lack of understanding on reasoning causes for the existing stagnancy in child undernourishment. This makes the attempt futile in addressing the set goals.

Therefore, we shall briefly introduce the Bill and its features following an evidence on how child poverty and under nutrition has declined across social groups in India for the reason that they constitute a major component of the beneficiaries in the Bill. We will also examine how the existing programmes brought under the NFSB were accessible to the excluded groups. Finally, we will discuss the nature of inclusiveness in NFSB.

2. The promises of NFSB - An overview

The National Food Security bill was introduced in 2011 and promulgated in 2013 with the aim of providing legal rights of food entitlement to the needy people such as children, pregnant and lactating mothers and adults from poor households. This bill relies on the existing ICDS, MDM and PDS programmes to achieve this objective with paradigm shift from welfare measures to right based approach where people are entitled to certain amount of food on subsidised rates. The importance of NFSB bill is multiple in nature as it also addresses indirect costs involved due to food insecurity. The prevailing high level of

malnutrition leads to forgo gross domestic product (Horton, 2001) due to inadequate food intake and essential nutrients result in the deterioration in physical growth and development (National Nutrition Policy, 1993; Horton, 2001; Satyanarayana, 1979), as well as cognitive development (Waterlow, 1974).

The PDS entitlement is the first component of the NFSB. It entitles every person belonging to eligible households to receive five kg. of food grains per person per month at subsidised prices. Households covered under Antyodaya Anna Yojana will be entitled to 35 kg. of food grains per household per month at the prices specified by the government. Eligible households will be entitled to food grains at the subsidized price not exceeding Rs. 3 per kg for rice, Rs. 2 per kg for wheat and Rs. 1 per kg for coarse grains for a period of three years from the date of commencement of this Act. Thereafter based on the price fixed by the Central Government from time to time but not exceeding the minimum support price for wheat and coarse grains; and the derived minimum support price for rice.

Secondly, pregnant and lactating mothers will be given a meal free of charge during pregnancy and six months after the child birth through the local *anganwadi*¹. A minimum of rupees six thousand is provided as maternity benefit, in instalments, as prescribed by the Central Government. Thirdly, every child up to the age of fourteen years will be entitled to nutrition provision. In the case of children in the age group of six months to six years, free of charge and age appropriate meal will be provided through the local *anganwadi* centre. In the case of children up to class VIII or within the age group of six to fourteen years, whichever it is applicable, every day one mid-day meal free of charge will be provided, except on school holidays, in all schools run by local bodies, Government and Government aided schools.

The nutritional standards of children in the age group of 6 months to 3 years, 3 to 6 years and pregnant women and lactating mothers are required to be met by providing "Take Home Rations" or nutritious hot cooked meal in accordance with the Integrated Child Development Services Scheme (ICDS); and supply of hot cooked meals to maintain nutritional standards of children in lower and upper primary classes under the Mid-Day Meal (MDM) Scheme. Under this scheme, it is mandatory to provide 450 calories and 12 gm. protein for primary and 750 calories and 20 gm. protein for middle school children.

In case of non-supply of the entitled quantities of food grains or meals to the entitled persons under chapter II, such persons shall be entitled to receive such food security allowance from the concerned State Government to be paid to each person within such time and manner as may be prescribed by the Central Government.

Altogether, it is an achievement of the Act that entitlement of the food has become a constitution right which was lacking in the past even though some of the provisions mentioned in the National Food Security Act were in place through the existing programme. Now it has become a legal right for the poor people, so they can legally make claim if they did not receive the food supply as per the bill. However, it has to be categorically mentioned that the marginalised groups in the country are not homogenous in nature and a few groups are marginalised as a result of long history of discrimination or they were never part of the mainstream development.

The Schedule Caste communities have faced discrimination for long time which has prevented them from making any significant improvement in their human capital. In addition to that, they were also subjected to different kinds of economic as well as social constraints. Similarly, STs were always out of the mainstream development process, facing geographical exclusion, displacement, inadequate human development indicators and inadequate implementations of policies such as PESA.

3. Social disparity in poverty and nutritional status of children

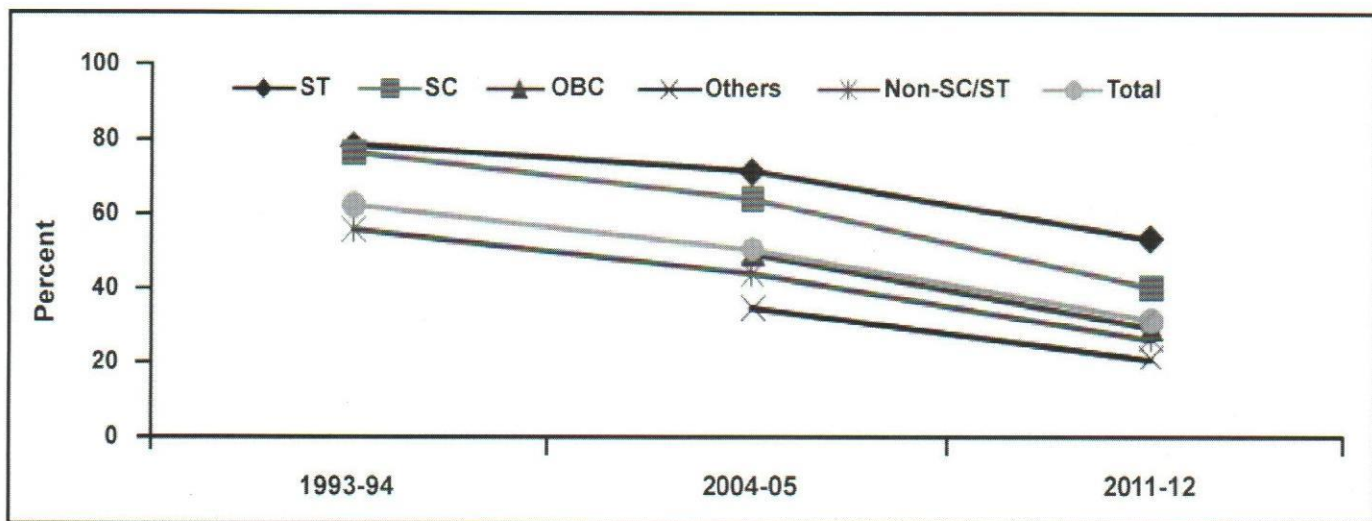
Indian society is heterogeneous in nature and broadly stratified on the basis of class, caste, gender, ethnicity and religion. The social and economic condition varies across social and religious groups. The social and religious status of the individuals plays dominant role in determining access to resources and privileges. The society is not horizontal, but it is vertical in nature, positioning one group over the other. The group on the top enjoys more power and privileges than the others falling below them in the ladder. The SCs and STs are on the bottom of the ladder and they enjoy the least power and privileges in the social hierarchy. The SC face the problem of social isolation and discrimination whereas STs face geographical isolation and segregation. In this context, it is important to examine how these social hierarchical privileges translate into the improvement of any indicator food insecurity such as poverty and under nutrition across social groups. In this section, we will

discuss the level and changes in child poverty and under nutrition by social groups based on the NSSO and NFHS surveys.

3.1 Disparity in child poverty

Child poverty has been defined in terms of the share of children below six years belonging to poor households using Tendulkar Method. In India, child poverty halved to 31.4 per cent during 1993-94 to 2011-12 at the rate of 3.7 per cent per annum (Figure 1 and Table 1). The social group wise child poverty shows a high incidence among

STs and STs over the period. In 2011-12, it is 53 per cent among STs, 39.7 per cent among SCs, 29 per cent among OBCs and the lowest 20.6 per cent among others. During 1993-94 to 2011-12, it indicates a relatively low decline in child poverty among STs and SCs as compared to Non-SC/STs. It declined at the rate of 2.1 per cent, 3.6 per cent and 4.1 per cent, respectively. The data for OBCs and Others is available for the period 2004-05 and 2011-12 that shows a substantial variation across social groups being substantially low rate of decline among SC/STs as compared to Others (Table 1).



Source: Estimated based on NSS 50th, 61th and 68th consumption expenditure unit level survey.
 Note: The estimates are based on Tendulkar committee recommendations and mixed recall period.

Fig. 1: Levels of child poverty across social groups in India - 1993-94, 2004-05 and 2011-12

TABLE 1: Annual changes in child poverty across social groups in India

Social groups	1993-94 to 2011-12	1993-94 to 2004-05	2004-05 to 2011-12
ST	-2.1	-0.8	-4.1
SC	-3.6	-1.6	-6.5
OBC	NA	NA	-7.3
Others	NA	NA	-7.0
Non-SC/ST	-4.1	-2.2	-7.1
Total	-3.7	-1.9	-6.6

Source: Estimated based on NSS 50th, 61th and 68th consumption expenditure unit level survey.

TABLE 2: Disparity ratio in child poverty across social groups in India

Social groups	1993-94	2004-05	2011-2012
ST/Non-SC/ST	1.4	1.6	2.0
SC/Non-SC/ST	1.4	1.5	1.5
ST/Others	NA	2.1	2.6
SC/Others	NA	1.9	1.9
OBC/Others	NA	1.4	1.4

Source: Estimated based on NSS 50th, 61th and 68th consumption expenditure unit level survey.

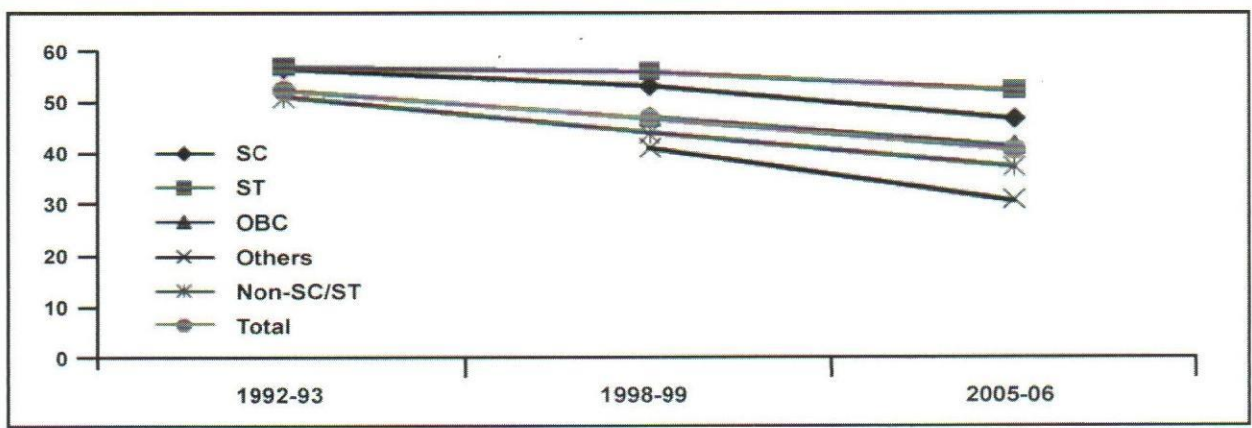
The objective of any development is not just the improvement in the development indicators, but it inherently aims to bridge the gap between various sections of the society. In India, child poverty has declined over the period with increasing rate of change across social groups. However, variation in the rate of decline in child poverty across social groups has increased the disparity between social groups. Disparity ratios were calculated between SCs/STs and others (Table 2). It was 2.1 for STs as compared to Others in 2004-05 and increased to 2.6 in 2011-12. It means that the children belonging to STs had 2.1 times more chances of being in poverty which further increased to 2.6 times during 2011-12 as compared to Others. Similar pattern were observed in the case of SCs and Others. The disparity between SC and Others was constant during 2004-05 and 2011-12. It shows that the chances of children being in poverty belonging to SCs were 1.9 times more than others. Even though disparities exist between OBCs and Others, but the extent is low as compared to SCs and STs.

3.2 Disparity in malnutrition

Similar to the levels, changes and disparity in child poverty across social groups in India, incidence of under nutrition also differs across social groups. In this section, an analysis has been discussed on the basis of the overall prevalence of under nutrition as a composite indicator of both acute and chronic under nutrition (Figure 2 and Table 3). In India, the prevalence of underweight children among the children below three years declined over the last two decades from 52.4 per cent in 1992-93 to 41 per cent in 2005-06 per cent at

the rate of 1.7 per cent per year (Table 3). During 1998-99 to 2005-06, the rate of decline (1.9 per cent) was marginally high as compared to that of previous period 1992-93 to 1998-99 (1.7 per cent). The prevalence of underweight is high among STs and SCs as compared to others with increasing difference between SC/STs and Others (even as compared to Non-SC/ST).

The prevalence of underweight declined from about 57 per cent to 47 per cent among SCs at the rate of 1.32 per cent per year and from more than 57 per cent to 53 per cent among STs at the rate of 0.61 per cent per year between 1992-93 and 2005-06. On the other hand, the decline in the levels of underweight is high among others followed by OBCs. Among OBCs+Others (Non-SC/ST), it declined from 51 per cent in 1992-93 to 37 per cent in 2005-06 at the rate of more than 2 per cent per year. Among OBCs, it declined from 47 per cent to 42 per cent at the rate of 1.72 per cent and among 'Others' it declined from 44 per cent to 37 per cent at the rate of 3.5 per cent during 1998-99 and 2005-06, respectively. It is clear from Table 3 that the rate of decline is high among the OBC and 'Others' as compared to SC/STs, which results in the increasing disparity among SC/STs and others (Table 5). The disparity between SCs and Non-SC/ST increased from 1.1 to 1.3 at the rate of 1 per cent during 1992-93 to 2005-06. It means that the chances of SC getting underweight are increased from 1.1 per cent to 1.3 per cent during 1992-93 to 2005-06. Even in case of STs and Non-SC/ST, the chance of STs being underweight increased from 1.1 to 1.4 per cent during same period at the rate of about 2 per cent. The disparities between SC/STs and Others are more prominent and increasing over the years.



Source: Based on IIPS, 1992-93, 1998-99 and 2005-06 unit level data

Fig. 2: Prevalence of underweight children below three years of age

TABLE 3: Rate of changes in child underweight

Social groups	1992-93 to 2005-06	1992-93 to 1998-99	1998-99 to 2005-06
SC	-1.32	-1.01	-1.68
ST	-0.61	-0.25	-0.93
OBC	NA	NA	-1.72
Others	NA	NA	-3.55
Non-SC/ST	-2.06	-2.30	-2.14
Total	-1.68	-1.69	-1.87

Source: Based on IIPS, 1992-93, 1998-99 and 2005-06 unit level data

TABLE 4: Disparity in the prevalence of underweight children

Social groups	1992-93	1998-99	2005-06
SC/Non-SC/ST	1.11	1.21	1.25
ST/Non-SC/ST	1.12	1.28	1.40
SC/Others	NA	1.29	1.52
ST/Others	NA	1.37	1.70
OBC/Others	NA	1.15	1.34

Source: Based on IIPS, 1992-93, 1998-99 and 2005-06 unit level data

4. Access and utilisation of food and nutrition programme

The variation in the incidence of poverty and under nutrition and the rate of change leads to the increasing disparity

between social groups. In a way, it is an obvious reason as each of the social groups is a separate entity with different socio-economic development. However, it cannot be attributed to this but a more generic factor attributed to

this is the disproportionate access. Thus, the question is who access these services? And does these services are fairly accessible to the poor among the marginalised communities? Therefore, we will examine how the accessibility to Integrated Child Development Services (ICDS) and Mid-Day-Meal (MDM) services varies across social groups. We will also examine how Below Poverty Line (BPL) cards are accessed viz-a-viz poverty ratios across social groups. For the purpose, we estimated the Utilisation Ratio for ICDS, SNP and MDM services (see, formula 1). The utilisation ratio is estimated is the ratio of share of utilisation of the services to poverty ratio share of actual beneficiaries accessing services to the total number of persons below poverty line. The ratio one indicates the absence of proportionate access to the services for a particular social group; while the ratio less than one indicates deficiency in accessibility or exclusion from accessing the services and ratio more than one indicates that accessibility is more than need or inclusion is large.

$$\text{Utilisation Ratio} = \left[\frac{U_i}{NB \text{ below poverty line}} \right]$$

Where, S_i is ICDS, SNP and MDM,

U indicates share of utilisation by beneficiaries and

NB indicates share of total number of beneficiaries

The beneficiaries differ from scheme to scheme. In the case of ICDS scheme, the beneficiaries are children of 0-6 years of age group. For SNP services, the beneficiaries are pregnant and lactating women; while the beneficiaries of MDM are children in the age group of 5-14 years.

4.1 Utilisation of ICDS services by the poor children, pregnant and lactating mothers

The utilisation of the ICDS services by children below six years of age, pregnant and lactating mothers are examined by using the data from National Family Health Survey- 3 (NFHS III) (See Table 5). The utilization of ICDS services in general is substantially low among the children to about 33 per cent in 2005-06. The utilisation of ICDS services across social group shows substantially high to 50 per cent for STs followed by 36 per cent for SCs and 28 per cent for 'Others.' Similarly, a substantially low 26.5 per cent of the children are utilising SNP services in India to 26.5 per cent with a highest utilisation of 44 per cent among STs followed by 30.4 per cent among SCs, 22.4 per cent among OBCs and 23.2 per cent among 'Others.'

On the basis of these results, one may conclude that utilisation of ICDS and SNP services is substantially high among STs and SCs. However, the comparison of these figures with the incidence of child poverty provides a completely different scenario. It can be observed from the utilisation ratio to child poverty that utilisation ratio for both the services is less than one which indicates that the access to these services is not enough to cover all the children belonging to poor households. The estimates of the utilisation of the services cover all children irrespective of the economic position; otherwise utilisation ratio will further decline. The inferences for social groups also changed the relative position being substantially low utilisation ratio for SCs and high for 'Others' in the case of ICDS services; whereas in the case of SNP services, it is lowest for OBCs and SCs and highest for Others.

TABLE 5: Utilisation of ICDS and SNP services and utilisation ratio by children below six years

Social groups	Utilisation in 2005-06 (%)		Utilisation ratio to child poverty	
	Any ICDS services	Any SNP services	ICDS services	SNP services
ST	49.9	43.9	0.71	0.63
SC	36.1	30.4	0.57	0.48
OBC	30.3	22.4	0.60	0.44
Others	28.3	23.2	0.84	0.69
Total	32.9	26.5	0.65	0.52

Source: Based on IIPS and Macro International, NFHS III, 2005-06 and NSSO 61th unit level survey

Apart from children, other major groups of beneficiaries of the SNP services are pregnant and lactating mothers. The utilisation of SNP services in India is 34.6 per cent among pregnant women and 21 per cent among lactating mothers (Table 6). The social group wise utilisation of SNP services shows a substantially high utilisation among SCs to 37 per cent followed by STs to 25.5 per cent, OBC to 19 per cent and the lowest is among 'Others' to 13 per cent. Though it appears that the 'Others' are utilising very less SNP services, however, if we see the

utilisation in proportion to their poverty level, it is clear that the utilisation by pregnant and lactating mothers across social groups is less than one. The estimated ratios suggest that utilisation of SNP services by pregnant and lactating women is fairly high among SCs to 0.7 and 0.61, as compared to 'Others' i.e. 0.54 and 0.43 respectively. However, these ratios being less than one also indicate that all the pregnant and lactating women belonging to poor households do not have accessibility to SNP services.

TABLE 6: Utilisation of SNP and utilisation ratio across social groups in India

Social groups	SNP utilisation from AWC 2005-06		Poverty (%) 2004-05	Utilisation ratio for SNP by	
	Pregnant women (%)	Breastfeeding mother (%)		Pregnant women	Breastfeeding mother
SC	36.9	32.3	53.0	0.70	0.61
ST	25.5	20.8	60.0	0.43	0.35
OBC	18.8	14.6	40.2	0.47	0.36
Others	13.1	10.3	24.1	0.54	0.43
Total	34.6	21.1	39.5	0.88	0.53

Source: Calculated from IIPS and Macro International, NFHS III, 2005-06: India Vol 1 and estimation of poverty from NSS 61th consumption expenditure unit level survey.

4.2 Utilisation of mid-day meal services

The utilisation of the MDM services by children is estimated from NSSO consumption expenditure survey for 2004-05. In 2004-05, households having children between age group of 5-14 years utilising MDM in the last 365 days have

been considered to estimate the share of MDM utilisation among children. The utilization of MDM services in general is very poor to 17.42 per cent at all India level (Table 7).

The Utilisation of MDM services by children across social group shows that about 25 per cent of ST and 21

TABLE 7: Utilisation and utilization ratio of MDM

Social group	Utilisation by households (%)	Utilisation ratio to poverty in 2004-05
SC	21.0	0.40
ST	24.5	0.41
OBC	18.1	0.45
Others	12.5	0.52
Total	17.4	0.44

Source: Estimated based on NSSO 61st round

per cent of SC have utilised MDM service as compared to 13 per cent of 'Others.' However, utilisation of MDM services in proportion to incidence of poverty clearly indicates that it has not adequately covered the children belonging to poor household as inferred from the estimated utilisation ratio for MDM services. The result shows that the utilisation ratio is less than one across social groups with substantially low among SCs and STs to 0.40 and 0.41 as compared that of 0.52 for 'Others.'

4.3 Possession of BPL and AAY cards

In India, more than 200 million households out of 250 million households possess PDS ration cards in 2010-11 as estimated on the basis NSSO survey. It means that about 20 per cent of the households do not have any sort of PDS cards invariably which indicates these

are completely excluded from availing services of the PDS. It is to be noted that share of household with not possessing cards is almost evenly distributed across social groups; while share of households accessing various types of PDS cards is substantially high among SCs and STs (Table 8). In this section, our purpose is to examine whether the possession of cards is proportionate to the poverty estimates and does it vary across social groups (Table 9).

The results are presented in Table 9 clearly, which indicate that the estimated possession ratio² is more than one in India as well as across social groups. It means that BPL and AAY cards are accessed to even non-poor households in terms of the criterion of official poverty line. This is quite possible because these cards are allocated to the eligible households identified on the basis of 13

TABLE 8: Possession of BPL and AAY cards by social group during 2010-11 (%)

Social group	Antyodayaanna yogna	BPL cards	Possession of AAY+BPL card among the people having PDS Card	Possession of AAY+BPL card of the total population	Other Card	Total
ST	8.9	58.1	67.0	53.87	33.0	100.0
SC	9.1	48.5	57.5	47.53	42.5	100.0
OBC	4.8	39.7	44.5	36.08	55.5	100.0
Other	2.8	23.9	26.7	20.54	73.3	100.0
ALL	5.5	38.7	44.1	35.34	55.9	100.0
Non-SC/ST	4.0	33.5	37.6	29.83	62.4	100.0

Source: Estimated based on NSS 68th consumption expenditure unit level survey.

TABLE 9: Possession of BPL and AAY-PDS cards and possession ratio to poverty ratio across social group in 2011-12

Social group	Share of households possessing AAY+BPL cards (%)	Poverty ratio (%)	Ratio of possession of AAY+BPL cards to poverty ratio
ST	67.0	43.0	1.56
SC	57.5	29.4	1.96
OBC	44.5	20.7	2.15
Other	26.7	12.5	2.14
ALL	44.1	22.0	2.01

Source: Estimated based on NSS 68th consumption expenditure unit level survey.

indicators such as access to land, type of house, social group, occupation etc; while poverty is estimated on the basis of consumption expenditure. Due to the lack of data, we rely on poverty estimates to examine the discrepancy in possession of cards. The results show that the possession of BPL and AAY cards is substantially low among SCs and STs to 1.96 and 1.56, respectively as compared to 2.14 among 'Others.' Ideally, the possession of card should have been more among SC and STs, if household food insecurity has to be addressed on equal opportunity hypothesis.

5. Discussion and conclusion

In this paper, the attempt has been made to examine whether the food security programmes that are operational and now incorporated in food security act are socially inclusive in nature and whether the act has been incorporated with sufficient checks and balances to make it competitive enough to strengthen socially inclusiveness. First, we discuss the results following a discussion on socially inclusiveness in National Food Security Bill.

The results are twofold. Firstly, proportion of child poverty and under nutrition is substantially high and rate of decline is low among SCs and STs as compared to 'Others.' Over the years, disparity between SC/STs and 'Others' in terms of poverty and under nutrition is widening because of rapid decline in poverty and child under nutrition among Others as compared to SC/STs. Secondly, access to the services provided under various food security programmes is showing relatively high among different beneficiary groups such as children, women and poor households belonging to SCs and ST, but the utilisation of these services is not adequately proportionate to their

poverty levels. For example, about 50 per cent of children belonging to SCs are utilising ICDS services and 44 per cent are utilising SNP services. However, the ratio of utilisation to the incidence of poverty is only 0.71 among SCs which is 0.84 in the case of 'Others.' Similar situation is evident in utilisation of MDM services and possession of BPL and AAY cards to access PDS food grains.

Thus, the major reason for the disproportionate access to the services provided under various food security programmes is the prevailing caste based discrimination against the SC beneficiaries. The studies have shown that children have denied the services (Mander & Kumaran, 2006; Thorat et.al, 2013; Jan Sahas, 2009). The NFSB do not take into account the discrimination practices under that constraint the accessibility of the services.

According to Thorat (2014) the policy should be two fold; one being general policy for all those facing common problem and other being specific policies to address the additional problems of excluded groups because of discrimination and exclusion. The lack of specific policies had an adverse impact on access and utilisation of services by SC/ST which has been highlighted by various studies (Mamgain & Diwakar, 2012; Jan Sahas, 2009; Thorat & Lee, 2005; SEW, 2011; Thorat et.al, 2013). In that line, NFSB should have spelt out policies with respect to i) location specific issues of the infrastructure, ii) recruitment of more service provider from lower caste personnel, iii) universalization, iv) sensitisation training to service provider on implication of discriminatory practices, and v) guidelines and regulations to addressing discriminatory practices in nutrition programmes to ensure uniform development across social groups.

Notes

¹ Locally the ICDS centre is called as anganwadi centre. This centre provides the health, nutrition and education services to the children in 0-6 years, pregnant women and lactating mothers.

² Similar to the utilisation ratio, possession ratio is the ratio of share of BPL and AAY card possessed to poverty ratio for a particular social group.

References

Diwakar, D.G. "Addressing utilization of the ICDS programme in Tamil Nadu, India: how class and caste matters." *International Journal of Sociology and Social Policy*, 34.3/4 (2014): 166-180.

Government of India. (GOI). Economic Survey of India. New Delhi: Ministry of Finance, 2013-14.

Government of India.. "National Nutrition Policy. Ministry of Women and Child Development" 1993. <http://www.wcd.nic.in/sites/default/files/National%20Nutrition%20Policy.pdf>

Gulati A. A., Ganesh Kumar, Ganga Shreedhar, and T. Nandakumar. "Agriculture and Malnutrition in India", *Food and Nutrition Bulletin*, 3.1 (2012): 74-86

- Horton, S.** "United Nations ACC/SCN Fourth Report on the World Nutrition Situation UN ACC/SCN in collaboration with IFPRI, Geneva, 2000, 132pp." *Agricultural Economics*, 26.1 (2001): 85-86.
- Hungama Report.** Fighting Poverty and Nutrition. New Delhi: Naandi, 2011.
- IIPS and ORC Macro.** National family health survey (NFHS-1), India, 1992-93. Mumbai, India: International Institute for Population Sciences, 1995.
- IIPS and ORC Macro.** National family health survey (NFHS-2), India, 1998-99. Mumbai, India: International Institute for Population Sciences, 2000.
- IIPS and ORC Macro.** National family health survey (NFHS-3), India, 2005-06. Mumbai, India: International Institute for Population Sciences, 2007.
- Jan Sahas.** Exclusion and Inclusion of Dalit Community in Education and Health: A Study. Dewas, Madhya Pradesh: *Jan Sahas Social Development Society*, 2009.
- Jha, P. and N. Acharya.** "Securing Food For all: Is it really difficult to afford?". *Economic and Political Weekly*, 48 (2013), 20-23
- Khera, R.** "Revival of the PDS: Evidence and Explanations." *Economic and Political Weekly*, 46.26 (2011).
- Mamgain, R. P and G. D Diwakar.** "Elimination of Identity-based Discrimination in Food and Nutrition Programmes in India." *IDS Bulletin*, 43 (2012): 25-31.
- Mander, H and M Kumaran.** "Social Exclusion in ICDS: A Sociological Whodunit?" (mimeo)." 2006.
- NNMB. Population, Diet and Nutritional Status of Rural.** Prevalence of Hypertension & Diabetes among Adults and Infant & Young Child Feeding Practices, Report of Third Repeat Survey. Hyderabad: National Institute of Nutrition, 2012.
- Sabharwal, N. S., Naik, A. K., Diwakar, D., G., and Sharma, S.** "Swallowing the Humiliation: The Mid-day Meal and Dalits." *Journal of Social Inclusion Studies*, 1.1 (2014b): 162-182
- Sabharwal, N. S., Sharma, S., Diwakar, D., G., and Naik, A. K.** "Caste Discrimination as a Factor in Poor Access to Public Health Delivery: A Case of Janani Suraksha Yojana." *Journal of Social Inclusion Studies*, 1.1 (2014a): 148-161
- Satyanarayana, K., N. Rao and B. S. Srikantia.** "Nutrition and work output." *Indian journal of nutrition and dietetics*, 16.5 (n.d): 170-174.
- SEW.** National Equity Infrastructure Audit-Phase 1, Briefing Paper 2. New Delhi: Social Equity Watch, 2011.
- Sinha. Dipa.** "Cost of Implementing the National Food Security Act." *Economic and Political Weekly*, 48.39 (2013).
- Svedberg, Peter.** "Reforming or Replacing the Public Distribution System with Cash Transfers?". *Economic and Political Weekly*, 48.7 (2012): 53-62
- Tarozzi, A.** "The Indian Public Distribution System as provider of food security: Evidence from child nutrition in Andhra Pradesh." *European Economic Review*, 49.5 (2005): 1305-1330.
- Thorat S.K. and Amaresh Dubey.** "Has Growth Been Socially Inclusive during 1993-94 – 2009-10?". *Economic and Political Weekly*, 47.10 (2012): 43-54
- Thorat, S.** "Understanding Complexity of Excluded Groups: A Case for Social Exclusion Framework." *Journal of Social Inclusion Studies*, 1.1 (2014).
- Thorat, S. and J. Lee.** "Caste discrimination and food security programmes." *Economic and Political Weekly*, (2005): 4198-4201.
- Thorat, S. and J. Lee.** Food security schemes and caste discrimination. Blocked by Caste: Economic Discrimination in Modern India. New Delhi: Oxford University Press, 2010.
- Thorat, S. K., Sabharwal, N. S., Naik, A. K., Diwakar, D. G., Sharma, S., Chandramalika Biswas, and Karimullah.** Social Exclusion and Rural Poverty: Role of Discrimination and General Factors in Access to Government Schemes for Employment, Food, Health Services, Agricultural Land and Forest Resources in the Poorest Areas in India. New Delhi: Indian Institute of Dalit Studies, 2013.
- Waterlow, J. C.** "Some aspects of childhood malnutrition as a public health problem." *British medical journal* 4.5936 (1974): 88.

"We do not inherit the Earth from our ancestors; we borrow it from our children."

– Native American Proverb

Realizing Total Customer Experience through Six Sigma Marketing: An empirical approach

K. MURALIDHARAN AND NEHA RAVAL

Loyal customer base is the key to successful business model and this pave ways to the intense customer orientation in contemporary business environment. Amplified need of customer orientation has brought monumental changes in marketing functionality. Marketing has progressed from traditional promotion based profit making business function to relationship based customer oriented business function. The focal point of recent marketing effort is on managing pleasurable Total Customer Experience (TCE). This scenario necessitates effective management of marketing actions at strategic, operational and tactical level. One well known approach that can cater to this marketing environment is Six Sigma. With the major focus on data based management philosophy, Six Sigma proposes effective guideline for different stages of marketing function. Amalgamation of these two fields is known as Six Sigma Marketing (SSM). This paper explores how empirical Six Sigma approach can be utilized to manage pleasurable TCE. With reference to real-world case study, this paper tries to demonstrate how empirical Six Sigma Marketing (SSM) approach works for effective marketing management.

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1. INTRODUCTION

Marketing as organizational functions has gone through many radical changes because of modernization and digitization. From merely exchange based approach to contemporary value based approach, marketing has come a long way as a field of education and management. Different factors like economical changes, customer requirements, organizational structure, and information technology have contributed significantly to shape this field as it is today. Intense market competition has proposed an array of products with competitive prices to the customers. Marketing in such situation has to be effective enough to address the issues related to geographical, economical or cultural differences, while maintaining name, fame and profit. Major responsibility of marketing efforts in such scenario is to inculcate feeling of trust among prospective customers for their offerings. This feeling of trust followed by close communication, value delivery and pleasurable customer experience are the ingredient of successful marketing programme for contemporary organizations. As continuous improvement initiatives, companies are focusing on creating pleasurable Total Customer Experience (TCE) in order to sustain and progress in competitive market. Pleasurable TCE can be best realized if companies can devise a method of data based follow up for each stage of marketing processes.

When it comes to data based process quality management, one should always think of the professional friendly quality improvement program called Six Sigma. The current need of marketing environment can be best addressed through integration of rigorous Six Sigma approach with innovative marketing filed. With the stand of reputed to improve production environment, Six Sigma is

now expanding its horizon to other business functions as well. One may see the article by Pestorius (2007), who explains the evolution of Six Sigma over other quality tools for different organizational functions. After its success stories in manufacturing, automobile and finance, Six Sigma is now expanding its horizon to the most customer intensive organizational functions called sales and marketing. This management approach is named as Six Sigma Marketing (SSM) (Creveling *et al.*, (2007), Webb and Gorman (2006), Reidenbach (2009), Muralidharan (2015)). According to the authors, SSM is “*a fact based process approach executed through coordinated marketing efforts, managed through measurement based Key Process Indicators (KPI) and root cause analysis*”. This paper tries to elucidate how Six Sigma can leverage productivity of marketing by effectively managing each phase of customer decision cycle which is the key to pleasurable TCE. This article offers a case study on web site quality improvement to substantiate this.

The article is presented in the following way: Section 2 explains different perspectives of Six Sigma philosophy. Section 3 discusses about changing scenario of customer orientation. Section 4 discusses how Six Sigma can contribute to different phases of marketing activity to improve the efficiency and productivity. An empirical study demonstrating SSM efforts to improve the website quality of a travel and tour facilitation start up company based in India is presented in Section 5. The article ends with some conclusion and findings.

2. Different perspectives of Six Sigma

Six Sigma is a management philosophy to reduce variations systematically and thereby improve quality of processes (Muralidharan, 2015). The concept is widely used in most of the organizations centered on process improvements and quality initiatives in a sustainable way. Based on an extensive literature review, following tenets of Six Sigma are identified:

- **Six Sigma as a metric:** Metric definition of Six Sigma is widely recognized as 3.4 DPMO to achieve high quality among product and services delivered to the customers. Metric definition of Six Sigma is based on treating variation as an evil to achieve higher level of quality. Six Sigma approach focus upon reducing variation so much so that there is 6σ distance between process target and nearest specification limit (Pande *et al.*, 2000).

- **Six Sigma as a methodology:** Improving quality requires phase based process management structure that support high quality standards of end product or service. Six Sigma follow structured DMAIC (Define-Measure-Analyze-Improve-Control) methodology to streamline quality improvement efforts. Though promoted under the umbrella of Six Sigma, DMAIC is the generic improvement methodology that can be applied anywhere (Hoerl, 2004).
- **Six Sigma as a set of statistical tools:** One of the reasons that DMAIC is so successful is that it focuses on the effective use of statistical tools (George, 2002, Snee, 2010, Muralidharan and Raval, 2017). Guidelines for using statistical tools based on difference phases of DMAIC methodology is proposed by Muralidharan (2015) and Hahn (2005) and the references therein.
- **Six Sigma as a management philosophy:** Genetic code of Six Sigma goes well beyond metric definition and DMAIC methodology of Six Sigma. Since Six Sigma evolves from statistical quality control, scientific management, and quality engineering, it is based on core scientific principle instead of rhetoric (Mast and Bisgaard, 2007).

Since Improvement being the core of Six Sigma philosophy, people always use a cause and effect model to describe any processes. To control quality of the output Y (say), one need to understand factors affecting performance of Y, called the causal variables denoted by X. Six Sigma resemble with empirical science based inferences on developing this causal connection between variables. Development of this causal connection is based on iterative step of discovery and justification (Mast and Bisgaard, 2007, Muralidharan, 2015). The discovery is based on developing hypothesis, ideas or conjecture based on observation and then improves the process as evidenced from the analytical tools. These theories are then assessed based on empirical evidence and hence justified through scientific method. Six Sigma promotes this theory-Justification based inquiry model at all level of organizational hierarchy. Defining research problem precisely, data base decision making and following each step of inquiry rigorously, these characteristics put Six Sigma at the higher cadre of quality improvement theories. Hence, all the above perceptions about Six Sigma helps us to understand very nature of the problem existing in a process.

However, Six Sigma as a quality improvement approach has progressed immensely in past few years. From structured manufacturing environment to service environment (George, 2000), from production to transactional business functions (Pestorius, 2007), from shallow defect reduction objective to holistic value creation objective (Montgomery and Woodall, 2008) – Six Sigma has undergone massive transformation.

3. Changing customer orientation

The goal of marketing function is to reach potential customer to satisfy their needs in the profitable way. To meet this goal and to adjust with external factors an organization need to use internal resources in optimum way (Ifezue, 2005). Amalgamation of these internal and external factors is leading transformational changes in marketing as explained below:

- **Need of unique value proposition:** Changing economic condition in last few decades has brought world market at one platform. Organizations from all around world are participating in international trade, as oppose to limited players dominated in such events. Marketing in such situation has to be effective enough irrespective of geographical, economical or cultural differences. Since globalization smudges the difference between domestic and international players, domestic players also required to identify their unique value proposition followed by similar chain of marketing efforts of close communication and pleasurable customer experience to survive in the competitive market (Cavusgil, 1993).
- **Service focused paradigm:** One of the reason for this amplified customer orientation is the shift towards service focused paradigm from product focused paradigm. Traditionally during product focused paradigm the centre of competition was based on advanced product features. High competition between producers due to a competitive array of products resulted in winning the battle ground based on embedded services with product. Hence market winning criteria are shifted from product focused to service focused (Jones and Sasser, 1995). Marketing strategies during product focused paradigm were merely based on understanding what features customers expect in the end product. This service paradigm requires altogether a different marketing strategy. Gradually service marketing changed its track towards maintaining close relationship with

customers and educating them. This new form of marketing is very well known as “Relationship Marketing” in marketing literature (Levitt, 1960). Through this intense customer connection, marketing as a customer focused function is getting advantage to better understand what customers need and what they value in offering. Instead of having superficial marketing research, recent marketing practices focus upon genuine insights into customers’ world (Gummesson, 1994b). Deep dives into customers’ world empower marketing to manage critical balance between what customer want, what the firm can offer and how to manage this relationship profitably.

- **Focus on customer value and hence on TCE:** Earlier marketing models where focused upon customer satisfaction as the preliminary quality assessment criteria for various offerings whereas; the new generation marketing is customer centric and is expected to provide some pleasurable experience for the customer (Parasuraman et al., 1985). Going beyond customer satisfaction is the need of time and necessity. When market is over flooded with a variety of offerings with competitive price and remarkable quality, organizations need to identify new way of customer orientation. Targeting customers merely based on physical aspects of offering is not enough, since there are many providers in market. Instead of bombarding customers with advanced features of offering, focus is now shifted to understand what customer value in offering. Instead of making selling as a major objective, new marketing efforts focus upon creating valued position of offering in the life of customer. Understanding what customers “value” becomes critical for the companies to survive in the market. Sigma level of the marketing processes could be one of the important parameter of value proposition here. Managing customer value on such realistic grounds is required to create pleasurable customer experience. Intense focus on customer value and emotional bonding between customer and offering results in to delighted total customer experience. As explained by Oswald et al. (2006) this delighted “Total Customer Experience (TCE)” is the way to achieve lasting customer loyalty and hence assuring marketing position.
- **Changing organizational structure:** The prime need of organizational set up is to be responsive and

flexible to customer requirements. New organizational structure is based on flexibility, innovation and responsiveness as their core criteria. Existence of such modern organization is based on their core product or service offering and hence called *cellular organization* (Snow, 1997). This advance organizational structure demands intimate integration of customers with organizational activities. Hence, marketing is not merely a function to make firm-customer connection after product is disseminating in the market, but it is becoming integral part of organization existence strategy (Gummesson (1994a), Achrol (1997)).

- **Increased reliance on Information Technology:** As discussed in previous units survival of the firm in contemporary market is determined by being competitive, focusing on TCE, and supporting flexible organizational structure. All of the above components required to establish strong channels of communication between different stakeholders. Companies are looking for unique environments in which they can establish close and constant communication with customers. World Wide Web is one such open platform which is changing information exchange environment (ITU, 2016). World Wide Web is providing unique platform based on current business environment as explained below,

Unlike traditional one, too many communication models are available in this new computer mediated environment facilitates too many communications models and hence create network of communication. Traditional campaigns are designed based on the assumption of homogeneous customer requirements. In this mode of

communication, customers merely act as passive listener. They don't get any opportunity to interact with a firm. This new web base environment allows customers to be proactive on digital platform. Customers can interact with firms, other customers and can give their feedback on digital platform. Hence, this new platform addresses heterogeneous users who are in search of varied experience. Engaging customers in whole channel of marketing instead of merely understanding their need is the major objective fulfilled by digital platform. Traditional campaign starts with media commercials addressing mass of customers where as digital campaign start with customer insights and tries to create a digital customer experience that they admire. Campaigns generally create brand through in store experience, which is now created on digital platform. Hence, organizations need to understand how they can bring in store/shop experience to digital platform.

4. Six Sigma Marketing: Integrating factors

Six Sigma as a process improvement approach is expanding its horizon from data rich manufacturing environment to service environment. On the other hand marketing is carving ways from superficial customer perception environment to data rich digital environment. Hence, Six Sigma converges towards service environment, which is the fundamental nature of marketing and marketing converges towards data rich environment which is the fundamental nature of Six Sigma. This complementary convergence of two fields provides great opportunity for possible integration between Six Sigma and marketing. See Table 1 for the Integrating factors between Six Sigma and marketing.

TABLE 1: Integrating factors between Six Sigma and marketing

	Marketing	Requirement	Six Sigma offering
Strategic level	Designing marketing strategy	Taking informed decisions	Following theory-justification based Six Sigma strategy
Operational level	Implementing marketing strategy	Following structured approach	DMAIC, QFD or DFSS approach
Tactical level	Working on marketing strategy	Keeping ground work in line with strategy	Statistical tools and measurements

Marketing as a business function plays important role to bring customers at the door step of the organization based on unique value proposition. However, to contribute in organization's financial success it is important to

examine customer's actions at each stage of awareness, consideration and conversion stage. Maintaining close customer connection at each of their decision making stages is the key for profitable firm-customer relationship.

SSM as a contemporary, data rich, empirical approach can help the organization to take informed decision at each stage of customer decision cycle. SSM can further prescribe desired changes in the Customer Relationship Management (CRM) and hence promotes flexible business model as per customer need.

As discussed above, the current marketing scenario necessitates focus on unique customer value, close firm-customer linkage and strong firm-customer communication channel. In such a situation it is important to take informed decision rather than simply guessing. Hence, identification of key factors for successful marketing strategy provides great room for Six Sigma integration with marketing. Further, adopting structured approach is important to channelize marketing strategy effectively. Six Sigma DMAIC (Define-Measure-Analyze-Improve-Control) approach can greatly help marketing to systematize its efforts. Major deliverables of each phase of DMAIC can help to track process progress with respect to designed strategy (see the case study presented in this article).

It is observed that, the difference between actual process performance and expected process performance can be realized only through objective measurements. Six

Sigma proposes this measurement based approach under DMAIC methodology through different statistical tools. Measurements obtained through these tools can greatly help to assess effectiveness and efficiency of marketing process with respect to customer requirements. This measurement based system also facilitates assessment of sigma level of the process, and can greatly help to examine current performance level of process and to evaluate magnitude of process improvement.

Thus, integrating Six Sigma at strategic, operational and tactic level required effective management of customer value over different phases of marketing. With great leverage in digital mode of marketing it is important to provide customer value to attract, engage and win customers. Understanding what customer value and designing marketing strategy based on their interest is the unbeatable way to get success in this digital era. Not wasting money and resources in creating digital features of business that is not valued by your customer is important part of contemporary marketing strategy (Verma et al., 2004). Figure 1 depicts the different stages of customer value management and hence framework to realize pleasurable TCE.

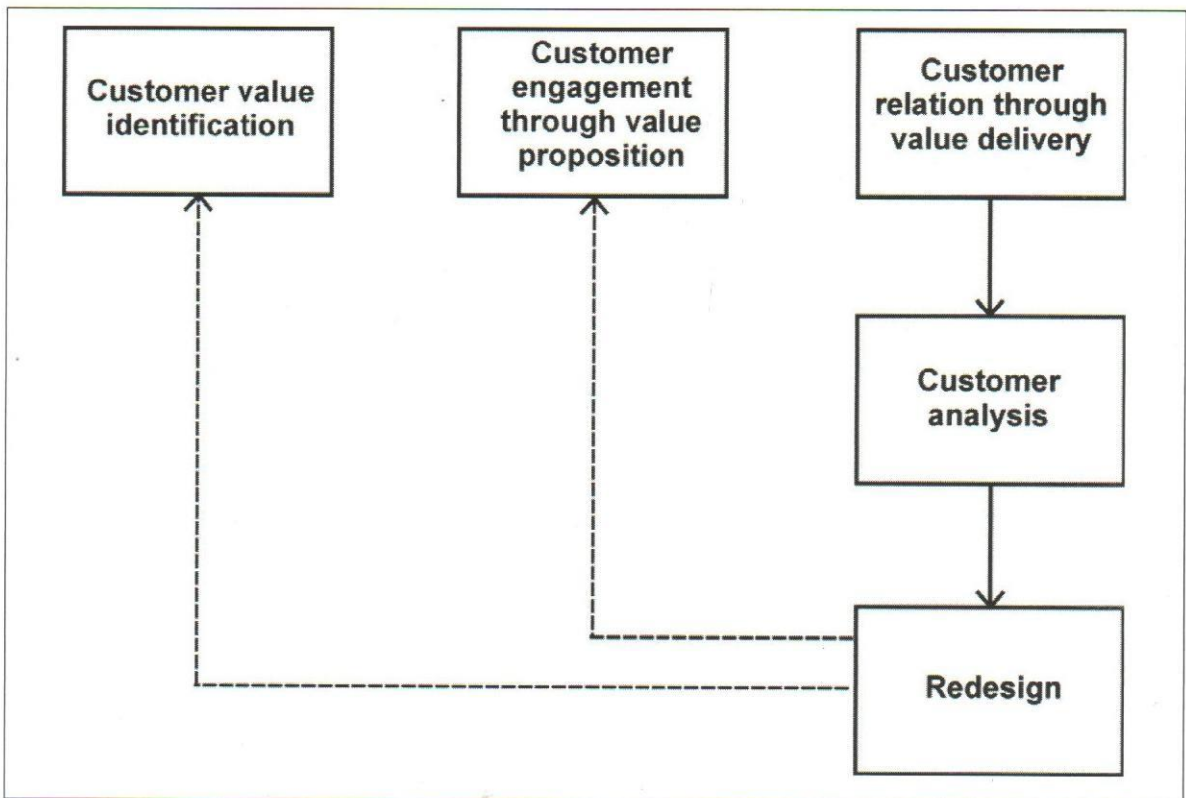


Fig. 1. Conceptual framework of TCE

5. Empirical study demonstrating TCE

To understand the integration between Six Sigma and marketing an empirical study was conducted with reference to marketing strategy of a travelling company- Divine Voyage Club (DVC) (www.divinevoyageclub.com) based in India. The improvements are realized through the DMAIC procedure of SSM.

5.1. Define phase (Strategic decision making through SSM): To design the whole marketing strategy and to make it more effective, the company DVC has decided to adopt evidence based approach at each stage of marketing efforts which enabled abundant scope for SSM application. In addition to this, marketing efforts were streamlined through DMAIC approach as proposed by Muralidharan and Raval (2017). Following dimensions were considered while making selection from the array of marketing modes.

- Since it's a small scale start up company, major parameter to be taken care while designing marketing strategy was cost. Company explored potentiality of different marketing mode based on reaching to wider market in cost effective way.
- Since travelling is the information intensive field, company was in search of such a marketing mode through which information delivery, information updates and customer contacts can be achieved easily.
- With customer focused strategy, company decided to manage customer value chain scientifically through SSM. Managing each stage of customer value chain

scientifically through understanding customer value, customer engagement, and customer satisfaction by establishing strong channel of communication is the expected outcome of marketing efforts of the company.

5.2. Measure phase (Operational marketing decisions): Here the priority was given to the selection of marketing mode of operation: To choose appropriate mode of marketing, company reviewed market trends and the limitation of each mode. Increased reliance on IT to search for relevant information made company to think about going for marketing mode which is digital in nature. However, to take decision regarding mode of marketing, few facts regarding digital trend, future perspective and its benefits were also reviewed.

According to ICT 2016 report, by the end of 2016, 3.9 billion people, that is 53% of the world population is not using the internet. 75% of people in Africa, 21% of European, 58.1% Asia and Pacific percentage is: 58.1% and in Arab States the percentage of population not using internet is 58.4%. With increased rate of internet usage from 23% in 2010 to 42% in 2016, Asian countries are next in line for wide spread usage of internet. As per ICT 2017 report, 70% of the world's youth (15-24 years of age) are online. Out of 830 million people who are online 320 million (39%) are from China and India. This statistics motivated DVC to go for digital phase of marketing.

To start with DVC launched initial phase of website and identified room for improvement. To understand improvement parameters XY matrix was created. Different

TABLE 2: XY matrix

X Variables	Y Variables							
		New visitors	Bring back customer	Visitor's engagement	Call to action	Conversions	Rating	Priority rank
	Y Weights	7	8	6	10	9		
Website visibility		10	7	1	0	1	141	5
Digital engagement		7	6	9	4	6	245	2
Customer value		9	8	9	9	9	352	1
Content		6	6	8	5	5	233	3
Updates		0	10	5	1	0	120	6
Trust and reliability		8	0	2	6	8	200	4

components required for basic website launch are identified to align business strategy with marketing efforts. With reference to business strategy, Y variables (output) are decided and prioritized on the scale of 1-10, where 1 indicates not much important and 10 indicates more important parameter to achieve based on business strategy. X variables are identified based on different causes identified through brain storming. The relative ranks of X variables are obtained with reference to Y variables as shown in Table 2. This XY matrix is created based on relative importance of different X with respect to given Y.

From the Table, we have identified the hierarchy of X from most important to relatively less important based on different Y. They are (i) understanding customer value, (ii) engagement through different digital platforms, (iii) engaging content, (iv) realization of trust and reliability, (v) website visibility, and (vi) offering updates notification. These variables are further subject to measurement based analysis and decision making.

5.3. Analyze phase (Tactical marketing decisions): Tactical decisions were required to understand customer value and customer engagement on different platforms. This necessitated carrying out the *customer value analysis* (CVA). To understand what customer value on digital platform of the travelling website, data were collected through small survey on website. To explore underlying customer value dimensions, data are further analyzed using factor analysis. To examine correlation between variables, KMO test was used. Here, KMO value is 0.746 which is fairly good to run factor analysis (Field, 2009). Bartlett's test of Sphericity tests the null hypothesis that the original correlation matrix is an identity matrix. To run factor analysis we need relationship between variables Here, p-value related to Bartlett's test of Sphericity showing significant (p value $0.00 < 0.05$) result. Hence, there is correlation among variables which can lead to grouping of variables and hence extracting factors. Three underlying theme of website quality identified through factor analysis are Security, Content, and Visibility. They further examined through SSM perspective. These three factors were further prioritized based on customers satisfaction score on each of these as shown in Figure 2.

Some of the significant findings of the CVA are as follows:

- With highest disagreement percentage (41.3%) and strongly disagreement percentage (19.6%), website loading time is the most important element to improve upon.

- With second highest disagreement percentage (10.9%) and strongly disagreement percentage (2.2%), package detailing is the second element for which company needs to consider improvement.
- With third highest disagreement percentage (8.7%), company detailing and picture quality on website are the next element in line to consider for improvement.

Along with proactive source of information (survey), data were also collected through passive information sources like ad-words and Google analytics. Customer behaviour on website gives further information for possible improvement. Google analytics is the tool, which can be used to dig deep further in customer behaviour on website pages. This live data helps to examine website performance constantly and keeping a strict watch on marketing efforts to get desirable results. Following metrics were observed to examine marketing efforts effectiveness:

- *Users*: the number of unique visitors on website.
- *Sessions*: represents the number of individual sessions initiated by users to website.
- *Pages per sessions*: This is the average number of pages viewed during a session on your website.
- *Average session duration*: This is the average length of session duration. Longer session duration indicates visitor's engagement on site.
- *Bounce rate*: This represents the percentage of visitors who enters the site and leave from the same page instead of continuing to view other pages. Bounce rate is calculated based on following formula,

$$R_b = \frac{T_v}{T_e}, \quad (2)$$

Where,

R_b = Bounce rate

T_v = Number of visitors viewing one page only

T_e = Total entries on that page

Bounce rate is helpful to understand effectiveness of landing page. Low bounce rate shows that landing page is effective enough to engage visitors and motivates them to visit other pages. High bounce rate indicates less effectiveness of landing page to keep customers engage.

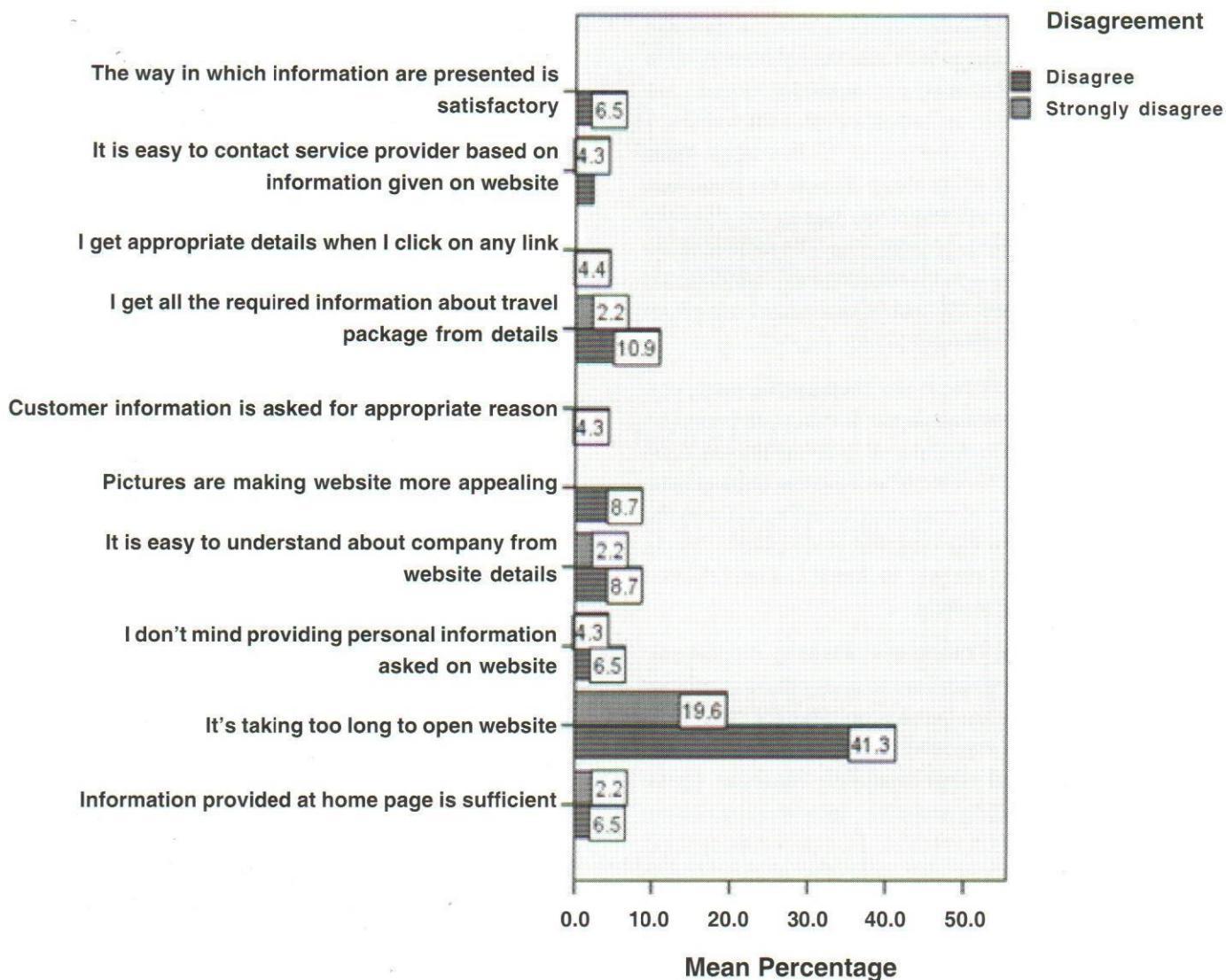


Fig. 2. Identification of elements to improve

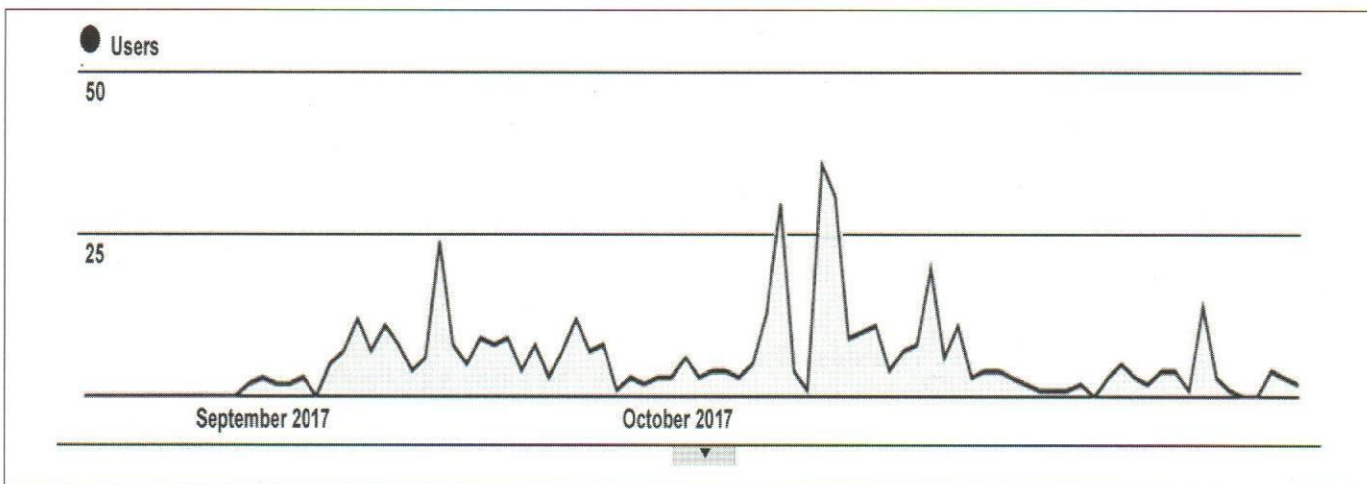


Fig. 3. Trend in website users

DVC decided to use all these information to decide about the investment they have to make for their marketing efforts. With an average 5 visitors per day, the trend in number of website users has increased (see Figure 3), specifically; the trend has increased during festivals

occasions and holidays. However, the important thing to understand was to get idea about customer acquisition. That is to understand which channel is effective enough to bring traffic on website which is shown in Figure 4.

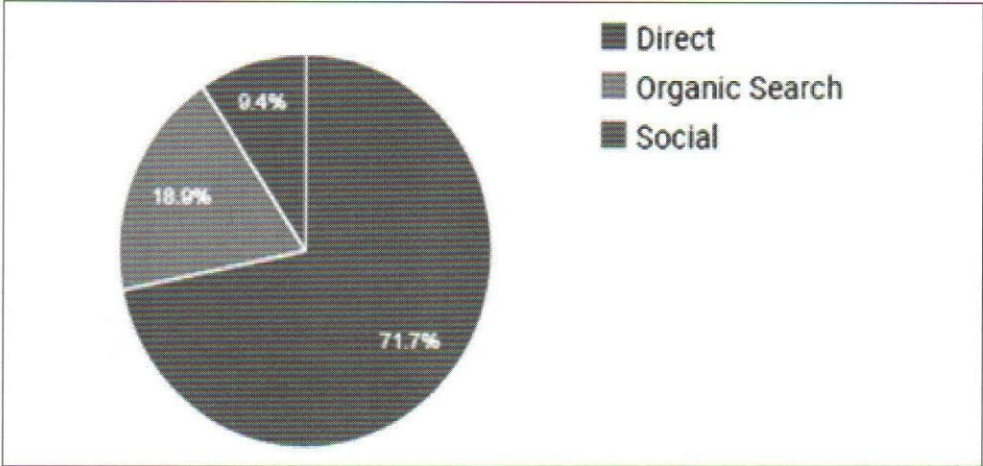


Fig. 4. Visitor's acquisition channels

Since, the launch about 71.7% users acquisition was realized through direct URL search. Due to brand awareness through word of mouth the organic search contributes 18.9% to the user's acquisition and the rest is contributed by Social media. With increased presence of millennial on social media, DVC decided to invest efforts in Social Media Marketing (SMM).

Since, DVC was launching initial phase of website, major action of interest (conversion) was to navigate visitors towards the contact us page. Understanding the path through which customers are reaching to the 'contact us' page and examining drop outs helps to optimize conversion path and hence improving conversion rate. Visitor's navigation path towards contact us page is shown in Figure. 5.

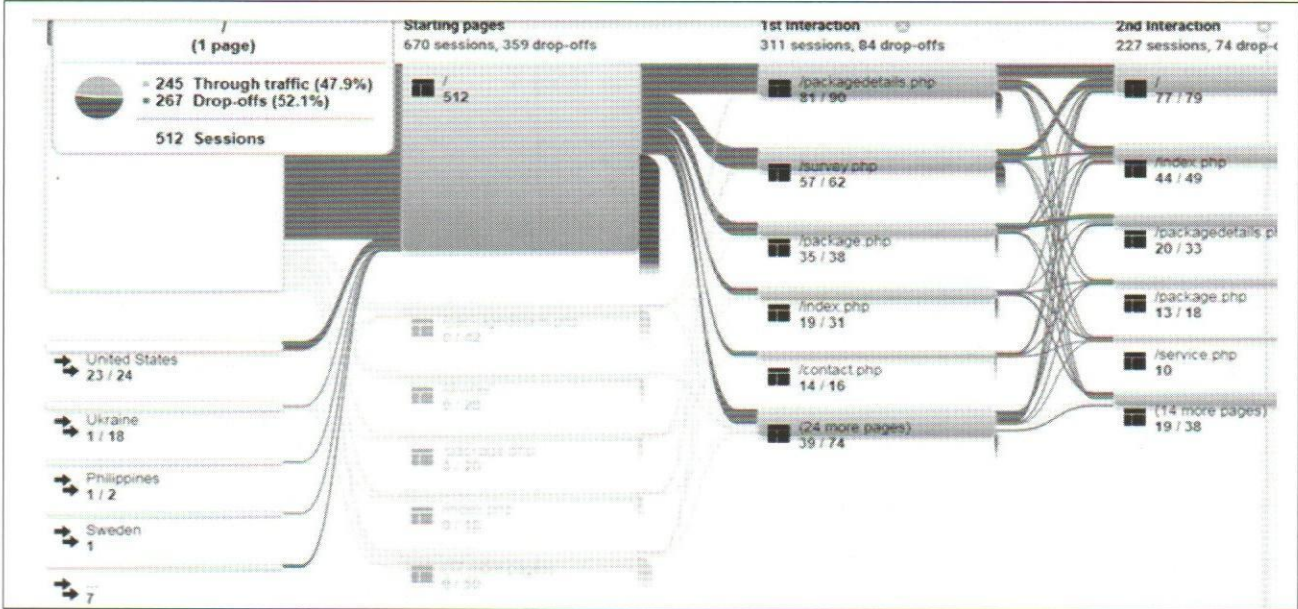


Fig. 5. navigation path towards contact us page

TABLE 3: DVC website pages with high bounce rate

Starting Page	Total sessions	Drop offs	Target (Conversion)	Total sessions	% success
/	512	267	/contact.php	16	3.125
/packagedetails.php	42	29	/contact.php	0	0
/divine/	28	12	/contact.php	0	0
/package.php	20	9	/contact.php	16	80
/index.php	18	10	/contact.php	0	0
17 pages	50	32	/contact.php	6	12
Number of opportunity	670		Number of success	38	

Visitors are reaching to contact us page through different landing pages with many drop offs and navigation to other pages. Table 3 shows number of sessions initiated at different starting pages, drop offs on those pages and navigation towards contact us page. For example, there are 512 session initiated at home page (/) out of which 267 (52%) drop offs observed. Finally only 16 sessions (3.125%) are initiated on contact us (/contact.php) page through home page. The page through which maximum success (80%) observed is different package page (/package.php). Hence, maximum visitors are reaching to contact us page through package page. So this is the path that can be optimized in new version of website. Based on given information sigma level of the conversion process is calculated. Out of 670 total opportunities, the number of successes is 38. Hence, number of defects are 670-

38=632. This correspond to $(670/632) \times 10^6 = 943283.58$ DPMO. Therefore, the sigma level correspond to this DPMO is 1.58σ .

5.4. Improve phase (Initiating website improvement based on analyse phase): Improvement efforts of DVC started with increasing website visibility on search engine. To do that different Search Engine Optimization (SEO) techniques were used. One of the important methods to improve website visibility is designing content of website embedded with keywords. Keywords are the words though which customers search for online information. Integrating these keywords with website content helps to improve website visibility on digital platform. To get information about highly competitive key words, keyword planner tool was used. Major keywords identified through this tool are shown in Table 4.

TABLE 4: Key words identified through key word planner tool

Competitive key words	Frequency
Packages	103
tour	36
tour packages	80
Travel	76
Honeymoon	41
Shimla kullu manali	312
booking	80

To further improve website visibility different tags like geo tags, Meta description, Meta key words were kept in html code prepared by the company. However, based on customer review and data analysis many changes were made on the website. The improvements include:

- Easy to reach contact details so that visitors can easily send their query and they don't required to navigate through the 'contact us page' all the time.
- Highlighting DVC's market differentiators on website was important. This can help company to further add value to the offering and help customers to take informed decision.
- Detailed information about different packages including price, places of interest, inclusion, exclusion, mode of transport etc. This major improvement was required so that maximum information can be conveyed through website only, which results into minimum personal interaction with prospective customers and hence contribute as time saving value added feature.
- How first visitors perceive company is largely depends about the details of company provided on the website. Hence, with focus to share long term goals of the company and highlighting major services, necessary changes were made in about us part of the website.

- To create feeling of trust among website visitors, additional testimonials were integrated on new version of website.
- Navigation to other pages of website was made easier from multiple locations.

Based on above efforts improvement was realized in different on-site measurements like web traffic, page per session, average session duration and bounce rate. As shown in Figure 6, an average number of visitors increased from 5.68 to 9.77 after implementing SSM approach. Change in other website performance parameter is shown in Table 5. As shown in Table 5, the total number of visitors increased from 86 to 179 within one month through SSM efforts. These improvements in a number of visitor's tag shows improved the *visibility* of a website. To evaluate the content of website there are three major measurements-pages/sessions, average session duration and bounce rate. No improvement is realized in pages/session and average session duration. However, bounce rate has reduced from 50.20% to 39.16%. Hence, we can say that *content* on the website is engaging enough to hold visitors' interest. Process sigma level was again examined based on a number of conversions realized over number of visitors. Improvement in sigma level is realized from 1.58 σ to 2.1 σ .

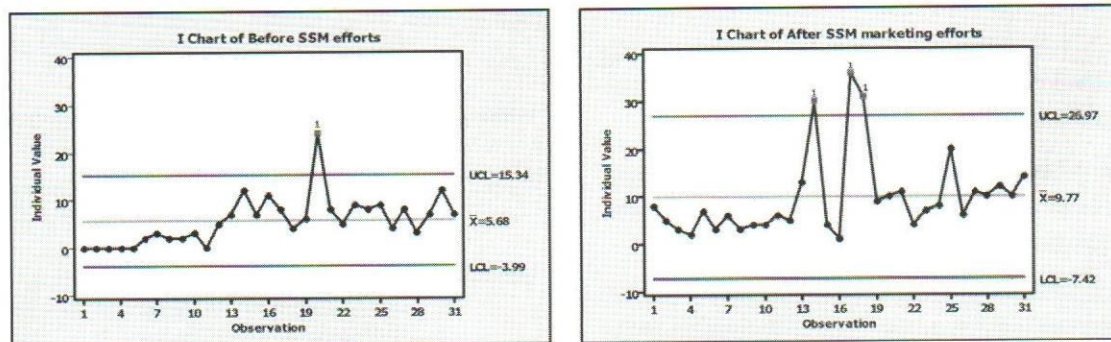


Fig. 6. Number of visitors before and after SSM efforts

TABLE 5: Website performance parameters

Parameter	Before SSM efforts	After SSM efforts
Number of visitors	86	179
Page/session	6.55	4.4
Average Session duration	8.12	5.21
Bounce rate	50.20%	39.16%
Sigma level	1.58 σ	2.1 σ

5.5. Control phase (Sustaining Continuous improvement efforts): This step of SSM DMAIC approach generally entails developing a control plan to maintain progress that was realized during Improve phase. Following steps are taken to sustain realized improvement:

- Considering high engagement realized on the website due to shared customer experience, DVC decided to integrate customer experience blog on website and customer review through different channel of communication.
- Considering insights from visitor's engagement through media type, DVC realized higher engagement on photos. Hence, travel photos are in the highest priority of DVC social media update.
- Considerable improvement realized on web traffic through Ad campaigns, made DVC to regularly opt for such campaign to constantly improve visitor's awareness.

6. Conclusion

In order to propose empirical approach to realize TCE through SSM, this paper proposed holistic approach with component identification of both the fields to proposing integration between them. The empiric approach proposed here attempts to integrate each dimension of Six Sigma with marketing efforts. Specifically,

- Through following evidence based marketing approach DVC is supporting discover-justification based philosophical dimension of Six Sigma.
- Imbedding Six Sigma DMAIC approach over strategic, operational and tactic decisions DVC adopted methodological aspect of Six Sigma.
- Usage of different tools over different phases of DMAIC approach demonstrates tool based dimension of Six Sigma.
- Evaluating marketing effectiveness through sigma level, supports metric based definition of Six Sigma.

In order to realize pleasurable TCE, following strategy was adopted at different stages of TCE model shown in Figure 1.

- *Customer value identification*: through website survey and different website parameters
- *Customer engagement*: through different medium like social media and word of mouth

- *Customer retention*: performance based on identified customer value
- *Customer analysis*: examining customer behaviour and their positive feedback on different medium is evident of the pleasurable TCE.

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References

- Aaker, David.** (2011). Five Challenges Facing Marketing. *Harvard Business Review*, October 26.
- Cavusgil, S Tamer.** (1993). Globalization of Markets and Its Impact on Domestic Institutions. *Indiana Journal of Global Legal Studies*, 1(1), 83-99.
- Creveling, Clyde M, Hambleton, Lynne, and McCarthy, Burke.** (2007). *Six Sigma for marketing processes An overview for Marketing Executives, Leaders and Managers*: Prentics Hall.
- Field, Andy.** (2009). *Discovering Statistics using SPSS*: Sage
- George, Michael L.** (2000). *Lean Six Sigma for services*: McGraw-Hill.
- George, Michael L.** (2002). *Lean Six Sigma: Combining Six Sigma Qualities with Lean Production Speed*: McGraw-Hill Education.
- Gummesson, Evert.** (1994a). *Relationship Marketing – From 4Ps to 30 Rs*:Stockholm.
- Gummesson, Evert.** (1994b). Service Management: An Evaluation and the Future. *International Journal of Service Industry Management*, 5(1), 77-96.
- Hahn, G J.** (2005). 20 key lessons learned. *Quality and Reliability Engineering International* 21, 225-233.
- Hoerl, Roger.** (2004). One perspective on the future of Six-Sigma. *International Journal of Six Sigma and Competitive Advantage*, 1(1).
- Ifezue, Alex N.** (2005). The Role of Marketing in Economic Development of Developing Countries. *Innovative Marketing*, 1(1), 15-20.
- (ITU), International Telecommunication Union.** (2016). ICT Facts and Figures 2016:The International Telecommunication Union.
- Jones, Thomas O., and W. Earl Sasser, Jr.** (1995). Why Satisfied Customers Defect. *Harvard Business Review*, November-December.
- Levitt, Theodore.** (1960). Marketing Myopia. *Harvard Business Review*
- Mast, De, and Bisgaard, S.** (2007). The Science in Six Sigma. *Quality Progress*, 41(1), 25-29
- Montgomery, Douglas C., and Woodall, William H.** (2008). An Overview of Six Sigma. *International Statistical Review*, 76(3), 329-346. doi: 10.1111/j.1751-5823.2008.00061.x

- Muralidharan, K.** (2015). *Six Sigma for Organizational Excellence: A Statistical Approach*: Springer
- Muralidharan, K, and Raval, Neha.** (2015). *Assessment of value added activities: Lean versus Six Sigma* Paper presented at the 3rd Annual convention and Competition on Lean Six Sigma.
- Muralidharan, K, and Raval, Neha.** (2017). Six Sigma marketing and productivity improvement. *A Quarterly Journal of the National Productivity Council*, 58(1), 107-114.
- Oswald A. Mascarenhas, Kesavan, Ram, and Bernacchi, Michael.** (2006). Lasting customer loyalty: a total customer experience approach. *Journal of Consumer Marketing*, 23(7), 397-405.
- Pande, Peter S, Neuman, Robert P, and Cavanagh, Ronald R.** (2000). *The Six Sigma Way: How GE, Motorola, and Other Top Companies are Honing Their Performance* McGraw-Hill Education
- Parasuraman, A., Zeithaml, Valarie A., and Berry, Leonard L.** (1985). A Conceptual Model of Service Quality and Its Implications for Future Research. *The Journal of Marketing*, 49(4), 41-50.
- Pestorius, Michael J.** (2007). *Applying the science of Six Sigma to the art of Sales and Marketing*. ASQ.
- Reidenbach, Eric.** (2009). *Six sigma marketing : From cutting costs to growing market share*: Amer Society for Quality
- Snee, Ronald D.** (2010). Lean Six Sigma – getting better all the time. *International Journal of Lean Six Sigma*, 1(1), 9-29.
- Snow, Charles C.** (1997). Twenty-First-Century Organizations: implications for a New Marketing Paradigm. *Journal of the Academy of Marketing Science*, 25(1), 72-74.
- Verma, Rohit, Iqbal, Zafar, and Plaschka, Gerhard.** (2004). Understanding Customer Choices in E-Financial Services. *California Management Review*, 4(46), 43-67.
- Webb, Michael J, and Gorman, Tom.** (2006). *Sales and Marketing: The Six Sigma Way* Kaplan

“If it can’t be reduced, reused, repaired, rebuilt, refurbished, refinished, resold, recycled, or composted, then it should be restricted, designed or removed from production.”

– Pete Seeger

Impact of Self Help Group – Bank Linkage Programme and it's Role in the Upliftment of the Poor

K. FAYAZ AND K. VENUGOPAL RAO

Development with social justice has been the fundamental target of development planning in India since independence; it has been evident that women have always been given very respectable position in the society. Gender equality in different socio-economic spheres has always been the top priority among policy makers, decision makers and the government. In the present socio-economic scenario, notions of women empowerment and their security can always be observed in the manifestos of all the political parties and this is the need of hour too for sustainable development. Despite making myriad efforts for women empowerment, the present socio economic status of women in India is very miserable. In this context, NABARD came ahead to launch Self Help Group (SHG) and bank linkage programme in 1992. These programmes have become a very effective tool of uplifting the socio economic status of poor women. There are ample facts across the globe to show, how the SHG and bank linkage programme through its functioning can provide productive employment opportunities, safe credit facilities, saving opportunities and thereby can eradicate poverty. The studies on the Self Help Group-Bank Linkage Programme (SBLP) of the National Bank of Agriculture and Rural Development (NABARD) underline that the programme has done extremely well in rural India in terms of its outreach, generating income, reducing poverty levels and empowering people both economically and socially. This paper evaluates the impact of SBLP on Self Help Group (SHG) members at the household level from a gender perspective. This is mainly because female SHGs are doing extremely well in terms of recovery of loans and per capita income and savings. Micro financing through self-help groups has proved to be a strategic measure for organizing poor people in groups and promoting savings habits to gain to access to institutional credit for their socio-economic development and empowerment.

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1. Introduction

Since ancient time it has been evident that women in our country have a respectable position in the society. But it has become more than six decades of independence, the socio- economic status of women is very severe in the rural and backward areas like Ananthapuramu. In the economy of our country, women constitute about fifty percent of the total human resources. However women are the more deprived and underprivileged than men as they are subject to many socio-economic and cultural constraints (Lakshmi and Vidivalagan, 2012)

Now it is the need of hour for achieving sustainable development that the development initiatives for women empowerment must be given importance to eradicate poverty, gender inequality, increase better standard of living. Self Help Group (SHGs) as small credit cooperatives is playing a vital role for all poor and all women in rural India. As it is well known universal truth which Aristotle said, "Man is a social animal". Since his birth man generally does not live alone. His insight of the world is based on his face to face interaction with his family members, friends and members of his community.

SHGs-Bank Linkage Programme is emerging as a cost effective mechanism for providing financial services to the "Unreached Poor" (Shivakumar and Prabhakaran, 2012), which has been successful not only in meeting financial needs of the rural poor women but also strengthen collective self help capacities of the poor, leading to their empowerment. Rapid progress in SHG formation has now turned into an empowerment movement among women across the country (Biswas, 2007).

Self Help Group by mobilizing women around thrift and credit activities have resulted in economic self reliance

there by changing their social attitude and status in the family and society, Self Help Group has emerged as a key programming strategy for most of the women development activities (Alam and Mohammed, 2012).

Most of the women across the globe rely on working in the informal sector for an income. Empowering women in developing countries is very essential to reduce global poverty since women represent most of the world's poor population. For achieving sustainable development and harmonious growth of a nation would be possible only when women are considered as equal partners in progress with men. However, in most developing countries, women have a low social and economic status (Gaonkar, 2004).

Emancipation of women is a pre-requisite for nation's economic development and social upliftment (Dey et.al, 2014). Poverty is the main obstacle for the improvement in the living standard of the women. The role of women and the need to empower them are the main focus of human development programmes i.e. Millennium Development Goals, including poverty alleviation (Report on India's MDGs, 2012).

Apart from myriad programs relating to poverty alleviation has been started, it was observed that micro credit system through SHGs bank linkage programme plays a very significant role for the woman empowerment in rural areas so as to the poor families could be benefited.

Rapid progress in SHG formation has now turned into an empowerment movement among women across the country. Economic empowerment results in women's ability to influence or make decision independently, increased self confidence, better status and role in household etc (Hardeep and Harkiranjeet, 2013).

The empowerment of women through SHGs would give benefit not only to the women at individual level but also for the family and community as a whole through collective action for development (Singh, 2013). Micro-finance programmes are important initiatives for providing small credit to the rural poor in order to alleviate poverty. Micro-financing programmes through Self-Help Groups (SHGs), have introduced in several parts of India, the potential to minimize the problems of inadequate access of the poor to the banking services. Since women empowerment is critical to the socio-economic progress of the country, investing in women's capacity building and empowering them to exercise their choices is not only valuable itself but is also the surest way to contribute to

economic growth and overall development (Dasgupta, 2001; Dhavamani, 2010).

Empowerment of women has now become a key issue in the Government's Five-Year Plans-by organizing women into SHGs to make the beginning of a major process of empowering women. Whilst, the agenda of SHGs is 'Empowerment' and shift from dormant masses of the rural women to vibrant masses by bringing more income in the hands and control of women so that they can lead a better social life.

2. REVIEW OF LITERATURE

Since Independence, the Government of India and the Reserve Bank of India (RBI) have made concerted efforts to provide the poor with access to credit. Despite the phenomenal increase in the physical outreach of formal credit institution and unwieldy procedures and risk perceptions of the banks left a gap in serving the credit needs of the rural poor. It is in this context that micro credit has emerged as the most suitable and practical alternative to the conventional banking in reaching the hitherto unreached poor population. Related to this at worldwide stage also, since the late 1970, development policy has increasingly taken recourse to micro finance to improve the access to financial services for poor households to deny the *consumer credit companies* (most of which are out the market today) which have forced the micro entrepreneurs towards increasing high debt levels and repayment obligations which they frequently could not fulfil.

At India level in the 1990s a new nationwide microfinance initiative linking banks, NGOs and informal local groups (self-help groups or SHGs was started in India. Better known as 'SHG- Bank Linkage',) it is expected to become a dominant form of financial access for the rural poor. A major challenge therefore is to widen access to finance of the rural poor-especially women, a highly disadvantaged and deprived group to meet their diverse needs (savings, credit, insurance services) through flexible products at competitive prices.

2.1 Historical background

Micro-finance institutes have been acknowledged as a pioneer in the field of micro-finance. Dr. Mahmud Yunus, Professor of Economics in Chittagong University of Bangladesh, was an initiator of an action research project 'Grameen Bank'.

2.2 Indian Scenario

India has adopted the APs model in a modified form. To alleviate the poverty and to empower the women, the microfinance has emerged as a powerful instrument in the new economy. With availability of micro-finance, self-help groups (SHGs) and credit management groups have also started in India. And thus the movement of SHG has spread out in India. 20 Banks are the predominant agency for delivery of micro-credit. In 1970, Ilaben Bhat, founder member of 'SEWA' (Self Employed Women's Association) in Ahmedabad, had developed a concept of 'women and microfinance'. The Annapurna Mahila Mandal' in Maharashtra and 'Working Women's Forum' in Tamilnadu and National Bank for Agriculture and Rural Development (NABARD)-sponsored groups have followed the path laid down by 'SEWA' a trade union of poor, self-employed women workers. In 1987 'Mysore Resettlement and Development Agency' (MYRADA) has promoted Credit Management Groups (CMGs). CMGs are similar to selfhelp groups. The basic features of this concept promoted by MYRADA are:

1] Affinity, 2] Voluntarism, 3] Homogeneity and 4] Membership should be limited to 15-20 persons. Aim of the CMG is to bestow social empowerment to women. In 1991-92 NABARD started promoting self-help groups on a large scale. And it was the real take-off point for the 'SHG movement'. In 1993, the Reserve Bank of India also allowed SHGs to open saving accounts in banks. The banks have externalized what would otherwise have been high transaction costs for mobilizing savings of the poor, appraisal and sanction of loans and improved loan recovery through the financial intermediary's role played by SHGs.

- 1) Self-confidence
- 2) Development of decision-making capacity
- 3) Position in the family
- 4) Position in the society
- 5) Thinking about Views regarding female education and employment
- 6) Views regarding Thinking about caste system
- 7) Attitude regarding towards assisting own family, village and society in solving their problems
- 8) Participation in social movements and politics
- 9) Awareness about health issues etc.

In the issues selected by 'Drushti', in addition to these issues, of woman's self confidence, her changing position in the society, the points, like whether she has started to thinking about society and social problems, whether she merely thinks of the problems or search for solutions also, whether she also thinks on the evils such as discrimination between men and women, social customs like dowry, casteism which have badly affected our society for long, are also taken into consideration. The SHG-Banking pioneered and promoted by NABARD has emerged as a primary microfinance service mechanism for the unbanked poor in India.

The multiple initiatives led by capacity building have made tremendous inroads into the conventional banker's mindset. They now view SHG-Banking as a new dimension of quality portfolio with very low risks and with marginal increase in operating costs. *The dimension and flexibility in SHG-banking now practiced in India is unmatched in world's banking system.* Being predominantly women focused, SHG-Banking is the first step towards feminization of the micro banking portfolio of Indian banks. Stimulating self-help capacity of the poor does spark off the entrepreneurial enthusiasm, risk mitigation mechanisms in low-income households; it also serves as an entry-road to overcome poverty and addressing other crucial social concerns.

2.3 Commercial Aspects of SHG Banking in India

There are two outstanding aspects to NABARD's *Linking Banks and Self-Help Groups*: with an outreach to 500,000 SHGs and a population of 40m rural poor, *it is the largest non-directed microsavings & microcredit programme in the developing world; and its bank lending rates—fluctuating at market rates around 7% in real terms — are among the lowest.* Is it a commercial proposition for the 17,000 participating bank branches, and perhaps for another 20,000 who might join the program to reach a population of 100m by 2008 (Prof. Dr. Hans Dieter Seibel, University of Cologne, Germany & Harishkumar R.) The study applied average cost analysis, attributing all costs duly to each product; and marginal cost analysis, in response to the advice of bank managers to ignore personnel costs of SHG banking because of existing idle capacities. Main performance indicators are non-performing loans, return on average assets, and operational self-sufficiency. This methodology was applied to seven units of three banks in October 2002. The results are indicative only.

- **Non-performing loans** to SHGs were 0%, testifying to the effectiveness of group lending to the very poor. In contrast, consolidated NPL ratios ranged from 2.6% to 18%; and of Cash Credit (CC) and Agricultural Term Loans (ATL) up to 55% and 62%, respectively.
- **Returns on average assets of SHG Banking** ranged from 1.4% to 7.5% by average and 4.6% to 11.8% by marginal cost analysis, compared to –1.7% to 2.3% consolidated. The operational self-sufficiency of SHG banking ranged from 110% to 165% by average and 142% to 286% by marginal cost analysis, compared to 86% to 145% consolidated. In contrast, ROA of Cash Credit varied from –10.2% to –0.5% and of ATL from –6.3% to 0.2%; OSS ratios from 54% to 102%. SHG Banking was found to be a robust financial product, performing well in healthy and distressed financial institutions.
- **Self-reliance of SHGs** based on internal savings and retained earnings was found to be rapidly growing, exceeding in older groups the volume of bank refinance by an increasing margin. In addition SHGs deposit substantial amounts of savings voluntarily in banks as a reserve for bad debts.
- In addition to direct effects on bank profits, SHG Banking has indirect commercial effects on banks in terms of improved overall vibrancy in banking activities. Indirect benefits at village level include the spreading of thrift and financial self-reliance and of a credit culture among villagers, micro entrepreneurial experience, growth of assets and incomes, the spreading of financial management skills, and the decline of private money lending. Intangible social benefits are reportedly many: self-confidence and empowerment of women in civic affairs and local politics, improved school enrolment and women's literacy, better family planning and health, improved sanitation, reduction of drinking and smoking among men, and a decline in adherence to local extremism.

The future sustainability of SHG Banking hinges on five factors:

- (a) A sound self-supporting institutional framework is in place.
- (b) Despite exceptionally low interest rates, linkage banking was found to be viable and profit making for

all financial institutions and SHGs; however, many rural banks require restructuring.

- (c) SHGs have substantially increased their level of self-reliance and deposited reserves, while banks are constrained by high statutory liquidity requirements.
- (d) Given the low inflation rate, preservation of the value of resources is no major issue, except in distressed banks.
- (e) With continually increasing internal funds, effective supervision of SHGs through a delegated system, together with the enforcement of prudential norms in banks and cooperatives, emerges as a major challenge to the long-term sustainability of SHG banking and rural finance in India.

SHG Bank Linkage Programme for Rural Poor

The study was based on primary details collected from 115 members in SHGs. The socio-economic conditions of the members were compared between pre and post SHG situations to quantify the impact. *The study findings concluded that SHG Bank Linkage Programme has made significant contribution to social and economic improvement of the member households of SHGs.*

There was a significant increase in the asset structure, Mean annual savings, average loan per member, overall repayment percentage, average annual net income, Employment per sample households. Availing loans from moneylenders and other informal sources with higher interest rate was significantly reduced due to SHG intervention. There was remarkable improvement in social empowerment of SHG members in terms of self confidence, involvement in decision-making, better communication, etc. The present study attempts to assess the performance of micro finance channelised through SHG Bank Linkage programme implemented by NABARD since 1992 in Eastern areas,

3. Research Methodology

During the process a detailed study was conducted to understand the genesis Self Help Group-Bank Linkage model of Microfinance and the factors impacting the empowerment of the rural poor. The factors affecting the functions of SHGs, NGOs and Banks.

Sources of Data

The study involved with review of literature and publications

reports of government bodies like RBI, NABARD, Planning Commission, DRDA, Public Sector Banks, Local panchayats and the research reports and case studies from various Microfinance Institutions and NGOs.

4. Research Problem

The research study focuses on the reason on spread of Self help Bank Linkage Program in the areas of Andhra Pradesh. The study would analyse the conditions which are discouraging the otherwise successful model of microfinance elsewhere that has the capability to uplift their poor economic conditions and can give a sustainable development.

5. Objectives of the study

- To examine the Self Help Groups in the state of Andhra Pradesh.
- To Analyse the Self Help group and Bank Linkage programme in Andhra Pradesh.
- To find out the possible SHG-Bank Linkage Program models in India.
- To suggest the policy measures for upliftment of the poor through Self Help Group and Bank Linkage programme.

6. The concept of SHG

Experience in many countries demonstrates that poor women make investments wisely and earn returns. However, the flow of financial assistance to them was too marginal, to enable them to cross the poverty line. The need to create a grassroots organizational base to enable women to come together, to analyze their issues and problems themselves, and to fulfil their needs was strongly advocated. In fact, experience shows that some of the successful 'group-based participatory programmers' have made significant improvement in the conditions of living poor women. The concept of self-help groups gained significance, especially after 1976 when experimenting with micro-credit and women SHGs. The strategy made a quiet revolution in Bangladesh in poverty eradication 'by empowering the poor women'.

SHGs are small informal associations created for the purpose of enabling members to reap economic benefit out of mutual help, solidarity, and joint responsibility. The benefits include mobilization of savings and credit facilities and pursuit of group enterprise activities. The group-based approach not only enables the poor to accumulate capital by way of small

savings but also helps them to get access to formal credit facilities. These groups by way of joint liability enable the poor to overcome the problem of collateral security and thus free them from the clutches of moneylenders. The joint liability not only improves group members' accessibility to credit, but also creates mechanisms like peer monitoring leading to better loan recoveries.

Self-help groups are comprised of people who share the same problem, life situation or Crisis. Members provide emotional support to one another; learn new ways to cope, discover strategies for improving their condition, and help others while helping themselves. People find in self help group's individuals much like themselves who are able to share pragmatic, experience tested insights gained from first-hand experience with the same situation.

7. Self Help Group Bank Linkage Program in Andhrapradesh

7.1 Genesis of SBLP

The formal financial institutions in India have ventured into microfinance in a massive way by adopting the SHG-Bank Linkage Program model. The present paper makes an attempt to review the performance of the program in AP state of India and across three major institutions—commercial banks, cooperatives, and the regional rural banks. The study also presents vital information about the leading NGOs with major credit linkages in Indian.

The Background

Out of around one billion people in India, 26% are poor (National Statistical Sample Organization, 2011). At the bottom the poor need credit for small productive assets, working capital, housing, illness, and emergencies. The demand for credit here is not only large but heterogeneous as well. Liberalization had an important bearing on the financial sector; banks, which had turned weak, were confronted with the challenge of making themselves profitable while maintaining their prudential requirements and competing with private and foreign banks. At this time, the rural credit system needed a fresh approach that could induce rationalization of the processes, policy, and regulations and consequently increase returns.

7.2 Role of NABARD

In India, the adaptation of the new microfinance approach by rural financial institutions assumed the form of the "Self-Help Group Bank Linkage Program." After an initial pilot study the

RBI set up a working group on non-governmental organizations (NGOs) and SHGs. The working group made recommendations for internalization of the SHG concept as a potential intervention tool in the area of banking with the poor. The RBI was quick to accept the recommendations and advised the banks to consider mainstreaming lending to SHGs as part of their rural credit operations. The SHG-bank linkage program is gaining increasing acceptance amongst NGO community and bankers. The NABARD envisions covering one third of the rural population in India by establishing one million SHGs through the SHG-bank linkage program the RBI and NABARD have tried to promote relationship banking, i.e., improving the existing relationship between the poor and bankers with the social intermediation of NGOs. The Indian model is predominantly a "Linkage Model," which draws upon the strengths of various partners: NGOs, who are best in mobilizing the poor and building their capacities, and bankers, whose financial strength is financing.

As compared to other countries where parallel model of lending to the poor is predominant, the Indian linkage model tries to use the existing formal financial network to increase the outreach to the poor, while ensuring the necessary flexibility of operations for both bankers and the poor. Various credit delivery innovations such as Grameen Bank Replications, NGO networking, credit unions, and SHG federations have been encouraged by NABARD for increasing the outreach. It has also instituted a Micro Credit Innovations Department for planning, propagating, and facilitating the microfinance movement. Given the network of institutional structures supporting the microfinance movement, the SHG-bank linkage program has been increasing its outreach substantially. Together the commercial banks, cooperatives, and regional rural banks had succeeded in linking 114,775 SHGs by March 2000. With an average size of 20 members per group, the program had reached over 2.2 million households. A large majority (85%) of the SHGs linked to banks were essentially women's groups. The new microfinance approach has benefited women largely and has emerged prominently as a women's program in rural India.

7.3 Banks and Microfinance

The NABARD, Small Industrial Development Bank of India, Housing Urban Development Corporation, and Rastriya Mahila Kosh are some of the institutions that operate as the wholesale financiers of microfinance. As "bulk financiers," they leverage funds from the government,

market, donors, and lenders for lending to its partners and NGOs. Reserve Bank of India and the government lend support to the SHG-bank linkage program through policy formulation and regulation while the NABARD acts as a facilitator and a refinancing agency. The program at the grassroot level is executed through a network of commercial banks, regional rural bank (RRBs), district central cooperative banks (DCCBs), and primary agricultural credit societies (PACS).

The program has been gradually gathering momentum. A review of the SHG credit linkages by these institutions indicated that commercial banks had established the maximum linkages. The RRBs had a sizable coverage but the performance of cooperatives in the program was minimal. The average loan per SHG also followed a similar pattern.

Commercial Banks: From the 1950s through 1970s, the financial system in many developing countries was pre dominantly composed of state-owned banks and branches of foreign owned commercial banks that provided short term commercial and trade credit. The Commercial banks have been found to be more suitable for microfinance because they are regulated and fulfil the conditions of ownership, financial disclosure, and capital adequacy and they have the necessary physical and financial infrastructure, including a large network of branches, and well established internal control and accounting systems.

Regional Rural Banks: The regional rural banks (RRBs) were established in 1975 to support the rural lending operations of commercial banks. In their quest to increase their outreach through subsidized lending the RRBs were bestowed with the title of "White Elephants" because of their severe nonperforming assets and viability problem. The RRBs were supported with a fresh infusion of capital from NABARD and RBI. As a result, RRBs gradually started showing signs of improvement in their performance. The creditable turnaround was possible due to a series of measures including increased employee participation, systematic customer contact, and the introduction of new products suited to the rural markets, like Farmers Credit Card and occupational loans. The RRBs also responded well to NABARD's initiative for extending their outreach to SHGs. Manjira Grameen Bank in Andhra Pradesh had maximum linkages with 2713 SHGs.

Cooperative Banks: The cooperative credit system is an umbrella network consisting of state cooperative

banks (SCBs) at the apex level, district central cooperative banks (DCCBs) at the intermediate level, and primary agricultural societies (PACS) at the grassroot level. Every fourth cooperative in India is a primary credit society. PACS are grassroot level organizations that raise capital, collect deposits, grant loans, and encourage various income augmenting activities such as horticulture, animal husbandry, bee keeping, and cottage industry. DCCBs, on the other hand, organize credit to PACS, carry out banking business, and sanction, monitor, and control the implementation of policies. NGOs and SHG Credit Linkages: State-by-State Non-governmental organizations were pioneer innovators of the microfinance approach in Andhra Pradesh.

Subtly, involuntarily, a shift began to occur and credit started to become something to be offered to people rather than to enterprises. Emphasis on business enterprises began to slip as less and less sophisticated entities became substitutes for viable enterprises. NGOs began lending for consumption purposes and, as further evidence gathered suggesting poor women's creditworthiness in terms of their better repayment capacities, NGOs also started lending to these women. With time they underwent transformation and a variant typology of institutions emerged. With coverage of two thirds of SHG credit linkages, the linkage program was predominant in the Andhra Pradesh, which was heavily concentrated in Andhra Pradesh, where 40% of credit linkages were established. The acceptability of the program was relatively higher in southern India, because the savings and the credit movement was launched here. Some of the other contributory factors were large coverage of DWACRA groups and the operation of Swarna Jayanti Swarojgar Yojna Program and the presence of leading MFIs.

The present study attempts to assess the performance of micro finance channelised through SHG Bank Linkage programme implemented by NABARD since 1992 in Andhra Pradesh. The study findings concluded that SHG Bank Linkage Programme has made significant contribution to social and economic improvement of the member households of SHGs.

Progress of SBLP in Andhra Pradesh:

With microfinance getting due policy attention and support, commercial banks accounting for the major share in the total deposits and network of branches in the country are expected to play a prominent role in the implementation of the Self-help Group-bank Linkage Programme (SBLP).

The SBLP being implemented since 1992 has emerged as the flagship microfinance intervention in India. The National Bank for Agricultural and Rural Development (NABARD), the apex bank for rural finance in the country is the key promoter of the SBLP in India.

The SBLP aims at providing financial services to the poor by linking them to formal financial institutions through the mechanism of self-help group (SHG). A SHG is a small informal group of up to twenty members working on the basis of principles of like self help and joint liability to obtain access to financial services from formal agencies. By March 2005, more than 1.62 million SHGs have been linked, directly or indirectly, to financial institutions like commercial banks, regional rural banks and co-operatives with an estimated outreach of about 24 million households. SBLP has even come to be considered as the biggest microfinance programme in the world.

Commercial banks accounted for about 52 percent of the total SHGs linked to all financial institutions in India. SHG-Bank Linkage Programme with the objective of eradicating poverty through improving access to formal institutional finance for SHGs. As on March 2003 NABARD has linked 7,17,360 groups disbursed an amount of Rs. 20,487 millions. Of these nearly 40% of the linkages with 48% of amount disbursement happened in Andhra Pradesh. These services and goods have been delivered through 30,942 branches of commercial, regional rural banks and cooperatives. The total no. of SHG linkages in AP during the year 2002-2003 were 79,037 and the amount disbursed is Rs. 4,541.3 millions. The targets fixed for the year 2003-2004 are 2,03,977 linkages, with a credit of Rs. 1,00,000 lakhs. But the question is to what extent are the various key players such as banks, NGOs, SHGs, will maintain quality and follow prescribed norms in achieving their targets? And the strategies adopted by the key players in the SHGS linkage process may have much influence on repayment and sustainability of SHGs.

In the recent past non-governmental organizations/voluntary organizations, which are the major SHG promoting institutions, have started micro-credit /finance activities. Earlier, these organizations (no. of participating NGOs and other Agencies are 2,800), used to act as intermediaries or facilitators between banks and SHGs. Now-a-days these NGO-MFIs with their rich experience have been regularizing their activities in a close monitoring system on one hand and influencing the SHG-Bank Linkage on the other, directly or indirectly. It might be one of the factors for high or increasing defaulting of SHGs to

banks under SHG-Bank linkage programme. Both District Rural Development Agencies and Velugu Project are promoting SHGs and SHG Federations at habitation, village, and Mandal levels seriously for the past 4/5 years. They are providing financial assistance in the form of revolving fund or matching grant to these groups so that they could cater the financial needs of their group members. The groups which formed for getting revolving fund/ matching grant/ govt. inputs, and the ineligible groups after reaching the objective might be defunct or become dormant or even get reorganized because of other reasons also. As a facilitator and promoter DRDA/Velugu linked the SHGs to banks for financial assistance in the form of loans. DRDA/Velugu is extending the financial assistance in the form of Community Investment Fund (CIF) along with the bank loan amount to promote livelihood activities.

Targets set at different levels have played a critical role than SHG- Bank Linkage norms, which has several consequences of which defaulting is one. Andhra Bank has received an award from Govt. of Andhra Pradesh for its best performance in SHG-Bank linkage programme during the year 2001-02.

At district and national level workshops organized by DRDA/Velugu, Banks, NABARD, organized by APMAS participants raised many issues related to default, rate of default in SHGs promoted by various agencies, period of defaulting, nature of defaulting (wilful), reasons for it, etc., loan size, attitude of banks and groups on SHG-Bank linkage, performance variation in the three models of SHGs Bank Linkage, influence of MFIs, multiple loans, dual membership in the SHGs and so on.

7.4 Factors for the SBLP success in AP

Government/Bank as Promoter

Commercial banks were accused of not doing much to adopt and scale-up SBLP even after it had been successfully pilot tested by NABARD. As a result, the SBLP had achieved only limited outreach in the first six years of its implementation. NABARD took efforts to bring more impetus in the implementation of SBLP especially by commercial banks. The Reserve Bank of India (RBI) called upon all commercial banks to give due priority to SBLP by making it a part of their corporate strategy. All the public sector commercial banks including AB duly followed the RBI's suggestion. SBLP has been included as a part of bank's corporate planning strategy. The top management of the bank is taking all steps to implement

SBLP on a priority basis. The state of Andhra Pradesh is considered to be the leader in the SHG movement in the country. The AP state government has taken many proactive steps in promoting SHGs in the state. By 2005, more than 4.92 lakh SHGs had been formed and linked to financial institutions, the highest for any state in the country. These SHGs have been formed and supported mainly by government agencies under various poverty alleviation schemes. Initially, groups were formed under a national poverty alleviation programme called Development of Women and Children in Rural Areas (DWACRA).

Under DWACRA, women below poverty line were mobilized to form small groups to take up various income generating activities (IGAs). The groups were provided with training and matching grant of up to Rs. 25,000 to take up IGAs. Banks were required to provide loan support to these DWACRA groups. The Andhra Bank was quite impressed by the performance of DWACRA groups both in terms of savings and lending. Subsequently, the AP state government launched the World Bank supported District Poverty Initiative Project (DPIP) called *Velugu* from 2000-01. *Velugu*, currently renamed as Indira Kranti Patham, is a community based called Society for Eliminating Rural Poverty (SERP) constituted by the state government. SERP implements the programme mainly through community based organisations like SHGs. SERP makes use of the existing District Rural 141 Development Agencies (DRDAs) to form and support SHGs. Specialised village based workers have been appointed by SERP for the purpose.

The staff has also been given training by SERP on SHG formation and management. SHGs have been formed on a massive scale by DRDAs in all the districts of AP. The state government also has played a proactive role in linking these SHGs with financial institutions. Targets were given to banks at state and district levels to link SHGs to banks. A massive drive for SHG formation and linkage, thus, was launched by the state government all over Andhra Pradesh.

The role of state government came as a blessing in disguise to NABARD which was making efforts to sensitise banks and government agencies at all levels about the need for promoting SBLP. NABARD organised a large number of training programmes on SBLP for the purpose. At the same time, the state government has shown keen interest in monitoring the progress of SBLP. The SBLP has been placed under the purview of the State Level Bankers' Committee (SLBC), the highest body for

monitoring the progress of banking developments in the state. The SLBC besides giving annual targets to different banks has been regularly monitoring the progress of SBLP at state and regional levels. Incidentally, the Andhra Bank is the convener of the SLBC.

7.5 Review of SHG-Bank Linkage Program in India Review of Models:

In India, three types of SHG models have emerged:

1. Bank-SHG-Members: The bank itself acts as a self-help group promoting institution (SHPI).
2. Bank-Facilitating Agency-SHG-Members: Facilitating agencies like NGOs, government agencies, or other community-based organizations form groups.
3. Bank-NGO-MFI-SHG-Members: NGOs act both as facilitators and microfinance intermediaries. First they promote groups, nurture them, and train them, and then they approach banks for bulk loans for lending to the SHGs. The third model, where SHGs were formed and nurtured by the NGOs, 136 was more popular among the bankers. Banks opened saving accounts and then provided credit directly to the SHGs, while NGOs acted as facilitators.

This approach has been widely accepted by the practitioners partly because of the large scale participation of state government through development agencies like the District Rural Development Agency (DRDA), District Women Development Agency (DWDA), and some of the centrally sponsored social sector missions, and also because of special initiatives of NABARD. Sixteen percent of the SHGs were credit linked under the third model where NGOs acted as facilitators as well as microfinance intermediaries. Under this model, NGOs formed SHG federations and then facilitated them to assume the role of MFIs. This model is expected to gain wider recognition with smaller banks venturing into large scale financing of SHGs.

Limitations of the Study:

- 1) The study is based on the information provided by the SHGs, the result would vary of other areas.
- 2) The diversity of commerce activities of AP and other areas may produce non-homogeneous opinion.

- 3) The influence of near vicinity of urban exposure and casual earning opportunities in AP may vary with the result from other state. The report has been prepared based on the data collected from the published secondary data.

Conclusion

The goal of Micro finance schemes should not only aim merely at increasing the income level of individual, household or group but also mainstreaming marginalised in the development process of the country. India cannot claim inclusive development when a section of the people is marginalised to periphery of the society. The rapid inclusive development process should accelerate the access to services like education and health services for all, especially the marginalised citizens. Micro finance schemes and SHGs may address the issue of poverty from broader social and economic perspectives.

Some valuable lessons can be drawn from this research paper like- SHGs are small informal associations created for the purpose of enabling members to reap economic benefit out of mutual help, solidarity, and joint responsibility. The benefits include mobilization of savings and credit facilities and pursuit of group enterprise activities.

The SHG-bank linkage program is gaining increasing acceptance amongst NGO community and bankers. The researcher finds out that internalization of the SHG concept as a potential intervention tool in the area of banking with the poor.

In India, three types of SHG models have emerged at present. In that Bank-NGO-MFI-SHG-Members model is very effective. This model work like- NGOs act both as facilitators and microfinance intermediaries. Where SHGs were formed and nurtured by the NGOs, was more popular among the bankers. Banks opened saving accounts and then provided credit directly to the SHGs, while NGOs acted as facilitators.

References

- Ahmed, F., C. Siwar, N. A. H. Idris, and R. A. Begum. (2011). "Microcredit's Contribution to the Socio-economic Development amongst Rural Women: A Case Study of Panchagarh District in Bangladesh." *African Journal of Business Management* 5 (22): 9760–9769.[Web of Science @]
- Ajay Tankha, (2002) "Self Help Groups as a Financial Intermediaries in India: Cost of Promotions, Sustainability and Impact Paths of SHG Development" ICCO and Cordaid, Ne*therlands

- Alam, M. S., and M. A. Ullah.** (2006). "SMEs in Bangladesh and Their Financing: An Analysis and Some Recommendations." *The Cost and Management* 34 (3): 57–72.
- Alamgir, D. A. H.** (2009). *State of Microfinance in Bangladesh*. http://www.inm.org.bd/publication/state_of_micro/Bangladesh.pdf.
- Alan Jolis** (2007) –"Banker to the Poor"; autobiography of Dr. Muhammad Yunus, Penguin Pub.
- Amin, Rai and Topa** (2003), *Does microcredit reach the poor and vulnerable? Evidence from northern Bangladesh*, *Journal of Development Economics*, p. 1-49.
- Andersen, L. E. and Nina, O.** (1998). Micro-credit and group lending: The collateral effect. Working Paper Series. Department of Economics, University of Aarhus, Denmark.
- Arya, Ved.** (1999, July). Towards a relationship of significance: Lessons from a decade of collaboration between government and NGOs in Rajasthan. Agricultural Research and Extension Network. Network Paper No.97.
- Asian Development Bank.** (2000). Finance for the poor: Microfinance development strategy.282
- Ashok Kumar V,** Report on "vis-avis banking with the poor" Andhra Bank performance of SBLP, 2009 7. Banerjee, A., & Newman, A. (1994). Poverty, incentive and development. *American Economic Review*, 84(2).
- Barry, Nancy, Armacost, Nicola and Kawas Celina** (1996) "Putting Poor people's Economics at the Center of Urban Strategies," Women's World Banking, New York.
- Barry, N.** (1995). "The Missing Links: Financial System that Works for the Majority," Women's World Banking, New York
- Basu and K. Jindal.** (Eds.), Microfinance emerging challenges. Tata McGraw Hill Baydas, M. M., Graham, D. H., & Valenzuela, L. (1997, August). Commercial banks in microfinance: New actors in the microfinance world. Micro Enterprise Best Practices.
- Berenbach, S. and Guzman, D.** (1994): "Financial Services for Micro Enterprises: Principles and Institutions". *The New World of Micro Enterprise Finance*, IT Publications, London.
- Bhuyan, K.** (1997): "Credit Utilization Pattern of IRDP Beneficiaries of Darrang District, Assam", *Journal of NEICSSR*, Vol.21.
- Binswanger, H. and Khandekar, S.** (1995). The impact of formal finance on rural economy of India. *Journal of Development Studies*, 32(2), 234–265.
- Bradley, S. W., J. S. McMullen, K. Artz, and E. M. Simiyu.** 2012. "Capital Is Not Enough: Innovation in Developing Economies." *Journal of Management Studies* 49 (4): 684–717. doi: 10.1111/j.1467-6486.2012.01043.x
- Bradley, S. W., K. Artz, and J. Hulett.** (2012). "The Innovation Necessity: Evidence from Microcredit in the Dominican Republic." *Journal of International Development*, 24: 112–121. doi: 10.1002/jid.1761
- Buckley, G.** (1997), *Microfinance in Africa; is it either the Problem or the Solution?* World development, Vol. 25, no. 7, p. 1081-1094. 16. Christen, R. Peck Rhyne, Elisabeth and Vogel, Robert C (1994)
- Carroll, G. R., and M. T. Hannan.** (2000). *The Demography of Corporations and Industries*. Princeton, NJ: Princeton University Press.
- Charitonenko, S., and S. M. Rahman** (2002). *Commercialization of Microfinance, Bangladesh*. Manila: Asian Development Bank.
- Chowdhury, A.M. R., M. Mahmud, and F. H. Abed.** (1991). "Impact of Credit for the Rural Poor: The Case of BRAC." *Small Enterprise Development*. 2. London: Intermediate Technology Publications.

It is important to reuse our resources. If you don't recycle and reuse things, you may run out of them.

– David Murdoch

Changing Dynamics of Formal- Informal Labour Market in Uttar Pradesh

NOMITA P. KUMAR

The present paper examines the trends, patterns and growth in informal and formal employment by sex, sector and place of residence in the state of UP, using the data of 61st (2004-05) and 68th (2011-12) rounds of NSSO's Employment and Unemployment Surveys. To examine the overall trend and pattern of employment in general and female employment in particular in the formal and informal sector, across industries this paper also focused on the distribution of workers across industrial categories.

1. Introduction

The Indian economy can well be studied in two discrete sectors i.e. formal (organized) and informal (unorganised). The concept of informal sector and informal workers proposed by NCEUS is more appropriate in the context of Indian statistical system and it better compatible with international definition of informal sector (Naik, 2009). In India, the National Commission for Enterprises in the Unorganised Sector (NCEUS) made an important distinction between organised or formal and unorganised or informal employment—"Unorganised workers consist of those working in the unorganised enterprises or households, excluding regular workers with social security benefits, and the workers in the formal sector without any employment/ social security benefits provided by the employers".

In terms of informality of employment the majority of developing and emerging regions surprisingly indicate that the share of informal employment in non-agriculture sector employment is lower for women than for men, except in sub-Saharan Africa and in Latin America and the Caribbean (ILO, forthcoming).

Today the unorganized or the informal sector account for more than 90 percent of the workforce in our country and 50 percent of the national income accrues from this sector, reports the Committee on Unorganised Sector Statistics (2012). Given the slow and inadequate growth of the employment opportunities in the formal sector, the informal sector is expected to absorb the large chunk of workforce in India. Ever since the launch of liberalization policies in 1990s, informalisation of jobs has become a matter of concern. The growing competition combined with increased market opportunities and limited resources have led to an emergence of an informal economy marked with

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employment vulnerability in the urban labour market. The predominance of the informal sector leaves majority of population to eke out their living as working poor and highly vulnerable due to the nature of their employment. The predominance of the informal sector has led to a situation of the benefits of economic growth being concentrated among few with a growing proportion of the population living as working poor.

Though the Government changed to policy strategy to that of inclusive and sustainable growth in the last decade or so the fundamental issue leading to growing informalization are yet to be targeted.

In India the share of informal sector worker is highest in Bihar followed by Uttar Pradesh, Rajasthan and Orissa. In Uttar Pradesh about 658 million workers constituting 97% of the total workforce, is currently employed in the unorganized sector or informal sector as per NSS Survey 2011-12. The role of informal sector in terms of providing employment opportunity to a large segment of the population especially women in the state is remarkable. The informal sector of India is a major contributor to country's development but at the same time it is overwhelmed by several problems such as no proper service rules, no wage rules, no job and social security and no possibilities of career advancement. Another important fact is that majority of female's viz. 98.6% (2011-12) of total women workers are engaged in the informal sector in Uttar Pradesh (NSS, 2011-12). In this paper attempt has been made to look at the extent of informalisation of employment and what could be the way forward to reverse the trend towards formalization.

In the light of this the present paper examines the trends, patterns and growth in informal and formal employment by sex, sector and place of residence in the state of UP, using the data of 61st (2004-05) and 68th (2011-12) rounds of NSSO's Employment and Unemployment Surveys. To examine the overall trend and pattern of employment in general and female employment in particular in the formal and informal sector, across industries this paper also focused on the distribution of workers across industrial categories.

The paper is organised in eight sections including this introductory section. In section II we have reviewed literature. Section III analysed the nature of sectoral distribution of workers. Section V highlighted the distribution of informal and formal workers by sector. Structure of employment in Informal sector has been

examined in section VI. And structure of employment in formal sector has been analysed in section VII. Trends and nature of growth in employment have been discussed in Section VII. Section VIII tried to investigate the trend and structure of female informal employment in formal sector. And the last section gives conclusions derived from the analysis.

2. Review of Literature:

The Indian labour market can be conceived of as a segmented market. One segment is the formal sector composed of workers who have salaried work, good working conditions, and are employed in organised business. The other segment is the informal economy consisting of small self-employed traders and business people, and casual workers in the formal or informal sectors. (Shonchoy, 2014). From 1999-2000 to 2004-05 most of the increase in employment in the formal sector consisted of informal workers (Sengupta, 2009,p.14). The informal sector accounts for a sizeable percentage of the total workforce in India (Papola, 1991). Study of Naik (2009) examines the informal sector employment and informal employment scenario across sectors, states, industry group etc in India using the new definition of informal sector and informal worker proposed by NCEUS.

According to him there is significant and positive correlation between informal sector employment and poverty as the percentage share of informal sector workers in the poor states is more than developed states. A high proportion of socially and economically underprivileged sections of the society are concentrated in the informal economic activities (Goyal and Singh, 2017).

In India the people mainly poor are engaged in the informal sector for better livelihood opportunities it is analyzed that a very high proportion of underprivileged section of society is engaged in an informal sector because of an alternative source of employment (Report of the Committee on Unorganized Sector Statistics, 2012). China, along with India, has also experienced greater labour flexibility and informalisation (Unni and Lu, 2007). Chang (2009) also argues that with the emergence of the 'global factory', the formal is becoming informal in a variety of ways. There is a decline in organised workforce, trade unions are becoming weak and their political advantage is declining (Goyal et al., 2017). Globalisation has led to increased competition in labour market where workers have to work for long hours and get low wages and they are not covered under any kind of insurances (Garg, 2005).

Female employment in India has risen by 9 million between 1994 and 2010, but the ILO estimates that it could have increased by almost double that figure if women had equal access to employment in the same industries and occupations as their male counterparts. Despite very rapid economic growth in India in recent years, we are observing declining female labour force participation rates across all age groups, across all education levels, and in both urban and rural areas," said ILO economist Steven Kapsos during a presentation of the report in India.

As pointed out by Bhatt (2017) that woman in India tend to be clustered in certain industries and occupations, such as basic agriculture, sales, elementary services and handicraft manufacturing. Women's share in total employment had increased significantly in household manufacturing industry in both rural and urban areas. In non-household manufacturing, their numbers had increased fast though not as fast as that of men (Banerjee, 1989). In services too women had made some gains mainly in urban areas. These gains were faster in the better paid professional services of teachers, health workers, etc. On the other hand, domestic service workers had also increased fast. Therefore the significant change in the share of regular employment among women service workers was only partially accounted for by the organised sector (Nirmala Banerjee, 1989).

The reason between why people suffer and choose informal sector has been suggested by many experts and few of the reasons are because they don't have basic level of education and skill, to get job in formal type of sector. Studies conducted in several parts of the country indicate the awful condition of women workers in the informal sector (Mohapatra, 2012). Himanshu (2011) in his study stated that the previous period (1999-2005) was of extreme distress and had therefore contributed to increasing participation of females, children and elderly with a large employment growth in informal employment, decline in organised sector employment and large deceleration in wage rates. In this context the slow employment growth during 2005-08, due mainly to a return to more normal participation rates especially of women, may not be too worrisome. (Himanshu, 2011).

In his study Kundu (1997) analyses the trend and types of employment for males and females, both in rural and urban areas, at the national level. He examines the changes in the nature and sectoral distribution of the workers and discusses the possible effect on their economic well-being. Study of Kalyani (2015), analyses

the labour market situation in India over the last five decades. Her paper examines a wide range of indicators, including sectoral shifts in occupational structure, growth in employment, formal-informal division of employment, employment elasticity and labour productivity, and also the poverty. Her paper also examines the trends in work participation rates for women and men in rural and urban areas and employment scenario between the rise in economic growth and the trends in poverty lines that take place in course of time (Muna, 2015).

Women work participation share a healthy percentage in formal and informal sector. The formal sector affords to manage only marginal number of the unemployed population although it is an informal/unorganized sector, which was perceived in the past and is increasingly recognized as an alternative source of employment in today's world. However, the worries in the informal sector are mounting and seem to be unbroken day by day. In their paper, Bhat and Yadav (2017) took some serious issue like migration, issues of working women in an informal sector and the child labour for the analysis and dealt with an important concern of perception and problems of informal workers in India. They concluded that strengthening anti-discrimination legislation in employment across all occupations will be essential for expanding employment opportunities for women (Bhat & Yadav, 2017).

In spite of growing literature in the informal sector, there are several serious issues which still need to be addressed. Though, many studies make significant contributions in the study of the nature, patterns and trends of female employment in the informal as well as in formal sector of the economy mainly at the all-India level (Srivastava, 2017; Unni, 2007; Naik, 2009; Mitra and Pandey, 2017; Chaudhry, 2011). However, there are no such studies for Uttar Pradesh in particular. Given this background, the present study aims to deal with the major issue related to employment of females in unorganised (informal) and organised (formal) sector of the state.

3. Sectoral distribution of workers

This section presents the distribution of total workers by sex in informal and formal sector of the economy in Uttar Pradesh, which is primarily an agrarian economy in terms of share of rural workforce, the size of workforce was 67798.37 thousand according to 2011-12 Employment and Unemployment survey and a majority of workforce was engaged in the informal or unorganised sector of the economy. In 2004-05 the size of workforce was 64845.37

thousand in unorganised/ informal sector. Despite the remarkable increase in the urban female workforce, both formal and informal sectors remain highly male-dominated. The distribution of informal and formal sector workers by place of residence and sex has been shown in table 1. The statistical distribution of informal sector workers in 2011-12 was 65774 thousand in UP constituting 97 percent

of total workers (Table 1, Figure 1&2). In rural areas the share of informal sector workers in each population segment recorded more than 95 percent and the share of female workers (99.57 percent) is more than male workers (98.52 percent) in 2011-12. In 2004-05 the situation was same for rural area (99.68 percent females and 98.44 percent males were engaged in informal sector).

TABLE 1: Distribution of Informal- Formal Sector Workers by Sex & Place of Residence (in 000)

Sector	Sex	Informal Sector		Formal sector		Total	
		2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Rural	Male	35744.	39496.	565	594	36309	40090
	Female	15941	13194	57	57	15998	13251
	Person	51685	52690	622	651	52307	53341
Urban	Male	9567	11066	904	1209	10471	12275
	Female	1989	2017	78	164	2067	2182
	Person	11556	13083	982	1373	12538	14457
Total	Male	45311	50563	1469	1802	46780	52365
	Female	17930	15211	135	222	18065	15433
	Person	63241	65774	1604	2024	64846	67798

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

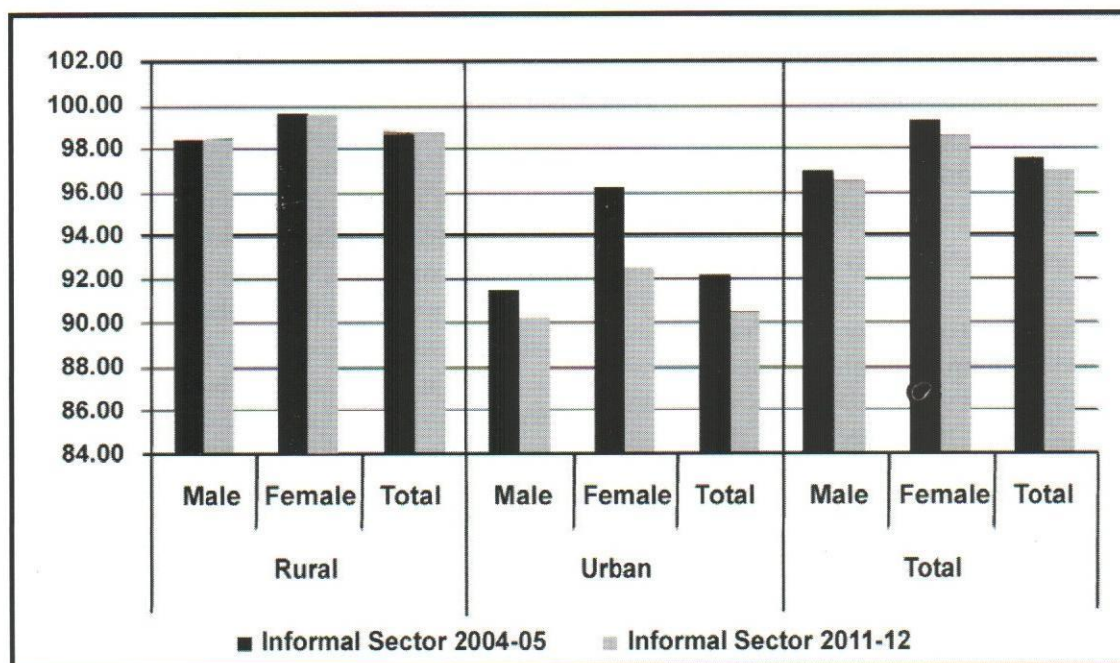


Fig. 1. Share of workers engaged in Informal Sector to total in UP

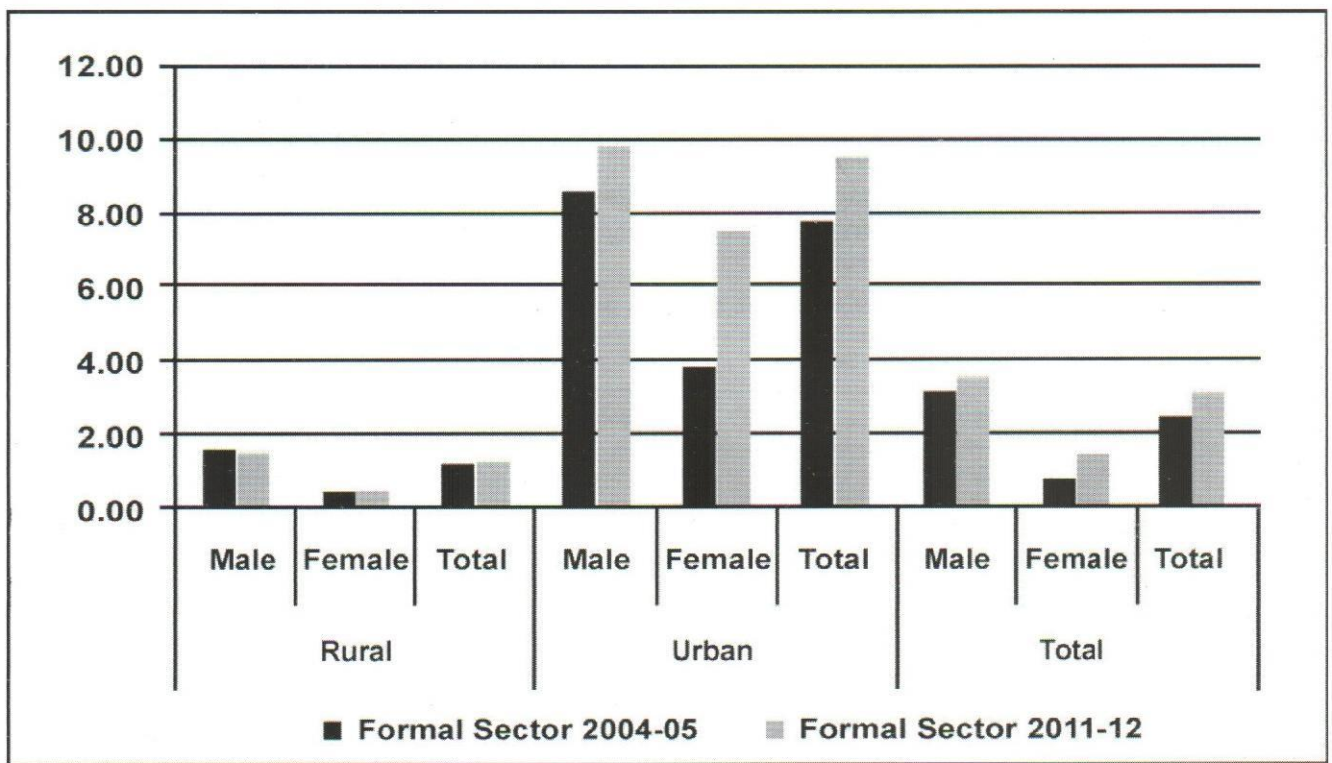


Fig. 2. Workers engaged in Formal Sector in UP

However, the percentage share of females declined slightly in rural areas in 2011-12 in the state. Contrary to this, around 92.47 percent of female as against 90.14 male workers engaged in the informal sector in urban areas. It is clear from the data in table 1 that the absolute number of workers in urban informal sector has increased in recent period both in case of males and females; however, the share of urban informal sector workers declined in 2011-12 (Figure 1).

4. Informal and Formal workers in Organised (Formal) and Unorganised (Informal) Sectors

Table 2 presents the distribution of total workers in informal and formal enterprises by place of residence. The concept of Informal Worker is based on the personal characteristic of the worker rather than enterprise. The National Commission for Enterprises in the Unorganized Sector (NCEUS) took note of all the aspects and decided to complement the definitions of unorganized/ informal sector with a definition of informal employment as: "**Informal workers consists of those working in the informal sector or households, excluding regular workers with social security benefits provided by the employers and the workers in the formal sector without any employment and social security benefits provided by**

the employers" The estimated number of informal workers is more than that of informal sector workers (Naik, 2009).

The cross tabulation of informal/formal sector workers and informal/formal workers shows that the estimated number of informal workers was 59.25 thousand in 2004-05 and increased to 61.44 thousand in 2011-12. It is observed from the table that around 49447 thousand workers are employed informally in rural areas, in which majority of workers are engaged in informal sector i.e., 99.52 %. This distribution shows that a large proportion of male and female workers are engaged in informal employment as compared to formal employment in rural areas. In informal employment, about 80.77 percent of the male workers are engaged as compared to 89.80 percent female workers in rural areas (Figure 3) whereas, in urban areas, share of female workers in informal employment as low (about 10.20 percent) as compared to male workers (19.23 %percent) in 2004-05 (Figure 3), showing low participation of females as informal worker in urban areas as compared to males.

Similarly in the year 2011-12 about 79.13 percent of the male workers were engaged as informal worker, as compared to 86.52 % female workers in rural areas whereas, in urban areas, share of female workers is low

TABLE 2: Sectoral Distribution of Informal and formal employment by Sex and Place of Residence (No. in 000)

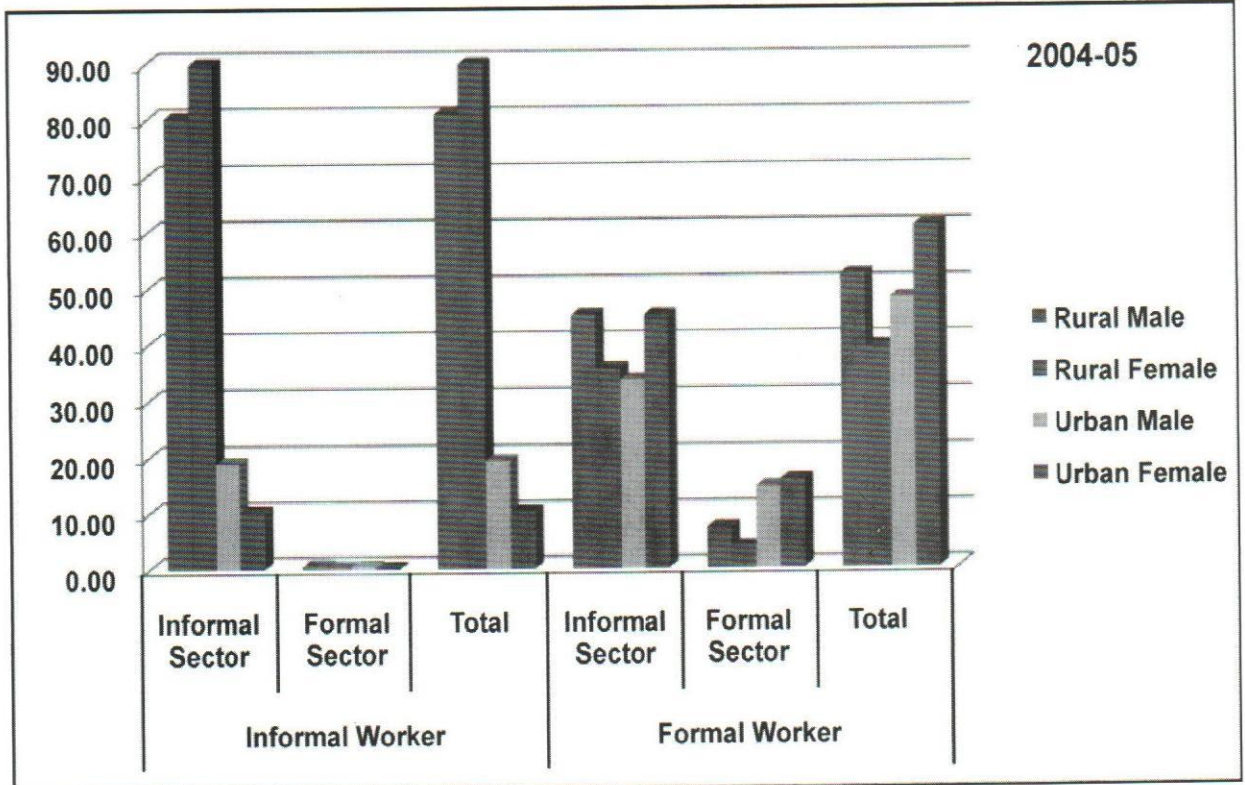
		Informal Employment (Worker)			Formal Employment (Worker)		
		Informal Sector	Formal Sector	Total	Informal Sector	Formal Sector	Total
2004-05							
Rural	Person	49,210	237	49,447	2,475	385	2,860
	Males	33,428	197	33,624	2,317	368	2,685
	Females	15,782	40	15,823	158	17	175
Urban	Person	9,631	172	9,802	1,925	811	2,736
	Males	7,841	164	8,005	1,726	741	2,466
	Females	1,789	8	1,797	200	70	270
Total	Person	58,841	409	59,250	4,400	1,196	5,596
	Males	41,269	361	41,630	4,042	1,109	5,151
	Females	17,572	48	17,620	358	87	445
2011-12							
Rural	Person	49,712	287	50,000	2,965	377	3,342
	Males	36,884	242	37,125	2,613	365	2,978
	Females	12,829	46	12,875	352	12	364
Urban	Person	11,193	248	11,441	1,891	1,125	3,016
	Males	9,316	171	9,487	1,750	1,038	2,788
	Females	1,877	77	1,954	141	87	228
Total	Person	60,905	535	61,441	4,856	1,502	6,358
	Males	46,200	412	46,612	4,363	1,403	5,766
	Females	14,705	123	14,828	493	99	592

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

i.e., about 12.66 percent as compared to male workers (19.99 percent) (Figure 4). Table above clearly exhibits the fact that as far as informal employment in formal sector is concerned, it was very low even insignificant in 2004-05 and 2011-12 for both males and females in rural as well as urban areas (Figure 3 & 4). The proportion of informal workers in formal sector was below 5 percent during 2004-05 and 2011-12 both in rural and urban areas.

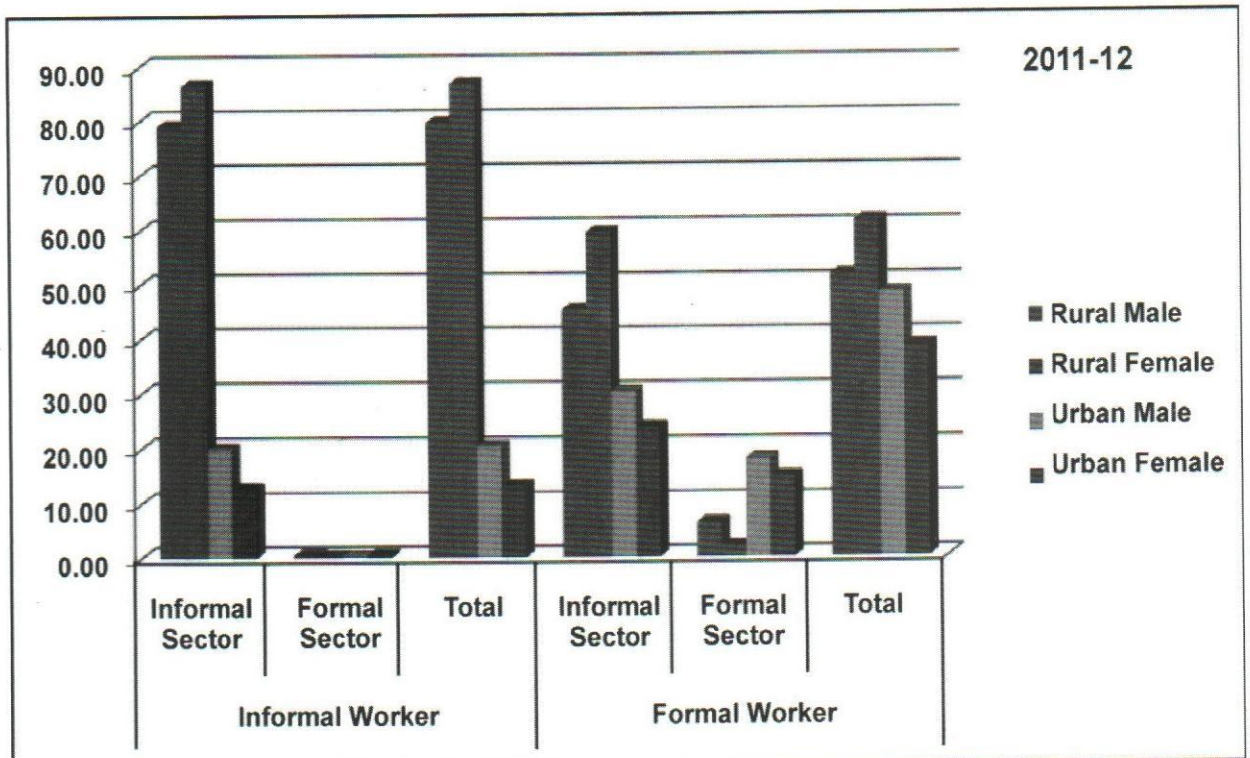
An important fact emerged from the analysis that the share of formal workers was high in Informal sector in 2004-05 and 2011-12 (Figure 3).

The percentage share of informal workers by sector and sex revealed that the share of informal workers in rural areas was invariably high in both the years i.e., in 2004-05 and 2011-12. Similarly the percentage share of females in informal employment is high as compared to



Source: Based on Table 2.

Fig. 3. Percentage to total informal workers/formal workers, 2004-05



Source: Based on Table 2.

Fig. 4. Percentage to total informal workers/formal workers, 2011-12

their male counterparts because working women do not have choice to work, or not to work they just work for the desire, need and for the survival of their family. On the other hand, the percentage share of male workers in formal employment is much higher in formal sector than that of females (Table 3). Even if there has been an increase in employment opportunities in the organised or formal sector that is mainly of informal workers. This share increased from 34.83 % in 2004-05 to 40.68 % in 2011-12 for males

and 70.63 % in 2004-05 to 79.79 % in 2011-12 for females (Table 3). The NCEUS (2007) explains that the country is currently in a state of “informalisation of the formal sector”, where the entire increase in the employment in the organized sector over this period has been informal in nature. Female informal employment is growing in urban Informal as well as formal sector in the state (table 3) which is leading to no job security, salary, no wage revision and no other benefits.

TABLE 3: Percentage share of formal and informal workers to total workers (in %)

	Informal Workers				Formal workers			
	Males		Females		Males		Females	
Rural	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12	2004-05	2011-12
Informal Sector	93.52	93.38	99.01	97.23	6.48	6.62	0.99	2.77
Formal Sector	34.83	40.68	70.63	79.79	65.17	59.32	29.37	20.21
Total	92.61	92.60	98.91	97.16	7.39	7.40	1.09	2.84
Urban								
Informal Sector	81.96	84.19	89.96	93.01	18.04	15.81	10.04	6.99
Formal Sector	18.12	14.11	9.97	47.07	81.88	85.89	90.03	52.93
Total	76.45	77.29	86.94	89.55	23.55	22.71	13.06	10.45

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

5. Structure of employment in Informal Sector

The share of informal sector workers recorded more than 90 percentile., 97.53 % and the share of male workers (69.88 %) was more than that of female workers (27.65 %) in 2004-05. There has been a tremendous change in the informal sector in terms of output and employment since last decade. The high level of growth of the Indian economy during the past two decades is accompanied by an increasing process of informalisation (MOLE, 2014).

Table 4 gives the estimated number of informal sector workers and share of informal sector workers to total workers by industry group. Table 4 shows the changing share of the informal sector employment during 2004-05 and 2011-12. Agricultural sector, which is the main contributor of employment, alone absorbs 99 percent of the workforce in Uttar Pradesh in 2004-05 as well as in 2011-12 in which share of female employment is more in

agriculture in 2004-05 i.e. 36.69 as compared to other sectors (table 4). However, this share has declined in 2011-12 to the level of 31.99 percent. The share of male employment in agriculture sector is more than that of female employment in informal sector; it was 63.31 percent in 2004-05 and 68.01 percent in 2011-12 (Table 4). After agriculture, it is the manufacturing sector where 24.24 percent of female workers are engaged in 2004-05 and 24.42 percent are engaged in 2011-12. It means that the share of industry sector in terms of manufacturing in the informal sector has increased. If we look by Industry group after manufacturing it is other services (18.62 in 2004-05 and 16.65 in 2011-12). It reveals that a large number of female workers are engaged in manufacturing and service sector in the state of Uttar Pradesh. The share of informal sector workers in the trade sector was 99.83 percent in 2004-05 and 99.40 percent in 2011-12. And in construction sector, this share was 99.83 % in 2004-05 and 99.35 % in 2011-12. (Table 4).

TABLE 4: Number of informal sector and their percentage share to total workers by industry group

Industry Group	No. of workers engaged in Informal Sector (in thousands)						Share of informal sector workers to total (in %)					
	2004-05			2011-12			2004-05			2011-12		
	P	M	F	P	M	F	P	M	F	P	M	F
Agriculture	39232	24839	14394	35177	23925	11252	99.99	63.31	36.69	100.00	68.01	31.99
Mining and Quarring	128	95	34	257	204	53	100.00	73.79	26.21	73.73	58.47	15.26
Manufacturing	8035	6041	1994	8539	6405	2134	97.68	73.44	24.24	97.71	73.29	24.42
Electricity ,Water etc.	75	71	4	232	169	63	72.01	68.11	3.89	77.82	56.67	21.15
Construction	3723	3580	143	8553	8212	341	99.83	95.99	3.84	99.35	95.38	3.97
Trade Hotel and Restaurant	6625	6128	497	6756	6324	432	99.83	92.35	7.48	99.40	93.05	6.35
Transport, Storage and Communication	2055	2035	20	2080	2072	8	91.26	90.36	0.90	92.23	91.89	0.35
Other services	3367	2522	844	4180	3252	928	74.25	55.63	18.62	74.99	58.34	16.65
Total	63241	45311	17930	65774	50563	15211	97.53	69.88	27.65	97.01	74.58	22.44

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

Almost 81.8 per cent of women workers are engaged as informal workers in agricultural sector of the economy in the state in 2004-05 (Table 5). A larger share of women workers are still engaged in agriculture sector in UP. Women are found to be over-represented in the agriculture sector because the flexibility, particularly in home-based work, is helpful to them given their other needs and demands upon their time in the form of unpaid labour. Women, who are generally unskilled and uneducated, are considered to be the cheap source of labour. However, this proportion has declined in 2011-12 to 76.16 percent. It is clear from the above analysis that as far as women's employment across industries is concerned it is much more concentrated in agriculture than men's, almost 76.16 per cent of employed women engaged in agriculture compared to 51.7 per cent of employed men (Table 5).

It can be observed that there has been a decline in the percentage share of workers engaged in agricultural and related sectors both for males and females during 2004-05 and 2011-12. It has come down from 81 percent to 76 percent during 2004-05 and 2011-12 for females and from 60 percent to 51 percent for males in agricultural sector. This is a sign of the structural transformation of

the agricultural sector. Even then majority of workers i.e., 66.5 percent in 2004-05 and 57.6 percent workers in 2011-12 are still dependent on agriculture. Along with the decline in the share of employment in agriculture, there has also been a decline in the share of employment of males in manufacturing both in terms of informal and formal employment. It has declined from 11.5 % in 2004-05 to 10.0 % during 2011-12. On the other hand female formal and informal employment in manufacturing has increased during 2011-12 i.e. from 10.5 % in 2004-05 to 13.6 % in 2011-12.

More importantly, informal and formal employment showing increase in electricity and water sector and also in construction sector both for male and female workers (Table 5). Substantial increase in share of female has been noticed in construction sector between 2004-05 and 2011-12 i.e. from 6.62% in 2004-05 to 34.4 % in 2011-12 in formal employment.

As far as service sector is concerned, it also registered increase in informal employment especially in case of females (from 4.09 % in 2004-05 to 5.87 % in 2011-12). There has been a drop or slight change in the

TABLE 5: Informal and formal Employment in Informal sector by industrial group

	2004-05						2011-12					
	Informal Worker			Formal Worker			Informal Worker			Formal Worker		
	P	M	F	P	M	F	P	M	F	P	M	F
Agriculture	66.59	60.11	81.83	1.08	0.81	4.20	57.65	51.76	76.16	1.36	0.31	10.42
Mining and Quarrying	0.08	0.10	0.02	1.90	1.32	8.45	0.05	0.06	0.00	4.68	4.00	10.53
Manufacturing	10.51	11.51	10.51	42.10	42.17	41.20	10.88	10.00	13.65	39.24	40.90	24.93
Electricity Water etc	0.03	0.04	0.00	1.35	1.37	1.14	0.17	0.15	0.25	2.60	2.31	5.08
Construction	4.39	5.96	0.68	25.96	27.67	6.62	11.64	14.99	1.13	30.03	29.51	34.49
Trade Hotel and Restaurant	10.75	14.16	2.76	6.76	7.08	3.14	10.63	13.08	2.93	5.76	6.41	0.22
Transport Storage and Com.	2.96	4.17	0.12	7.09	7.72	0.00	3.02	3.98	0.00	4.98	5.39	1.51
Other Services	4.69	4.95	4.09	13.76	11.85	35.25	5.96	5.98	5.87	11.35	11.18	12.81
Total	100	100	100	100	100	100	100	100	100	100	100	100

*Percentage share to total workers

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

proportion of employment in the trade, hotel, restaurant and transport, storage and communication sector in terms of male and female informal employment. Though, female share in formal employment in transport has increased slightly during 2011-12 (i.e. from 0.0 % to 1.51 % in 2011-12). Other sectors which registered increase in share of formal employment of male and female are construction and electricity and water supply (Table 5).

Share of female employment in manufacturing sector show considerable decline i.e. 41.2 % in 2004-05 to 24.9 % in 2011-12 in informal sector. Male-female share in formal employment has declined in 2011-12 in the sectors like service, manufacturing, trade and hotel etc. However maximum decline in the share of formal employment of females has been noticed in the service sector. The detailed analysis of industrial structure of female employment in informal sector shows that the entire decrease in proportion of informal employment in the agriculture has been compensated by an increase in employment in the construction sector (Chaudhry, 2011).

6. Structure of employment in Formal Sector

Formal sector of the economy provides a better life in terms of income, working condition, security of tenure, social

security benefits and access to safe working condition etc. But the share of workers in formal or organised sector is extremely low as compared to informal or unorganised workers. Table 6 in which the estimated number of formal sector workers and their percentage share to total workers by industry group has been presented, shows that the estimated number of workers was 1604 thousand in 2004-05 and it has increased in 2011-12 to the level of 2024 thousand. Share of employment by Industry and sex reveals that the female contribution is more in case of service sector (community, social, and personal services) in 2004-05 as well as in 2011-12. However, this share has declined very sharply in 2011-12. It appears from the Table 6 that a large number of workers has been engaged in the formal sector by enterprise characteristics but their job are informal in nature. They did not have any social security, job security and other benefits which the regular wage employees were getting in the formal sector and over the years the share of workers in this category increased very slightly i.e. from 2.47% in 2004-05 to 2.99 % in 2011-12 (Table 6).

It can be observed from the distribution of formal sector workers across industrial group in terms of informal and formal employment (Table 7) that in formal sector large

TABLE 6: Number of workers in Formal Sector and their percentage share to total workers by industry group

	No. of workers engaged in Formal Sector (in thousands)						Share of Formal sector workers to total (in %)					
	2004-05			2011-12			2004-05			2011-12		
	P	M	F	P	M	F	P	M	F	P	M	F
Agriculture	3.15	2.27	0.88	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	91.74	91.74	0.00	0.00	0.00	0.00	26.27	0.03	0.00
Manufacturing	190.63	190.07	0.56	200.46	199.35	1.11	2.32	3.05	0.03	2.29	0.00	0.01
Electricity ,Water etc.	29.21	29.21	0.00	66.15	59.59	6.55	27.99	29.13	0.00	22.18	0.02	2.20
Construction	6.48	6.48	0.00	56.03	55.11	0.92	0.17	0.18	0.00	0.65	0.00	0.01
Trade Hotel and Restaurant	11.05	8.58	2.47	40.71	40.71	0.00	0.17	0.14	0.50	0.60	0.00	0.00
Transport, Storage & Communication	196.75	196.61	0.14	175.14	160.27	14.87	8.74	8.81	0.68	7.77	0.01	0.66
Other services	1167.32	1036.29	131.03	1394.19	1195.76	198.42	25.75	29.12	13.43	25.01	0.02	3.56
Total	1604.60	1469.52	135.08	2024.40	1802.53	221.88	2.47	3.14	0.75	2.99	0.00	0.33

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

number of workers are engaged in service sector. In 2004-05, 81.14 percent male and 100 percent (percent from informal workers engaged in formal sector) females were engaged in formal sector as informal worker. Similarly, 89.02% males and 90.08 % of females in 2011-12 are engaged as informal workers in formal sector. In this period percent share of female worker in transport, storage and communication has increased slightly (which was negligible in 2004-05). An increase in share of formal employment in electricity and water supply has also been noticed in 2011-12, specially in case of females (Table 7). Although the share of female formal workers in service sector has decreased during 2004-05 to 2011-12 (from 13.43 % in 2004-05 to 3.56 % in 2011-12) but their share has increased slightly in transport, storage and communication sector (0.16 % in 2004-05 to 2.68 % in 2011-12) followed by electricity and water, construction, trade and hotel sector.

The decline in the share of female workers in formal sector has been observed in the state during 2004-05 and 2011-12, which resulted in substantial growth of workers in the informal sector. This is particularly due to

globalization and privatization, which in general have had an impact on the entire economy i.e. both the informal and formal sectors.

7. Growth in Employment

An analysis of employment pattern indicates in Table 8 that as far as overall growth in employment is concerned it has increased at a significant rate in formal sector during 2004-05 and 2011-12, especially in urban areas. Conversely rate of growth of female employment in rural areas has declined in informal sector due to decline in their participation in agriculture. Hence the growth of female employment is negative in informal sector between 2004-05 and 2011-12. Urban informal sector registered slow or less growth as compared to urban formal sector in terms of compound annual growth rate (CAGR).

The growth rate for male workers in rural areas is higher in informal sector than their male counterparts (i.e. 1.68 % as compared to 0.82 % for female employment). Highest growth rate recorded in case of urban female workers at the rate of 13.24 percent per annum in formal sector due to growth in employment in electricity, gas

TABLE 7: Informal and Formal Employment in Formal Sector by Industrial Group

	2004-05						2011-12					
	Informal Worker			Formal Worker			Informal Worker			Formal Worker		
	P	M	F	P	M	F	P	M	F	P	M	F
Agriculture	0.00	0.00	0.00	0.26	0.20	1.01	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.16	6.60	0.00
Manufacturing	9.19	10.42	0.00	12.80	13.75	0.65	2.79	3.62	0.00	12.46	13.26	1.12
Electricity Water etc	0.21	0.24	0.00	2.37	2.56	0.00	1.17	1.52	0.00	4.02	3.84	6.65
Constriction	0.46	0.52	0.00	0.39	0.42	0.00	0.77	1.00	0.00	3.49	3.67	0.94
Trade Hotel and Restaurant	0.86	0.97	0.00	0.63	0.46	2.85	0.08	0.10	0.00	2.71	2.90	0.00
Transport Storage and Com.	5.93	6.72	0.00	14.43	15.55	0.16	5.93	4.74	9.92	9.63	10.12	2.68
Other Services	83.36	81.14	100.0	69.12	67.06	95.34	89.26	89.02	90.08	61.54	59.62	88.61
Total	100	100	100	100	100	100	100	100	100	100	100	100

* Percentage share from total

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

TABLE 8: Growth Rate (CAGR) of Workers by Sector, Sex & Place of Residence (2004-05 to 2011-12)

Place of Residence	Sex	Informal Sector	Formal Sector	Total workers
Rural	Male	1.68	0.82	1.66
	Female	-3.10	0.12	-3.09
	Person	0.32	0.76	0.33
Urban	Male	2.46	4.95	2.68
	Female	0.24	13.24	0.90
	Person	2.09	5.74	2.40
Total	Male	1.84	3.46	1.90
	Female	-2.70	8.62	-2.59
	Person	0.66	3.95	0.74

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

and water supply. In rural areas growth rate of female workers is found negative in informal sector (table 7). So it is clear that rate of growth is higher in formal sector than

informal sector in UP, especially in case of females. Female employment grew at faster rate in construction and electricity sector between 2004-05 and 2011-12.

TABLE 9: Growth Rate (CAGR) of Workers by Sector Place of Residence, Sex & Industry Group 2004-05 and 2011-12

Industry Group	Informal Sector		Formal Sector		Total	
	Male	Female	Male	Female	Male	Female
Rural						
Agriculture	-0.79	-3.88	-19.56	14.87	5.83	-61.49
Mining and Quarrying	-1.77	-1.00	20.01	10.05	-16.92	35.31
Manufacturing	0.10	-1.57	-0.62	9.83	0.20	-1.89
Electricity, Water etc.	20.05		6.78		1.47	
Construction	21.35	8.95	2.93	49.32	14.30	50.85
Trade Hotel and Restaurant	0.72	-1.95	-17.04		1.16	-24.11
Transport, Storage & Com.	4.33	-55.23	6.29		2.21	44.83
Other services	1.63	2.11	4.17	-4.11	2.24	1.35
Total	1.66	-3.38	1.67	13.63	5.48	-22.97
Urban						
Agriculture	4.51	-10.05	4.02		9.04	-41.90
Mining and Quarrying	-20.50		119.16		-21.64	
Manufacturing	2.05	5.44	2.74	-13.56	2.13	4.30
Electricity, Water etc.	44.00		13.02	39.01	1.96	78.86
Construction	9.14	-5.80	3.10	19.06	3.30	41.09
Trade Hotel and Restaurant	0.41	-2.08	13.14	-100.00	0.64	3.80
Transport, Storage & Com.	-4.12		-9.85		-9.68	
Other services	9.23	6.69	-0.37	-5.66	2.58	12.19
Total	2.87	1.40	2.07	-2.79	1.49	6.50

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

Employment in formal sector grew at faster rate i.e. at an annual rate of 1.67 percent in case of males and 13.63 percent in case of females in rural areas (Table 9).

Female employment grew at an annual rate of 49.32 percent in construction in rural and 19.06 in urban areas, followed by 14.87 in agriculture 10.05 in mining and

quarrying and 9.83 % in manufacturing between the years 2004-05 and 2011-12 (Table 8). In urban informal sector female employment grew at an annual rate of 6.69 % in service sector and 5.44 % in manufacturing sector, whereas other sectors like agriculture, construction and trade, hotel and transport registered decline in growth of

female employment in informal sector. Female employment in service sector has registered a negative growth between 2004-05 and 2011-12 both in rural and urban informal sector. In service sector female

employment grew at an annual rate of 2.1% in rural and 6.69% in urban informal sectors between 2004-05 and 2011-12.

TABLE 10: AAGR of Informal and Formal Employment between, 2004-05 & 2011-12

Industry Group	Informal Sector		Formal Sector		Total	
	Male	Female	Male	Female	Male	Female
Rural						
Informal Sector	1.65	-3.39	2.03	14.96	1.68	-3.10
Formal Sector	3.47	2.17	-0.74	-5.93	0.82	0.12
Total	1.66	-3.38	1.67	13.64	1.66	-3.09
Urban						
Informal Sector	2.91	0.79	0.23	-5.65	2.46	0.24
Formal Sector	0.68	46.69	5.79	3.65	4.95	13.24
Total	2.87	1.40	2.07	-2.78	2.68	0.90

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

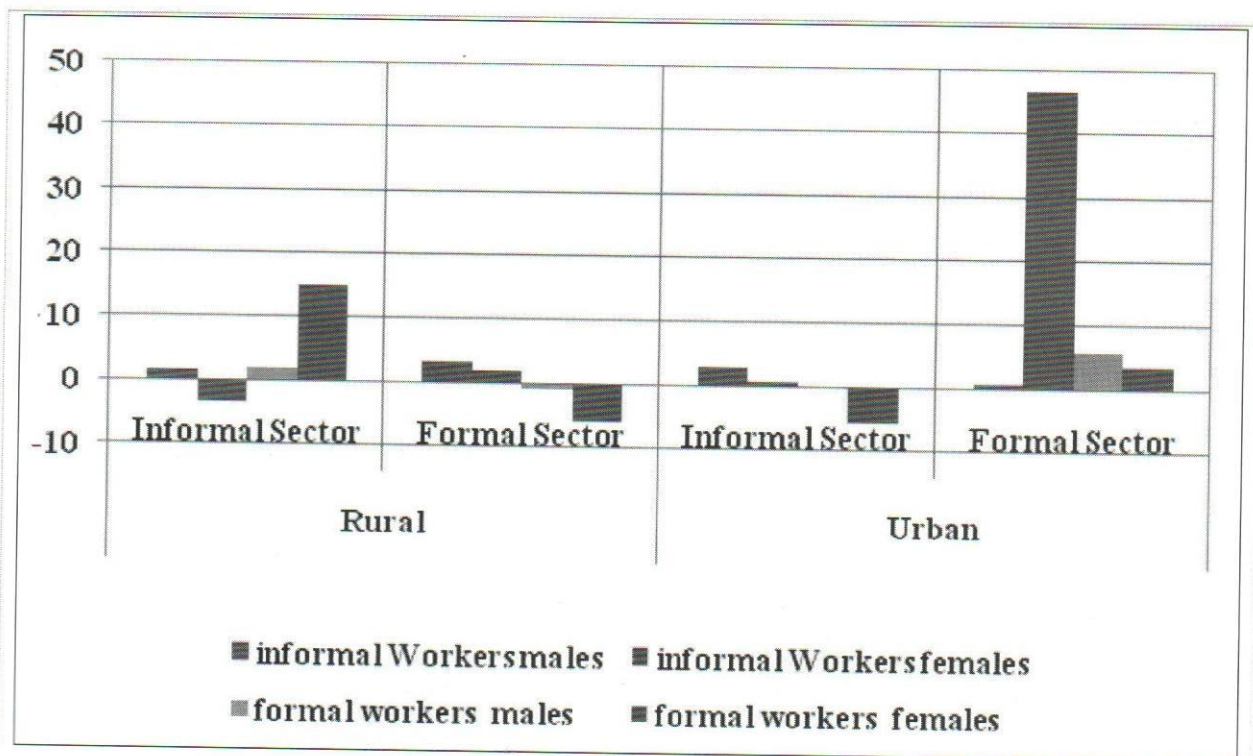


Fig. 5. CAGR of Informal and Formal Employment (2004-5-05 -2011-12)

There has been substantial negative growth in agricultural employment (informal). The large drop in growth of female employment in the agriculture as well as in manufacturing sector has been compensated by an increased growth in female employment in construction sector in rural as well as in urban areas. This can be explained in terms of NEREGA, which mainly involve construction work in rural areas (Choudhry, 2011). The growth scenario of female employment in Uttar Pradesh is significantly different from that of the total employment and male employment. In table 10 the compound annual growth rates of informal and formal worker has been presented.

Since formal employment can largely be expected to be created in the formal/organized sectors of the economy, it is not surprising that the overall decline in formal employment in the economy coexists with decline in formal employment in the formal sector. Between 2004-05 and 2011-12, formal employment in the formal sector declined for both male and female workers i.e., 3.38 percent per year in case of female and 0.74 % in case of males (Table 10). The decline in informal sector took place across major industry groups such as Trade (in female employment) and transport (in male employment) whereas some of the other industry groups such as electricity and manufacturing experienced increase in formal sector employment (Table 11).

Highest growth has been observed in the construction sector in case of total and male formal workers (Female employment in construction sector also grew but at very low base as their participation in construction was negligible in 2004-05). In fact, all industry groups experienced increases in informal employment in the formal sector.

Growth rate for female workers engaged in informal sector are quite high in the sectors like electricity and water supply (57.93%), construction (15.58) and mining, quarrying (7.95) between 2004-05 and 2011-12. But in formal sector, the highest growth rate for the female workers is observed in transport, storage and communication (17.8 %) followed by manufacturing (11.98%) and service sector (7.16%). Growth rates for male workers in construction industry (42.6 per cent growth rate), in trade, hotels and restaurants (29.64 per cent growth rate) and electricity, gas and water supply (12.62) are quite high (Table 10). However, employment growth rate of females in informal sector registered decline in agriculture at the rate of 4.02% per annum, trade hotel (14.7 %) and transport and communication (2.31 % per annum).

As far as growth in employment is concerned, construction and service sector emerged as a major growth

TABLE 11: Growth Rate (CAGR) of Workers by Industrial Group, Sector and Sex, 2004-05 and 2011-12

Industry Group	Informal Sector			Formal Sector		
	Person	Male	Female	Person	Male	Female
Agriculture	-1.80	-0.62	-4.02	-	-	-
Mining and Quarrying	12.28	13.64	7.95	-	-	-
Manufacturing	1.02	0.98	1.14	0.84	0.80	11.98
Electricity ,Water etc.	20.67	15.53	57.93	14.59	12.62	-
Construction	14.87	14.84	15.58	43.25	42.86	-
Trade Hotel and Restaurant	0.33	0.52	-2.31	24.28	29.64	-1.00
Transport, Storage and Communication	0.20	0.30	-14.70	-1.92	-3.35	17.88
Other services	3.67	4.32	1.59	3.00	2.41	7.16
Total	0.66	1.84	-2.70	3.95	3.46	8.62

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

driver in formal as well as informal sector for females in Uttar Pradesh. Though electricity sectors have a very small share in total employment, it registered a quite high annual growth of about 57 per cent between 2004-05 and 2011-12 in female employment in informal sector. Although growth of employment of females in sectors like trade, hotel and transport decelerated in informal sector between 2004-05 and 2011-12 but transport and communication witnessed a considerable growth in female employment between 2004-05 and 2011-12 in formal sector, indicated that the share of females in formal sector employment has increased however, the growth of informal sector still

exceeds the growth of the formal sector because in formal sector most of the women are still employed as part time worker and the formal sector is gradually becoming more important as most of the work being created in formal sector are informal in nature as worker do not have access to social and job security. Most of the females in formal sector are engaged as informal worker in the service sector (registered a growth at the rate of 14.95 percent per annum between 2004-05 and 2011-12). It can also be noted that growth rate of female informal employment is high in formal sector as compared to males (Table 12 & Figure 6).

TABLE 12: Compound annual Growth Rate of Informal workers in Formal Sector by sex 2004-05-2011-12

	Males	Females	Total
Agriculture	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00
Manufacturing	-14.26	0.00	-14.26
Electricity ,Water etc.	39.49	0.00	39.49
Construction	14.22	0.00	14.22
Trade Hotel and Restaurant	-30.13	0.00	-30.13
Transport, Storage & Communication	-3.53	0.00	4.61
Other services	3.84	14.95	5.80
Total	2.25	16.97	4.60

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

8. Regular Employment of Female informal worker in Formal Sector:

Regular employment is normally regarded as a signifier of good quality employment since it is more associated with security of employment, higher incomes and social protection. (Srivastava Ravi, 2014). Women's employment in regular employment (RE) in electricity and water sector maintained a very high growth of about 34.53 per cent during 2005-12 (Table 13). Female employment in manufacturing sector also grew by an annual rate of 7 percent as an informal worker in regular employment. Regular employment declined at an annual rate of 2.9 percent between 2004-05 and 2011-12. Conversely, service sector registered sharp decline at the rate of 11.10 % per annum between 2004-05 and 2011-12 in female regular employment. We also observed decline in the share of female informal workers in regular workforce, it was 157.1 thousand in 2004-05 and declined to 131.86 in 2011-12. This decline is attributable to large decline of regular

workforce in service sector i.e., from 122.66 thousand to 60.54 thousand in 2011-12. (Table 13). There has been a sharp increase in regular employment of females in the sectors like electricity and water and manufacturing in the state as these sector registered annual growth of 7.0 % and 34.5 percent respectively between 2004-05 and 2011-12 (Table 13).

The growth of regular employment of women in Uttar Pradesh has slowed down. The number of women workers substantially declined in absolute number between 2004-05 and 2011-12, registering a negative annual growth of around 2.9 per cent in the state. This decline in growth in women's employment has been largely due to decline in women's share in service sector (Table 14). Contrary to this, a remarkable increase has been recorded in case of female casual workers who are engaged as informal workers. By the type of employment the highest annual growth has been noticed in casual employment (CE) i.e., 12.4 percent, followed by self -employment (SE) i.e., 7.2

TABLE 13: Female informal workers in the Formal Private sectors in 2004-05 and 2011-12(in '000)

Industrial Group	Female Informal Workers in '000								Compound Annual Growth Rate			
	2004-2005				2011-2012				2004-05-2011-12			
	SE	FE	CE	All	SE	FE	CE	All	SE	FE	CE	All
Agriculture	6.09	0.00	8.94	15.03	52.73	0.00	0.00	52.73	43.3	0.0	-100.0	23.3
Mining and Quarrying	0.00	0.00	30.25	30.25	0.00	0.00	53.30	53.30	0.0	0.0	9.9	9.9
Manufacturing	51.73	29.40	66.33	147.46	19.29	44.12	62.77	126.2	-15.2	7.0	-0.9	-2.6
Electricity water etc	0.00	4.06	0.00	4.06	0.00	24.07	1.64	25.71	0.0	34.5	0.0	36.0
Construction	0.00	0.00	23.68	23.68	17.49	0.00	157.03	174.5	0.0	0.0	37.1	39.5
Trade hotel and restaurant	0.00	1.01	10.24	11.25	1.14	0.00	0.00	1.14	0.0	-100.0	-100.0	-31.8
Transport storage and comm..	0.00	0.00	0.00	0.00	0.00	3.14	4.51	7.65	0.0	0.0	0.0	0.0
other services	3.37	122.7	0.00	126.14	1.99	60.54	2.30	64.83	-8.4	-11.1	0.0	-10.5
Total	61.2	157.1	139.5	357.9	92.64	131.9	281.5	506.0	7.2	-2.9	12.4	5.9

Source: Calculated from NSSO 61th and 68th Round Survey on employment & Unemployment.

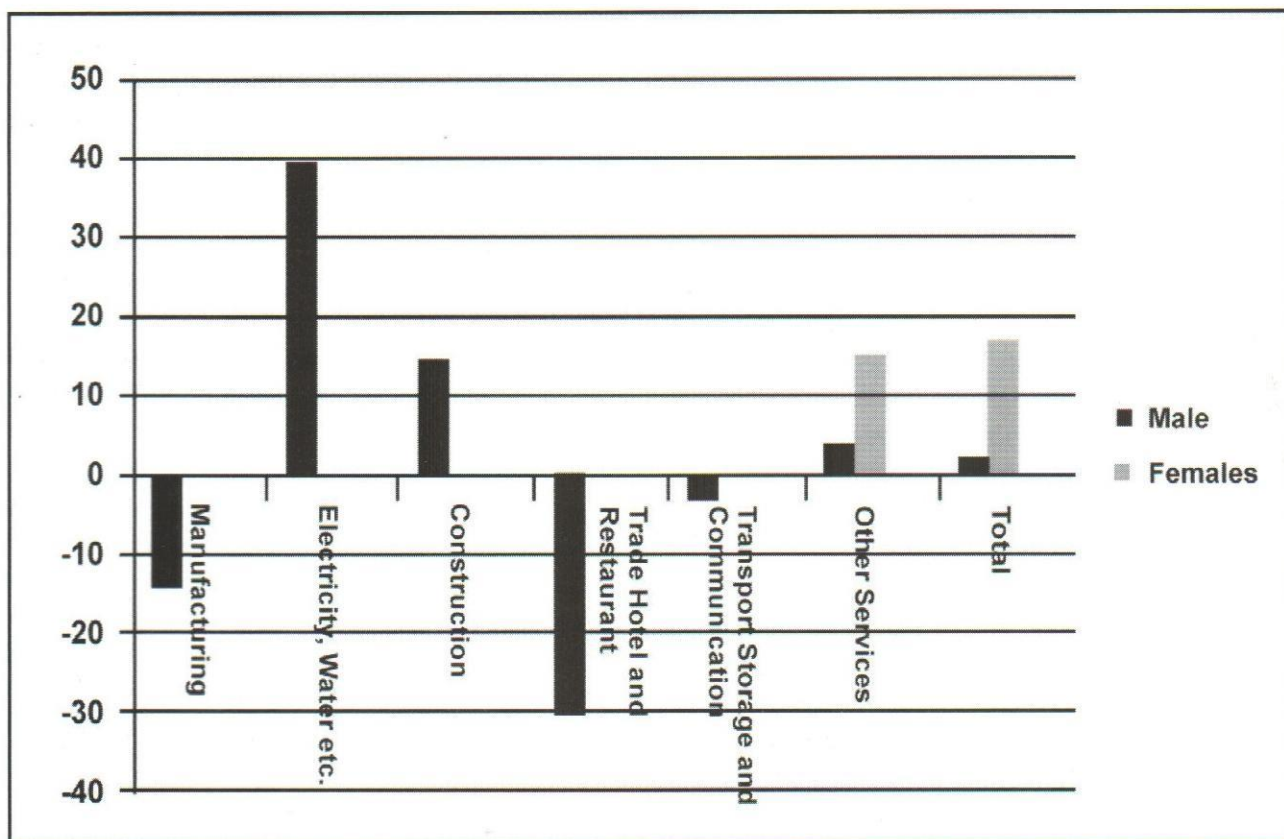


Fig. 6. Average annual Growth Rate of Informal workers in Formal Sector by sex 2004-05-2011-12

TABLE 14: Share of Female Informal Workers in Formal Private Sector by industry

	2004-05				2011-12			
	SE	RE	CE	All	SE	RE	CE	All
Agriculture	10.0	0.0	6.4	4.2	56.9	0.0	0.0	10.4
Mining and Quarrying	0.0	0.0	21.7	8.5	0.0	0.0	18.9	10.5
Manufacturing	84.5	18.7	47.5	41.2	20.8	33.5	22.3	24.9
Electricity water etc	0.0	2.6	0.0	1.1	0.0	18.3	0.6	5.1
Construction	0.0	0.0	17.0	6.6	18.9	0.0	55.8	34.5
Trade hotel and restaurant	0.0	0.6	7.3	3.1	1.2	0.0	0.0	0.2
Transport storage and	0.0	0.0	0.0	0.0	0.0	2.4	1.6	1.5
Other services	5.5	78.1	0.0	35.2	2.1	45.9	0.8	12.8
Total	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0

Source: Calculated from NSSO 61st and 68th Round Survey on employment & Unemployment.

percent per annum between 2004-05 and 2011-12. The overall growth in female informal employment in formal sector has been registered at the rate of 5.9 percent per annum (Table 14).

The share of female informal employment in formal sector can be seen from table 14 in which share of female employment has been shown by type of employment i.e. self-employed (SE), regularly employed (RE) and casually employed (CE). Women's share in regular employment has increased in manufacturing and electricity sector and declined in service sector (it was 78 % in 2004-05 and came down to 45.9 % in 2011-12). Majority of females are employed casually in construction sector i.e., 55.8 % and manufacturing sector (22.3 %).

9. Conclusion

The proportion of informal sector employment to total employment is high in both the rural and urban areas as compared to formal sector employment in UP. In the agricultural or unorganized sector its overwhelming share does not come as a surprise but in the formal or organised sector, tremendously high percentage of workers is engaged in the informal employment. Almost same trend has been observed in rural and urban economy of the state. The share of informal employment in the total employment has been increased contrary to this the share of formal

employment in the total employment has declined both for males and females. The other surprising finding relate to male and female workers as the proportion of women workers engaged in the informal sector to the total female workers is lower than the male counterparts. It has also emerged from the above analysis that female share in regular job has declined and increased in casual type of employment in 2011-12 in the state.

Number of women workers in informal sector in Uttar Pradesh is more than 90 percent of the total labour force as employment opportunities for them are extremely limited particularly in rural areas because employment opportunities in agriculture for women are declining and not enough employment opportunities being created in formal sector. Majority of women workers in informal sector come from those sections of the society which need income at any cost. Women face many difficulties like: poor health conditions, harassment at work, inadequate and unequal wages, poor housing facilities, long working hours, lack of safety measures etc. The unequal gendered distribution of household responsibilities puts them at a vulnerable position in the labour market, where lack of social protection and of adequate child care support services limits their choice of opportunities. As a result disproportionate numbers of women engaged in the most vulnerable and insecure types of employment in informal sector.

The involvement of state government and policy maker to improve the working and living conditions of worker in general and female worker in particular is very much required. Better infrastructure, market information, government incentives, providing them legal framework, and good quality education etc. would large extent will facilitate to beat challenges to informalisation not only in unorganised sector but also manage growth of informal employment in organized enterprises. Hence, a holistic approach is needed to address the issue of informalisation especially of women's employment and to protect the quality of employment in terms of decent work conditions, women's association and self-help groups should be promoted both in rural as well as in urban areas (Malhotra, 2013).

References

- Banerjee Nirmala.** (1989), Trends in Women's Employment, 1971-81: Some Macro-Level Observations, *EPW*, Vol.24, No.17, April, 29 1989.
- Bhatt and Yadav.** (2017), Economic Informal Sector and the Perspective of Informal Workers in India, *Arts Social Science Journal*, 8: 241. doi: 10.4172/2151-6200.1000241
- Chang, D.** (2009), Informalising Labour in Asia's Global Factory', *Journal of Contemporary Asia*, Vol.39, No.2, 161-179.
- Chowdhury Subhani.** (2011), Employment in India: What Does the Latest Data Show? *EPW*, Vol. 46, No 32.
- Garg, P.** (2005), Globalisation and its Impact on Labour, *The Indian Journal of Political Science*, Vol. 66, No.4, 813-830.
- Goyal and Singh.** (2017), Globalisation and its Implication on Informal Sector in India, *Man and Development*, Vol.40, No.2.
- Himanshu.** (2011), Employment Trends in India: A Re-examination, *Economic & Political Weekly*, Vol. 46, No 37.
- Kalyani, Muna.** (2015), Labour Market Situation in India: An Analysis, *International Journal of New Technology and Research (IJNTR)* ISSN: 2454-4116, Vol.1, No.8, pp. 44-52.
- Kundu Amitahh.** (1997), Trends and Structure of Employment in the 1990s, Implications for Urban Growth, *EPW*, Vol. 32, No. 4, pp. 1399-1405.
- Malhotra Santosh.** (2013), Low Female Employment in a Period of High Growth: Insights from Primary Survey in Uttar Pradesh and Gujarat: A Study Commissioned by the International Labour Organization, DWT/CO, New Delhi Institute of Applied Manpower Research, Planning Commission, Government of India, IAMR Report No. 9/2013.
- Mitra Arup and Pandey.** (2017), Unorganised Sector in India, Employment Elasticity and Wage-Productivity Nexus; in KannanK. P., Mamgain Rajendra P. & Rustagi Preet (2017) (eds.), *Labour and Development: Essays in Honour of Prof. T.S. Papola*, Academic Foundation, New Delhi.
- Mohapatra, K.K.** (2012), Women Workers in Informal Sector in India: Understanding the Occupational Vulnerability, *International Journal of Humanities and Social Science*, 2.
- Naik Ajay Kumar.** (2009), Informal Sector and Informal Workers in India, Paper prepared for the special IARIW-SAIM Conference on "Measuring the Informal Economy in Developing Countries." Kathmandu, Nepal, September 23-26, 2009, website: <http://www.iariw.org>.
- NCEUS.** (2007), National Commission for Enterprises in the Unorganised Sector, 2007, Conditions of Work and Promotion of Livelihoods in the Unorganised Sector. New Delhi: Government of India and New Delhi: Academic Foundation, August.
- NSC** (2012), Report of the Committee on Unorganized Sector Statistics, National Statistical Commission, GOI.
- Sengupta A. K.** (2009), The Challenges of Employment in India: An informal Economy Perspective, Report of the National Commission for Enterprises in the Unorganised sector, Government of India, Academic Foundation, New Delhi, p.14.
- Shonchoy Junankar.** (2014), The informal Labour Market in India: Transitory or Permanent Employment for Migrants? *Journal of Labour and Development*, Vol.3, No.9.
- Srivastava, Ravi.** (2016), Changing Employment Conditions of the Indian Workforce and Implications for Decent Work, <https://escarpmentpress.org/globallabour/article/download/1113/1169>
- Srivastava Ravi and Naik A.K.** (2017), Growth and Informality in the Indian Economy; in KannanK. P., Mamgain Rajendra P. & Rustagi Preet (2017) (eds.), *Labour and Development: Essays in Honour of Prof. T.S. Papola*, Academic Foundation, New Delhi.
- Unni, J. and Ravindran, G.** (2007), Growth of Employment (1993-94 to 2004-05): Illusion of Inclusiveness? *Economic and Political Weekly*, Vol. 42, No. 03, 20 Jan, 2007.
- Unni, J. and Lu, M.** (2007), Informal Employment in India and China, *The Indian Journal of Labour Economics* 50(3): 531-540.

A society is defined not only by what it creates, but by what it refuses to destroy.

– John Sawhill

Corrigendum

The Paper titled” **Indian Labour Migration to the Gulf: Recent Trends, the Regulatory Environment and New Evidences on Migration Costs**” authored by S. K. SASI KUMAR, Productivity. Vol. 60, No. 2, 2019, July-Sept 2019, pages 111-125).

At Page 125, Footnote no 1-8 wrongly inserted. The correct Footnote is “**The exchange rate applied for the survey was 1\$ = 61.95 INR, the average rate prevailing during the survey period**”.

The mistake is regretted.

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