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150 YEARS OF CELEBRATING THE MAHATMA

October 4

World Habitat Day

Theme:

FRONTIER TECHNOLOGIES AS AN INNOVATIVE TOOL TO TRANSFORM WASTE TO WEALTH

SHELTER

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FROM THE EDITOR–IN–CHIEF

The theme of World Habitat Day 2019 (WHD) is 'Frontier Technologies as an Innovative Tool to transform Waste to Wealth'. Frontier technologies that could contribute to sustainable development include artificial intelligence, 3D printing, drones, biofuel technologies, and nanotechnology which are advanced and innovative technologies resulting in a rapid or incremental change that creates more value for the users. This year's theme reminds us of our collective responsibility to transfer emerging frontier technologies from lab to land for appropriate and smart waste management practices so as to transform waste to wealth in cities and towns. Sustainable waste management has also been a priority area of action under Sustainable Development Goals (SDGs) and the Habitat III 'New Urban Agenda' (NUA).

This year's theme has also special significance for India in the context of Government of India's sustained waste management efforts, through its flagship programme of 'Swachh Bharat Mission' (SBM), which have yielded significant positive results in the waste management front. In urban India, out of 84458 wards, 76851 (91%) wards now have 100% door-to-door solid waste collection; 56% waste processed; almost 88.0 megawatts (MW) of energy generated from waste-to-energy (WTE) projects; and the waste-to-compost production stands at 43,87,000 metric tonnes (MoHUA Dashboard, 20th September, 2019).

The Government of India's efforts towards transforming waste to wealth is also reflected in the 'Waste to Wealth Mission' project which has been approved under the recently constituted Prime Minister's Science Technology and Innovation Advisory Council (PM-STIAC).The objective of the Mission is to identify, develop and deploy existing & new technologies to treat waste to generate energy, recycle materials, and extract resources of value so as to create a clean and green environment. The mission will assist and augment the SBM and Smart Cities projects by leveraging science, technology and innovation to create circular economic models that are financially viable for waste management to streamline waste handling in the country. To take it forward, the Office of the Principal Scientific Adviser (PSA) to the Government of India and IIT Delhi have already come together to bring the best of science and technology to implement waste management in India. Under this initiative, a Waste to Wealth Programme Management Centre will be set up at IIT Delhi.

As the waste management continues to be a critical challenge for our cities, given the huge daily waste generation, the challenge is to find the alternatives to landfills through innovative ideas, tools and technologies. The principle of 6R's- Reduce, Reuse, Recycle, Refuse, Recover and Reform will have to be at the centre of any strategy on sustainable waste management. Effective urban governance, integrating urban informal sector with waste management, creating general awareness & behavioural change, and using frontier technologies as an innovative tool are some of the critical challenges that need to be addressed for transforming waste to wealth.

This volume of Shelter is based on the WHD theme on 'Frontier Technologies as an Innovative Tool to transform Waste to Wealth' in order to raise general awareness and address key issues involved in waste management. The theme papers contributed by UN-Habitat India, A.K. Jain, and Dakshayini Patil & Mamatha Raj highlight the current challenges and present different technologies available for effective waste management. In the policy review section, R. Chatterjee & S. Seal reviews the policy level intervention on the scientific disposal, reuse and recycle of C&D waste while Amrita Rastogi calls for governmental interventions for integrating informal sector with the solid waste management to improve the urban informal economy in India. This volume also presents case studies contributed by K.K. Pandey, N.B. Mazumdar, and Dipu Biswas & Sukanya Ghosh on different tools and technologies for transforming waste to wealth in India, which can be appropriately replicated by other cities and towns. The efforts of Petlad Municipality for door to door waste collection and sanitary napkins & diapers presented in this volume have been recognized and selected for HUDCO award for Best Practices. This volume also contains a special feature on leveraging resources for Implementation of PMAY-HfA by K.K. Chauhan. The 'My Opinion' section contains views of Dr. Bindeshwar Pathak on wide ranging issues relating to sanitation and waste management in India.

The array of articles contained in this volume of Shelter provide diverse insights into a range of issues related to sustainable waste management practices and technologies so as to transform waste to wealth. Hope you enjoy reading this issue of Shelter.

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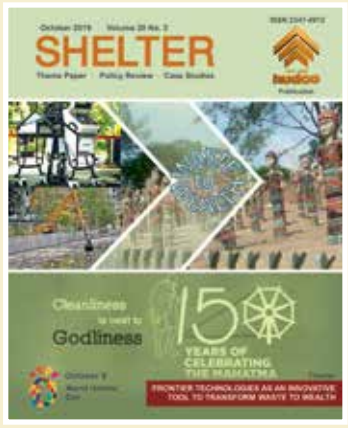

Theme

The theme of World Habitat Day 2019 (WHD) is 'Frontier Technologies as an Innovative Tool to transform Waste to Wealth'. Frontier technologies that could contribute to sustainable development include artificial intelligence, 3D printing, drones, biofuel technologies, and nanotechnology which are advanced and innovative technologies resulting in a rapid or incremental change that creates more value for the users. This year's theme reminds us of our collective responsibility to transfer emerging frontier technologies from lab to land for appropriate and smart waste management practices so as to transform waste to wealth in cities and towns. Sustainable waste management has also been a priority area of action under Sustainable Development Goals (SDGs) and the Habitat III 'New Urban Agenda' (NUA).

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The Government of India's efforts towards transforming waste to wealth is also reflected in the 'Waste to Wealth Mission' project which has been approved under the recently constituted Prime Minister's Science Technology and Innovation Advisory Council (PM-STIAC).

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TREE PLANTATION DRIVE BY HUDCO ON THE OCCASION OF THE 150TH BIRTH ANNIVERSARY OF MAHATMA GANDHI

CMD HUDCO Dr. M Ravi Kanth IAS (r) planting saplings at HUDCO House, Lodhi Road, New Delhi

CMD HUDCO Dr. M Ravi Kanth IAS (r) planting saplings at India Habitat Centre, Lodhi Road, New Delhi

HUDCO has been undertaking several activities under the Swachh Bharat Mission initiatives such as tree plantation, Kavi Sammelans, Logo Branding on all HUDCO Stationeries, Seminars, Workshops, Competitions, lectures on Mahatma Gandhi, etc.

As part of a series of events planned to mark the 150th birth anniversary of Mahatma Gandhi under the Swachh Bharat Mission, a Tree Plantation Drive was undertaken at HUDCO House, New Delhi on 28th August 2019 in which Dr. M. Ravi Kanth, IAS(r), Chairman & Managing Director, HUDCO along with the employees of HUDCO's HSMI and Regional Office-NCR planted numerous *Tabernaemontana Coronaria shrubs "Chandani"*.

In another Tree Plantation Drive to commemorate the 150th birth anniversary of Mahatma Gandhi, Dr. M. Ravi Kanth, IAS(r), Chairman & Managing Director, HUDCO planted saplings within India Habitat Centre complex, Lodhi Road, New Delhi along with the employees of HUDCO. On the occasion, a mass awareness campaign rally was also organized by HUDCO.

CMD HUDCO, EDT, HSMI faculty and RO-NCR Staff during Tree plantation at HUDCO House

EDT HSMI Dr S K Gupta planting saplings at HUDCO House

RC, NCR Mr. K K Chauhan planting saplings at HUDCO House

FRONTIER TECHNOLOGIES TRANSFORMING WASTE TO WEALTH

-Innovating Waste Management in India

UN-HABITAT INDIA

Frontier technologies become an innovative tool when they are applied instead of current technologies resulting in a rapid or incremental change that creates more value for the users. Examples of frontier technologies that could contribute to sustainable development on a general level are artificial intelligence, 3D printing, drones, biofuel technologies, and nanotechnology.

Key Words: Frontier technologies, nanotechnology, innovation, digital technologies, Biofuel production technologies.

Contributed by UN-Habitat India (parul.agarwala@un.org), New Delhi.

This article exemplifies how frontier technologies within digital, biofuel, and nanotechnologies are used as innovative tools to transform waste to wealth. The cases are selected based on their potential in terms of inspirational power, diversity, and feasibility in India. They reveal how innovations utilize waste to create value in monetary terms and indirectly add value to the society by reducing and removing waste. However, future players should be aware of potential pitfall regarding the existing capacity, need for large investments, data security, and difficulties in changing existing practices when adopting the frontier technologies.

INTRODUCTION

Waste management is amongst the urgent issues cities are dealing with today. Improper management of waste leads to numerous issues. Large amounts end up in landfills or natural bodies leading to pollution of local environments, threats to human health and natural ecosystems, generation of GHGs, etc. It can have adverse social consequences, as waste dumps are often located in the outskirts of cities and in other areas with a predominantly economically disadvantaged population. Inefficient waste management has economic consequences, both because of the managerial costs, and also due to the lack of utilization of the potential resources hidden in the waste (EEA, 2014).

With the right approaches, numerous opportunities exist to avoid the negative consequences and to transform waste to wealth. Both waste and wealth are wide concepts. Waste can be considered as anything that has fulfilled its primary use: the unpacked plastic wrapping, the worn-out shoes, the vegetable peels. Likewise, wealth comes in many forms: the direct profiting from selling, the indirect positive economic impacts of a change, the personal benefits of an action. Many of these opportunities for turning waste into wealth can be captured under the often mentioned 5 Rs: to rethink, refuse, reduce, reuse, or recycle waste. Each of these presents ways of generating wealth.

Due to the severity of the problem of waste, we should not restrict ourselves to a specific subset of solutions to transform waste to wealth. However, solutions evolve and improve

Figure 1: Pandharpur landfill, Maharashtra. © SuSanA Secretariat (CC BY 2.0)

based on the learnings and experiences of others. Likewise, new inventions expand the toolbox to reduce negative consequences of waste and utilize its unexploited potential. In this article, we explore innovations based on frontier technologies which transform waste to wealth. Further, the focus is on technologies that are feasible to implement in India, specifically.

FRONTIER TECHNOLOGIES AND INNOVATION

We understand innovations using frontier technologies as the following. An innovation is a product or method that adds more value to at least one dimension for someone (Sawhney, Wolcott, and Arroniz, 2006). The dimension could be price, effectiveness, longevity, or design. The value added should be high enough to offset a potential drawback on another dimension. Frontier technologies are the most advanced technologies within a field, meaning they are superior to alternative technologies on at least one dimension keeping the other dimensions constant. Frontier technologies become an innovative tool when they are applied instead of current technologies resulting in a rapid or incremental change that creates more value for the users. Examples of frontier technologies that could contribute to sustainable development on a general level are artificial intelligence, 3D printing, drones, biofuel technologies, and nanotechnology (UNCTAD, 2018: 4).

The pace of technological development is high, and technologies tend to build on each other resulting in current innovations today becoming inferior products or methods in the future (Ibid.: 4-7). This raises the question of how can we be sure that we apply the best tools available to solve the waste problems? Luckily, information and communications technology is constantly becoming more widespread, making it easier to share ideas, experiences, and innovations around the world.

The main purpose of this article is to exemplify which types of frontier technologies have the greatest potential to transform waste to wealth in a country like India and to promote good cases of innovative solutions. Some innovations may already be implemented sporadically across the country, but then we want to raise the awareness regarding the successful cases in order to inspire further prevalence.

Context of the solutions

The relevant initiatives for transforming waste to wealth, whether they are focused on technology or any other kind of innovation, are very dependent on context. The needs and opportunities are different from city to city, between cities and rural areas, and especially between countries.

Generally, solid waste management is understood as primarily an urban issue, as city residents generate far more waste than those in rural areas.

This has several explanations, including that people in rural area buy fewer packaged items from stores, and are more likely to reuse and recycle materials. Considering the rapid urbanization happening across the globe, the need for well-structured solid waste management is on the rise. This is evident as the increase of solid waste in cities is faster than their population growth (Hoornweg and Bhada-Tata, 2012).

Waste generation patterns differ a lot between countries. Generally, waste generation in lower and lower middle income countries is projected to increase to 184% and 159% respectively in 2025, compared to 2010 levels. Meanwhile, in high income countries it is only expected to increase by 14% (Hoornweg and Bhada-Tata, 2012). These differences are due to developing countries experiencing increasing population levels, rapid urbanization, rising living standard, and comparatively faster economic growth compared to developed countries (Guerrero, Maas, and Hogland, 2012). Still, it is important to notice that the per capita waste generation is far greater in high income countries.

The different situations call for different approaches. Typically, in high income countries most waste is collected, and the focus is on reducing waste generation and enhancing the systems to utilize waste as resources. On the other hand, waste management in developing countries is often inadequate, and it is difficult to upscale the existing systems at a rate that can keep up with the rapid urbanization. Also, the composition of waste varies depending on the wealth of countries: while solid waste in high income countries is dominantly consisting of paper, plastics, and other inorganic materials, the largest fraction by far in low income countries is organic waste (Hoornweg and Bhada-Tata, 2012).

When approaching the waste issue through implementing new technology, it is also necessary to consider how the consequences of this may differ in varying contexts. When focusing on frontier technologies, it is fair to assume that the technology is more likely to be new or at least not widely implemented in many fields. Hence, the potential consequences of introducing the technology into the society need to be assessed taking the country level and regional characteristics into account.

This article is focused on frontier technologies in an Indian context. The remainder of this article is structured as follows: Three areas of technology that can contribute to the transformation of waste to wealth are presented. These are digital technologies, waste to biofuel technologies, and nanotechnologies. Under each of these, an explanation of the technology and how it can be used is provided, followed by examples that are in place already or would be feasible to implement in India. Next, opportunities and barriers for each technology is outlined. Finally, a discussion of the role of frontier technologies in promoting more sustainable waste management concludes the article.

DIGITAL TECHNOLOGIES

Many new innovations have used digital technologies in the development process e.g. as a problem-solving tool, data storage, or in the design phase. However, for some innovations, the key component is a digital technology in itself. The World Economic and Social Survey 2018, "Frontier technologies for sustainable development", highlights artificial intelligence, robotics, communications technology, and digital financing as sub-technologies within the digital technology field.

Artificial intelligence is the use of algorithms and machine learning to create data processing, pattern recognition, and problem-solving software. Different types of artificial intelligence have succeeded in the health sector by diagnosing patients, predicting natural disasters to arrange treatment, and evaluating treatments and

policies. Research in artificial intelligence started in the 1950s, so it is not new. However, the rapid increase in computer processing power since then has enabled the application of artificial intelligence. Other examples include robotics which can provide more efficient execution of repetitive tasks and add precision to the final product, like 3D printing. Furthermore, 3D printing enables customized and decentralized manufacturing. A drone is another type of robot easing transportation and surveillance in remote areas. Communication technology connects the world making response time decrease and knowledge easier to access. Digital financing is when transactions and savings are administered using electronic solutions. It reduces transaction costs and provides security measures and transparency. Especially, the blockchain technology is secure and transparent making it interesting for distribution networks in addition to the financial industry.

In sum, digital technologies cover a lot of areas and keep expanding. Several of the sub-technologies are also applied together making room for further development. Examples of how different digital technologies have been utilized to transform waste to wealth are presented below.

Figure 2: Waste collection truck, Ahmedabad, Gujurat.

Innovations using digital technologies

Waste management consists of different steps where each of them can be subject to innovation and wealth generation. First, waste must be located. Second, someone needs to collect it. However, the waste owners and waste pickers have to be connected, and the connection depends on the type of waste. Lastly, waste collection needs to be financed. Here, different public, non-profit, and for-profit organizations are identified that have optimized the steps using frontier technologies.

How to find waste? Various cities in India have implemented a mobile application where citizens can communicate easily with the employees of the municipality. It functions as a single platform to complain and access information regarding municipal services. Waste-related issues are also included in the app, so the municipal workers become aware of problems and eventually deal with them (Indore Municipal Corporation, n.d.). The case shows how communication technologies like mobile apps are used to share information about the location of waste. Another way to locate waste builds on drone technology. A Danish municipality and a private company are working together to locate oil spills in a harbour. They have developed a satellite-driven air drone which identifies areas of oil spill and then sends the coordinates to a water drone that removes it from the water (Smart Aarhus, 2019). These two cases of waste location contribute to the process of removing waste by first locating it, resulting in a healthier and cleaner environment.

How to get people to collect waste? Having a waste management system in place with formal

employees is often an effective way to collect waste since people are paid to do it. However, this is not always possible, e.g. in areas with high poverty levels, where the capacity constraint is often so severe that no effective waste management systems are in place. A social enterprise has developed a mutually beneficial system where residents in poor areas of Haiti, the Philippines, and Indonesia can collect plastic and sell it to a recycling station. The challenge was that most residents did not have a bank account meaning they would have to deal with cash. This was not a viable solution because of local conditions such as crime and corruption. Therefore, the enterprise created a mobile-based secure and transparent platform using blockchain technology. This was possible because mobile phones have become so cheap and common that almost every person in these areas owns one. Now, every time they hand in some plastic at the stations, they receive digital tokens which can be used to buy groceries in shops that collaborate with the enterprise. The system gives incentive for local residents in poor areas to collect and recycle plastic waste in exchange for being able to buy food. In addition, the recycled plastic is bought by international companies that use it as an input in their production process (Frankson, 2017).

How to match people with the right type of waste collector? In developing countries, waste collection still often happens by waste-pickers walking around and collecting only a few different types of waste at a time. Only a few waste-pickers choose to gather more rare types of waste. In Brazil, a mobile app that solves the problem has been developed. The app functions in the way that people who want to get rid of their waste post their address and type and amount of waste, and then all waste-pickers can see the request of waste collection. One waste-picker then accepts the request and collects the waste which can later be sold to a recycling station (Be Brazil, 2018). The app makes it easier for waste-pickers to find the waste, and it becomes more convenient for waste owners to recycle their waste, resulting in more waste getting recycled.

How to collect waste more efficiently? When waste is collected more efficiently, it either becomes possible to collect more waste spending the same amount of time, or it becomes possible to save resources in terms of fuel or man-power. Using geographical information systems and optimization software, researchers have calculated more efficient routes for municipal solid waste transportation in Chennai city (Sanjeevi and Shahabudeen, 2016). Singapore has equipped its public garbage cans with sensors that detect when every single garbage can need to be emptied. The data is then analysed to calculate the optimal routes for the trucks, having in mind that all the bins do not have to be emptied with the same frequency (Gaia Discovery, 2015).

How to get people to pay for municipal waste management services, righteously? In opposition to electricity and water distribution networks, it is difficult to efficiently monitor the amount of waste each household produces and, thereby, how much individual households should contribute to the operation of waste management services. One simple method is to add a lump-sum tax and a small proportional tax to a person's overall income or property tax. However, the amount of waste produced depends on socio-economic characteristics, meaning that low-income groups face the risk of paying more than high income groups per kilogram of waste (Bandara et al., 2007). One professor has developed a model by analysing big data. The model uses data on water consumption and income to calculate waste collection fees as a function of water utility fees, making it possible to charge the cost of waste management through the water supply charging system. The model has been implemented in several Chinese cities (UNEP, 2017: 108).

Opportunities and barriers

Overall, digital technologies show a great potential of making waste management systems more effective or organizing systems in areas without formal systems. Most of the cases mentioned above have been implemented in parts of developing countries. A majority of the innovations rely on some kind of software that requires access to a mobile phone as the only hardware needed. On the other hand, the cases of drones and sensors in public garbage cans originate from more developed countries. The hardware for those innovations is more expensive; hence the municipalities should be certain that it will not be broken or stolen when placed in public places. Some frontier technologies may not be applicable in the current state of India. This is also the case with the problem of robots overtaking jobs from manual labour. The business case of investing in an expensive automatization device may not be economically viable to implement in developing countries, as labour is far cheaper than the operation and maintenance cost of the new technology.

Another requirement for having critical infrastructure relying on digital technologies is both data security measures to prevent cyber-attacks and power supply without outages. Some developing countries may need capacity building in terms of investments in the electricity grid and data security legislation including an agency to secure the enforcement before they are ready to adopt the products and methods based on digital technologies.

Lastly, most digital technologies need data. Especially technologies concerning the public use and store individual citizens' data. Potentially, it can create a trade-off between fast development and protecting the citizens' anonymity and personal information. Likewise, having very soft legislation regarding protecting intellectual property rights can lead to faster development when technologies can easily be copied from foreign countries. However, in the long run, it can decrease domestic innovation when domestic firms have poor incentives to invest in R&D because their competitors can gain from their inventions without sharing the costs of development.

BIOFUEL PRODUCTION TECHNOLOGIES

One way of making use of waste is to convert it to energy. This can be done in a variety of ways. One is incineration, which was amongst the first technologies to directly transform waste into heat and/or electricity. It is still very widespread, but other ways can be more efficient. In recent years, new technologies have evolved. For certain fractions of waste, methods that do not include direct combustion can produce larger amounts of energy. This is the case for organic waste, which can be utilized as biomass to create biofuels.

Generally, biomass is any plant or animal material that is used for electricity or heat production. Examples include crops, wood, manure, etc. Biomass can be used for similar things as other types of fuels; transportation, power generation, and heat generation. The conversion to energy can happen in many ways. A bonfire is a simple example of converting wood to heat energy – basic incineration, comparable to what happens in incineration plants. Here, biomass can be used as a more sustainable alternative to fossil fuels. CO_2 is still released into the atmosphere, however in smaller amounts and with less additional pollutants. For other uses, biomass can be converted to biofuels through different processes.

It is often discussed whether biomass is sustainable. As it was initially mostly produced directly from edible crops, the production would require lots of space, would require cultivation of more land to feed animals and people, could be threatening local biodiversity, and could result in higher food prices (Springer and Schuchard, 2015). The biomass

generated from food sources are known as first-generation, and still very prevalent. However, more sustainable types of biomass production are on the rise. Second-generation biomass is made from non-food organic material, providing a way to get around some of these issues.

Organic waste can be used as second-generation biomass. Different waste products, primarily from agriculture, can be converted into biofuels, and can replace less sustainable fuel types such as coal and oil while utilizing waste as a resource. There are numerous ways to do this, and large potentials for harvesting other benefits in the process. Below, some recent examples of transforming waste to energy in the form of biofuels are outlined.

Innovations transforming waste to biofuels

Converting organic waste to biofuels is a way of transforming it with numerous benefits. This way of using waste as a resource can be favourable for both environment and climate, small business owners getting rid of their waste, larger companies using the waste, etc. Below are a few examples of how positive impacts can be obtained by using technologies to transform waste to biofuel.

How can waste be used as a resource? By converting it to biofuels, waste is utilized as a resource instead of being dumped. There are countless examples of this for different kinds of organic waste. One example is the conversion of coconut shells into producer gas, which has been studied in recent years (Sreejith, Muraleedharan, and Arun, 2013). The abundant and otherwise useless coconut shells are here transformed into a useful product, reducing GHG emissions by large amounts when used instead of traditional coal gas. Many organic wastes can be transformed in a similar manner.

How can disposal of waste be made easier? Another benefit of converting waste to biofuels is that the possibility to profit from the waste encourages companies to facilitate easier disposal of wastes that would otherwise be challenging or expensive to dispose of. An example is one company that collects used cooking oil from kitchens in Mumbai, and uses a chemical process to turn it into biodiesel (Münzer Bharat, n.d.). A by-product of the process is glycerine, which can also be used e.g. for pharmaceutical applications. If not for this collection of used cooking oil, it is otherwise difficult for kitchens to dispose of it. This results in that many, especially smaller, kitchens reusing cooking oil many times, even though it might be contaminated and that repeated reheating of the oil turns it highly unhealthy. If not reused, cooking oil is often dumped in nature, leading to environmental pollution. To properly dispose of the cooking oil, kitchens need special containers that can withstand acidity and the high temperatures of the oil, as it will usually have to be disposed of immediately after use. The company provides kitchens with containers matching their individual needs, and conducts collection of the containers at an agreed-upon interval. Thus, this scheme makes use of a waste to biofuel technology to improve human health and the environment while profiting from the produced biodiesel.

How can problematic waste disposal be combatted? A type of waste that is often disposed of in undesirable ways is agricultural and farm waste. By-products and leftovers may not be exploited for energy recovery, but most challenging is perhaps the crop stubble left on the fields after harvesting. For the most part, these are burned, leading to massive GHG emissions, reduced air quality, as well as nutrient loss in the soil and other issues (Jain, 2014). Governments have tried to reduce the stubble burning, sometimes with bans or economic incentives, with some luck. An example of another way to motivate a more sustainable way of managing this waste is provided with a project by a private company (Primove, n.d.). Here, agricultural waste is converted into biogas, which can be used instead of fuels

such as gasoline and diesel. This both reduces the adverse climate impacts of the improper treatment of the waste and of the fossil fuels that would be used if not for the biogas. Further, the farmers providing the waste are economically compensated. This creates an incentive for the farmers, but it can also secure them economically in case of a season with poor yield. This can provide a safety net especially for small-scale farmers, who may otherwise risk to go out of business after a single bad season.

Opportunities and barriers

Production of biofuels from organic waste can help to reduce both waste and the need for fossil fuels, thus reducing pollution and GHG emissions. Easier collection of the waste, possibly including paying for it, can help e.g. farmers and small businesses sustain their livelihoods. All in all, conversion of waste to biofuels poses many opportunities, but it is not without barriers.

A possible issue is that first generation food based biomass is very problematic, and an increased demand for biofuels may also sustain the continuous production of this. Centrally, food based biomass has led to a surge in food prices, especially evident in developing countries (Malins, 2017). Second generation biomass is a solution to this issue, but a negative view on biomass still exists, and might slow down these innovations.

Further, converting waste to biofuels require the facilities to do so. These can be expensive to invest in, and the potential benefits will not be obtained without proper financing. However, businesses waking up to the possible profits of these investments might be one way to kick start these processes.

Figure 3: Crop stubble burning, Sangrur, Punjab. © Neil Palmer, CIAT (CC BY 2.0)

NANOTECHNOLOGY

Nanotechnology is the area of science that is engaged in the behaviours of molecules and materials at an infinitesimal scale. It is a technology that can be applied in many fields where properties of resistance, conductivity, filtration, preservation, and chemical reactivity are relevant (UNCTAD, 2018: 17-18). Nanotechnology is typically used to improve existing products such as solar cells, space equipment, and drug delivery to specific cells.

Innovations using nanotechnology

Waste reduction can be accomplished by several means. The durability of products as well as the reusability of products reduce the quantity needed. Furthermore, the same service can be performed, or the same product produced, using fewer inputs which also saves waste once the service or product needs to be replaced. Below, some applications are presented that use nanotechnology to take a step in the right direction regarding the mentioned possibilities of waste reduction.

How to extend the durability of products? With a focus on food,

it happens that one does not get to consume it before it is too old, or a shop has not sold before it becomes unsaleable. However, large quantities of especially tropical food do not even reach the store before it is uneatable for humans. An international research team has developed a nanobiotechnological treatment for tropical fruits that delays their ripening. The treatment consists of a natural plant extract called hexanal and is applied by impregnating the shells of the fruits (IDRC, 2016). By applying the technology, the process turning food into waste is delayed, which increases the food supply and increases the farmers' earnings.

How to make products more reusable? Items related to personal sanitation should only have a short life span due to the necessary avoidance of bacteria. However, using antimicrobial technology it is possible to make e.g. sanitary pads for women that can be washed and are reusable regularly for up to four years without compromising one's health (Real Relief, n.d.). The impact of the technology is two-fold; first it reduces the use of disposable sanitation products and, second, it has the potential of increasing personal sanitation in areas with low access to sanitation products and water.

Opportunities and barriers

The cases explored seem to be highly relevant to reduce waste. Furthermore, they are easy to implement in India since they are transportable and cheap products. If domestic production facilities are in place, the use of nanotechnological products becomes even more sustainable. One challenge of supplying the products is that the market needs to be educated on how to deal with the slightly different products and methods. A greater challenge may be to change habits when using sanitary products or treating cars. However, the farmers have a large incentive to adopt the nanotechnological method of delaying of ripening.

FRONTIER TECHNOLOGIES IN THE BIG PICTURE

The aforementioned technologies are examples of innovations that could be beneficial to implement or disseminate in India and other developing countries. New technologies can help combat the waste issues that are especially prevalent in these countries as existing waste management systems are inadequate. Innovations can help change the way that people dispose of, treat, and think about waste. However, new and innovative technologies are only a part of the solution.

While new technologies can contribute with improvements to some extent, it is critical to weave them into a broader and more comprehensive strategy. A more urgent focus in India is to strengthen and build upon the already existing waste management systems as they have several shortcomings. The study cited above (Vij, 2012) suggests a number of strategies to improve waste management in India and thereby turning waste into resources. These include: incorporating waste management in new plans; characterizing waste and examining quantities; encouraging better collection and transportation of waste; improving disposal and recycling of waste; implementing financial management measures to promote better waste management; and mobilizing local communities, resident welfare associations, and NGOs to participate in waste management programmes. These strategies should be central in the development towards a system based on waste to wealth principles while new innovations can be implemented along the way to improve performance on various sustainability indicators.

Another opportunity to consider when it comes to technological progress in developing countries is that of leapfrogging; the idea that countries can bypass less efficient technologies and directly implement newer technologies, without going through the same development

stages of the countries that invented these in the first place (UN/DESA, 2018). This is very relevant when discussing frontier technologies, as these can help pave the way for leapfrogging. When innovative technologies emerge, the second-best technologies will become cheaper, thus making them affordable to put into use in developing countries. Of course, it is necessary to have infrastructure that supports these technologies, but still, many areas may be able to benefit indirectly from new inventions implemented in high income countries.

Many technologies and much expertise for improved solid waste management already exist. In developing countries, there are several areas of needs beyond technology innovation. According to a study conducted in India, the earlier mentioned stressors on the solid waste management system are made worse by *"financial constraints, institutional weaknesses, improper choice of technology and public apathy towards Municipal Solid Waste"* (Vij, 2012: 437). This necessitates different approaches.

To successfully implement technologies or changes in a system of any kind, it is necessary to give the users the proper knowledge and skills to adopt the new practices. However, making people change their behaviour can still be challenging. Norms, perceptions, and habits can keep them in their usual routines. To facilitate a behavioural change, it is necessary to employ a strong communicative approach to convince people that new practices and methods are more convenient, faster, and beneficial for them and for the environment (UNEP, 2015). This can be obtained by encouraging people to adopt the new practices, enabling them to change practices by making it easier, engaging them in the issue in question, and exemplifying how they should act. It takes time and work to bring about behavioural change, but it is a necessity to enable general changes in e.g. waste management practices.

Behavioural changes are not only necessary to pave the way for new technologies, but also as a means to reduce waste in itself. "Waste management starts with waste generators, which includes basically everyone, either as a person and consumer, a resident or a tourist, or as a business owner or an employee of a company or an organization." (UNEP 2015). By bringing about a change in behaviour of people, waste generation can be reduced significantly. Taking water as an example: tasks requiring water do not require a specific amount, e.g. it is often possible to shorten the length of a shower, to save some water while washing hands, or boil one decilitre less of water when cooking. This idea can be transferred to many other areas and fractions of waste.

The key performance enablers to unlock behavioural changes are knowledge and awareness of own actions. Information campaigns and knowledge sharing are important tools to enable this, and the growing presence of digital technologies is making dissemination of information easier. Further, the data revolution makes continuous feedback of one's actions possible using new technologies. For example, integrating internet of things to citizens' homes or to companies provide opportunities to create unified dashboards e.g. on people's phones that enable them to monitor their behaviour in terms of energy consumption, water consumption, and waste generation disaggregated on the different sources and machines in their homes and companies. Furthermore, they can set targets to reduce their waste generation and follow their own progress. Likewise, the government can combine data from different sources at the individual level and utilize it to inform people about their environmental footprint and the resulting consequences. The government can also use the data to evaluate the effect of information campaigns and optimize them to target specific groups.

Figure 4: Waste picker, Noida.

CONCLUSION

Waste management is an urgent issue, especially in urban areas. In India and other developing countries, waste amounts are growing at rapid rates. Meanwhile, waste management systems are often inadequate. This calls for immediate actions to be taken, not just to reduce the amount of waste ending up in landfills and nature, but also to harvest the possibilities for transforming waste to wealth.

Numerous frontier technologies can be applied to utilize waste as a resource. These includes digital, biofuel production, and nanotechnologies. This article has covered some examples that can be feasible to introduce in India, or can serve as an inspiration for what can be obtained with new technologies. The technologies present a wide array of opportunities, but certain barriers may also be present. These include: shortcomings in existing infrastructure and capacity; needs for large investments to introduce the new technologies; data security concerns; and difficulties in changing existing practices.

The direct implementation of new technologies is not the sole solution to waste problems in a country like India. The country might also benefit from higher income countries putting new technologies into use by leapfrogging, i.e. implementing the second-best technologies that are becoming cheaper as other countries introduce frontier technologies. Further, new innovations must be considered as a part of a whole. First and foremost, comprehensive strategies are needed that assess and address the issues and needs in different contexts. Frontier technologies can fit somewhere within these. Finally, an important focus in reducing waste is behavioural change. By informing people of the impacts of waste and their options for minimizing the amounts they generate, waste can be reduced at its source. This is a great starting point for better waste management.

REFERENCES

Aarhus Smart (2019). "TAPAS – Testbed in Aarhus for Precision Positioning and Autonomous Systems". https://www.smartaarhus.eu/projects/tapas-testbed-aarhus-precision-positioning-and-autonomous-systems (accessed 10.09.2019).

Bandara, Nilanthi J. G. J., J. Patrick A. Hettiaratchi, S. C. Wirasinghe, and Sumith Pilapiiya (2007). "Relation of Waste Composition to Socio-Economic Factors: A Case Study". Environ Monit Assess (2007) 135:31-39.

Be Brazil (2018). "Brazil's 'Recycling Tinder' wins innovation award in Paris". http://www.bebrasil.com.br/en/news/brazils-recycling-tinder-wins-innovation-award-in-paris (accessed 11.09.2019).

Boysen, Earl, Nancy c. Muir, Desiree Dudley, and Christine Peterson (n.d.). "Nanotechnology Makes Cars Shinier, Safer, More Fuel Efficient". Dummies. https://www.dummies.com/education/

science/nanotechnology/nanotechnology-makes-cars-shinier-safer-more-fuel-efficient (accessed 11.09.2019).

EEA, European Environment Agency (2014). 'Waste: a problem or a resource?'. https://www.eea.europa.eu/downloads/ed86ac17b9aa4213b80c0f49c5896d8c/1472651944/waste-a-problem-or-a-resource.pdf (accessed 11.09.2019)

Frankson, Shaun (2017). "Plastic Bank Deploys Blockchain to Reduce Ocean Plastic". https://www.ibm.com/blogs/systems/plastic-bank-deploys-blockchain-to-reduce-ocean-plastic/ (accessed 11.09.2019).

Gaia Discovery (2015). "Smart Bins: Singapore uses technology to beat rubbish overflow." https://www.gaiadiscovery.com/waste-pollution-recycling/smart-bins-singapore-uses-technology-to-beat-rubbish-overflo.html (accessed 11.09.2019).

Guerrero, Lilliana Abarca, Ger Maas, and William Hogland (2012). 'Solid waste management challenges for cities in developing countries'. Waste Management, 33(1), 220-232.

Hoornweg, Daniel and Perinaz Bhada-Tata (2012). 'What a Waste: A Global Review of Solid Waste Management'. World Bank. http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/What_a_Waste2012_Final.pdf (accessed 11.09.2019)

IDRC, International Development Research Centre (2016). "Nanotech extends shelf life of fresh fruit." ScienceDaily. www.sciencedaily.com/releases/2016/06/160617114011.htm (accessed 11.09.2019).

Indore Municipal Corporation (n.d.). "Indore 311 App". https://www.smartcityindore.org/311-app/ (accessed 10.09.2019).

Jain, Niveta (2014). 'Emission of Air Pollutants from Crop Residue Burning in India'. Aerosol and Air Quality Research, 14(1): 422-430.

Malins, Dr. Chris (2017). 'Thought for food: A review of the interaction between biofuel consumption and food markets'. https://www.transportenvironment.org/sites/te/files/publications/Cerulogy_Thought-for-food_September2017.pdf (accessed 11.09.2019)

Münzer Bharat (n.d.). Münzer Bharat Website. http://www.muenzer.in/en (accessed 11.09.2019)

Primove (n.d.). AgroGas Website. http://www.primove.in (accessed 11.09.2019)

Real Relief (n.d.). "SafePad". http://www.realreliefway.com/en-us/life-saving-products/health/safepad™/safepad™ (accessed 11.09.2019).

Sanjeevi V. and P. Shahabudeen (2016). "Optimal routing for efficient municipal solid waste transportation by using ArcGIS application in Chennai, India". Waste Management & Research, 34(1), 11–21.

Sawhney, Mohanbir, Robert C. Wolcott, and Inigo Arroniz (2006). "The 12 Different Ways for Companies to Innovate". MIT Sloan Management Review, 47(3), 74-81.

Springer, Nate and Ryan Schuchard (2015). 'Fuel Sustainability Brief: Biofuels'. Business for Social Responsibility. https://www.bsr.org/en/our-insights/report-view/fuel-sustainability-brief-biofuels (accessed 11.09.2019)

Sreejith, Chenicheri Chandroth, Chandrasekharan Muraleedharan, and Palatel Arun (2013). 'Life cycle assessment of producer gas derived from coconut shell and its comparison with coal gas: an Indian perspective'. International Journal of Energy and Environmental Engineering, 4:8.

UNCTAD (2018). Technology and Innovation Report 2018. Harnessing Frontier Technologies for Sustainable Development.

UN/DESA (2018). World Economic and Social Survey 2018. Frontier technologies for sustainable development.

UNEP, United Nations Environment Programme (2015). 'Global Waste Management Outlook'. https://www.uncclearn.org/sites/default/files/inventory/unep23092015.pdf (accessed 13.09.2019)

UNEP, United Nations Environment Programme (2017). 'Asia Waste Management Outlook'. http://wedocs.unep.org/bitstream/handle/20.500.11822/27289/Asia_WMO.pdf?sequence=1&isAllowed=y (accessed 11.09.2019)

Vij, Dimpal (2012). 'Urbanization and Solid Waste Management in India: Present Practices and Future Challenges'. Procedia - Social and Behavioral Sciences, 37(1), 437-447.

RECOVERY OF WEALTH FROM WASTE

MR. A.K. JAIN

Technology plays an important role by providing intelligent, smart, performance based and efficient system of digital waste management, sensor-based collection, transportation, pollution monitoring, energy simulation, resource recovery, asset maintenance, air quality measurements, etc. Mobile and web channels can also help to involve the citizens in waste management for recovery of resources.

Keywords: Municipal Solid Waste, Swachh Bharat Mission, Technologies, Waste to Energy.

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Swachh Bharat Mission (SBM), which was launched on 2nd October 2014, has made a difference. The Indian human settlements are now cleaner and more hygienic. As the campaign is at completion stage, it is time to review the SBM and scale it up from cleaning to conversion of waste into wealth. This paper discusses the strategy of 5 Rs i.e. Refuse, Reuse, Reduce, Recycle and Recovery of energy, fuels and resources from the wastes.

INTRODUCTION

The total municipal solid waste (MSW) generated in urban India is 62 million tons (mt) per year or 160,000 TPD. This is predicted to increase by a factor of 2.7 by the year 2030 and 7 by 2050. Only 60 per cent of total waste is collected, of which 30 per cent is treated and rest goes to rivers, roads, parks and nallas (drains) causing serious problems of health and environment. Solid waste includes food waste, bottles, paper, packings, old clothes and furniture, industrial waste, construction and demolition waste, bio-medical waste, electronic waste, and nuclear radioactive waste. A critical problem of waste that has emerged recently is that of Plastic Waste. It roughly comprises 10% of total garbage, which is about 5.6 million tonnes each year. Plastic Waste in Delhi is estimated at 690 mt, Mumbai 408 mt and Bengaluru 314 mt/day.

SWACHH BHARAT MISSION

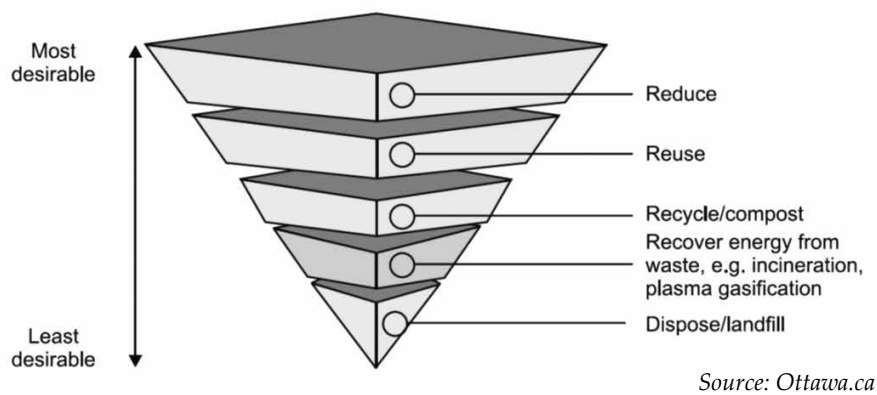
Swachh Bharat Mission (SBM), which was launched on 2nd October 2014, has made a difference. The Indian human settlements are now cleaner and more hygienic. As the campaign is at completion stage, it is now time to review the SBM and scale it up from cleaning to conversion of waste into wealth. Accordingly, the strategy has to focus on recovery of energy, fuels and resources from the wastes. The Government of India has notified several Rules and Regulations for disposal and treatment of various wastes. These include: Atomic energy (safe disposal of radioactive waste)Rules, 1987; Bio-medical Waste Handling Rules, 1998; Municipal Solid Waste Management Rules, 2000; and Plastic Waste Handling Rules, 2016.

Municipal Solid Waste (Management&Handling)Rules, 2000 require the development and improvement of properly engineered and constructed sanitary landfills (SLF) from which pollutants do not escape and have an impervious bottom layer for leachate collection and treatment. However, there is a strong opposition to location of new landfills, which are seen as an environmental hazard, causing health risk from flies and rodents, air and water pollution through leaching and fires from methane exhumed from the landfill.

THE STRATEGY OF 5 Rs

The present practice of waste management is characterized by small-scale, labour-intensive, unregulated and unregistered low-technology recycling. A large quantity of waste is dealt by the rag pickers who not only help in cleaning the neighbourhood, but also collect, reuse, recover and recycle an estimated one third of municipal waste. They recover from the waste saleable and recyclable materials such as paper, plastic bottles, metal, etc, which are sold in the market and industries. Sometimes, compost/ fertiliser is produced from the organic wastes which is used in parks, kitchen gardens, etc. This is starting point for the recovery of energy, fuels and resources from the wastes.

Figure 1 : Strategy of 5 Rs for Waste Management



Source: Ottawa.ca

The strategy of the waste management (Figure 1) begins with the simple, doable actions, as given below:

1. **Refuse:** Whenever and wherever possible, choose items that are not packaged in plastic and carry your own bag, container and utensil. Heavy tax and penalty on plastic carry bags, styrofoam, single use plastics, bottles and straws can diminish their use. Plastics can be replaced by more sustainable options like reusable steel, glass bottles and non-disposable utensils. Disposable sanitary napkins can be replaced by menstrual cups and cloth pads.
2. **Reuse:** Choose glass, paper, stainless steel, wood, ceramic and bamboo over plastic and non-toxic straws, utensils, to-go containers, bottles, bags, etc. which can be reused.
3. **Reduce:** Reduce waste by half and cut down the consumption of goods that contain excessive packaging. The Ministry of Drinking Water and Sanitation, Government of India has requested various government departments to avoid the use of plastic bottles for drinking water during meetings. The States of Maharashtra, Uttar Pradesh, Bihar and Sikkim have banned the plastic carry bags and have restricted the usage of plastic water bottles in government functions and meetings. The 2015 National Games of India (Thiruvananthapuram) aimed at "zero-waste" venues to make the event "disposable-free" and banned the usage of disposable water bottles, plastic tableware and tumblers.
4. **Recycle:** Waste can be recycled keeping in view the entire life-cycle of items, from source to manufacturing, distribution and disposal. Waste plastic (HDPE) can be recycled into plastic timber, pellets, tiles, waste containers, liners, railway sleepers

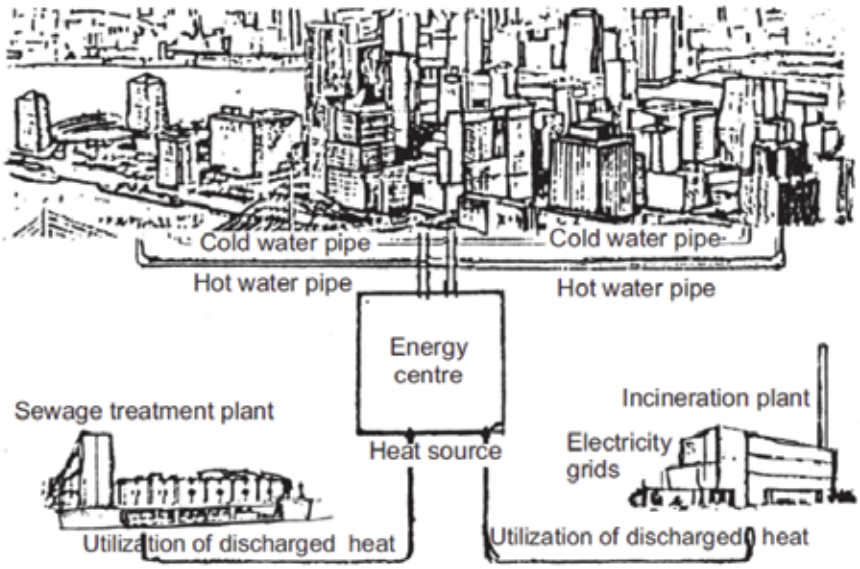
and construction materials. Recycled plastic can also be used for road surfacing which can help to reduce the pollution. It is necessary to adopt ecosystem-based adaptive management for solid wastes. Construction and demolition waste can be recycled into structural members, steel girders, beams, joist and aluminium framing, bricks, roofing tiles, concrete blocks, paving blocks, windows and door panels, etc,

5. **Recovery:** The waste has potential to yield energy, fuels and raw materials for industry, buildings, roads, etc. As the organic matter decays, it produces biogas, known as landfill gas (LFG), which can be used as useful energy. Indian municipal waste has a potential to generate 150-250 cum of biogas/LFG per ton depending upon the quality of wastes. By employing a set of generator and transformer, bio-gas can be converted into electrical energy.

WASTE TO ENERGY

Waste to Energy projects can be set up in cities with population above two million, generating more than 300 tonnes per day or more of combustible waste. The Indian Renewable Energy Development Agency (IREDA) points out that the country has so far realised only about 2 percent

Figure 2: Waste to Energy Plant as a link between Waste Treatment and the City



of its waste-to-energy potential. A market analysis by Frost and Sullivan (2017) predicts that the municipal solid waste-to-energy market could be growing at a compound annual growth rate (CAGR) of 0.7 percent in the near future. By setting up of a Solid Waste Energy and Recycling Facility (SWERF), the need for future acquisition of land for landfills can be reduced by 90 per cent. Odours and health risks are also reduced by handling of recyclates. Greenhouse gases are reduced by efficient conversion technology.

In Waste to Energy System (Figure 2) prior to the collection of solid waste, recyclables are sorted out and retrieved for processing. The solid waste that remains is then sent to the waste-to-energy plant for incineration, which reduces the volume of solid waste by about 90%. It also produces steam that runs turbine generators to generate electricity. High-capacity rotary crushers reduce the size of bulky solid waste and improve its burning efficiency. The incinerator is heated to temperatures between 8000°C and 10,000°C, a lining of silicon carbide tiles protects the incinerator walls. Catalytic fabric filter systems and two-zone electrostatic precipitators remove pollutants from the fuel gas before it is released from the plant while ash is collected, and the ferrous material is removed for recycling. Energy can be recovered from waste through thermal, thermo-chemical, bio-chemical and electrochemical methods.

- **Thermal Conversion:** The process involves thermal degradation of waste under high temperature and then complete oxidation of the waste occurs. The major technological option under

this category is incineration.

- **Thermo-Chemical Conversion:** This process entails high temperature-driven decomposition of organic matter to produce either heat energy or fuel oil or gas. These are useful for wastes containing high percentage of organic non-biodegradable matter and low moisture content. The main technological options under this category include Pyrolysis and Gasification.
- **Incineration:** Incineration is a process of controlled combustion of solid wastes and residue. The heat generated during incineration is recovered and utilised for production of steam, hot water, and for generating electricity. Incineration is economical for the treatment of large quantities of solid wastes by thermal process.
- **Pyrolysis/Gasification:**

  In this process segregated combustible matter is allowed to dry and thereafter it is shredded in a hammer mill. The combustion/pyrolysis of shredded matter takes place in a fluidised bed reactor without any fuel support. The end product includes combustible "producer" gas, which can be utilised for production of power. The heat produced in the process can also be employed for production of steam.

Fuel from Wastes

The Waste to Fuel processes can yield the following resources:

- Bio-methane gas, bio-diesel, syngas, bio-ethanol, fuels and other energy resources
- Briquettes, pellets, bio-char, etc.
- Energy recovery. However, it may be an expensive option due to rigorous environmental compliance requirements.

A waste with good proportion of organic matter can be a good substrate for recovery of bio-energy potential (from biodegradable fraction of the organics) or for the recovery of thermal energy potential (equivalent to calorific value observed). As such, following kind of fuels can be generated from wastes (Table 1):

Table 1: Waste to Fuel Conversion Processes

Waste to Solid Fuels	Waste to Liquid Fuels	Waste to Gaseous Fuels
Briquettes Pellets Charcoal/ Bio-char	Bio-diesel Bio-ethanol Bio-Oil	Biogas Syngas

Several proprietary anaerobic processes have been developed for energy recovery as biogas from various liquid and solid wastes. Anaerobic technology has emerged as a mature technology for conversion of waste to fuel and energy.

Landfill Gas Extraction (LFG)

The waste deposited in a landfill gets subjected, over a period of time, to anaerobic conditions. This leads to landfill gas production containing about 45-55% methane. The methane can be recovered through a network of pipes and utilised as a source of energy. Landfill gas extraction system helps to reduce Green House Gas emissions. While planning for LFG, pH and Nutrient content of the waste should be considered.

Fuel-Pellets: Municipal Solid Waste (MSW) comprises various materials such as paper, plastics, glass, metals, vegetable matter, rags, rubber, etc. It is essential to segregate the organic materials from MSW in such a way that it is free of sand, moisture and ferrous and non-ferrous materials. The segregated organic matter can be dried, ground and pelletised. This ground organic matter can be added by biomass to enrich calorific value of fuel pellets.

A pilot project of the Department of Science and Technology had been set up at Mumbai for producing about 80 tons per day of fuel pellets as a coal substitute and having a calorific value of 3500 Kcal/Kg.

Figure 3: Producing electricity from methane involves a Receiving Tank, Biodigester (by Anaerobic Bacteria) and a Combined Heat and Power Unit

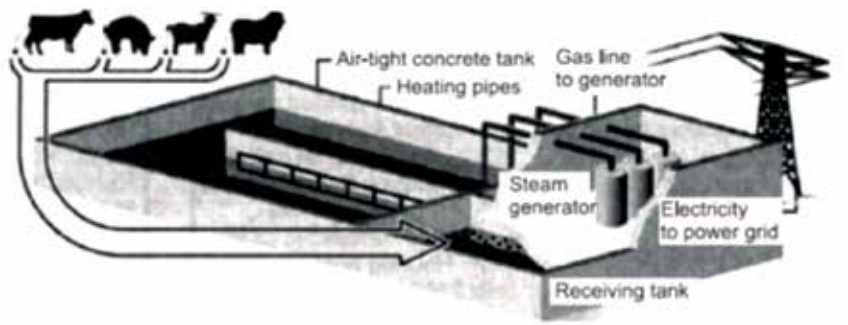


Figure 4: Bio-gas generation from human and animal wastes

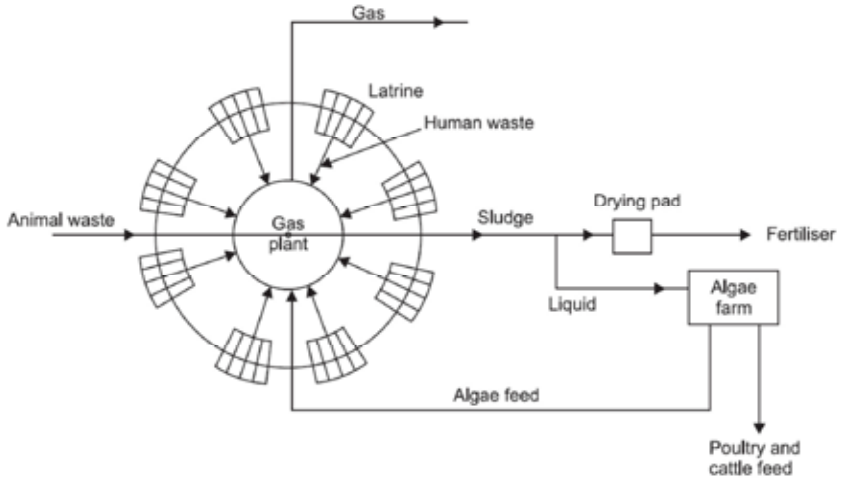
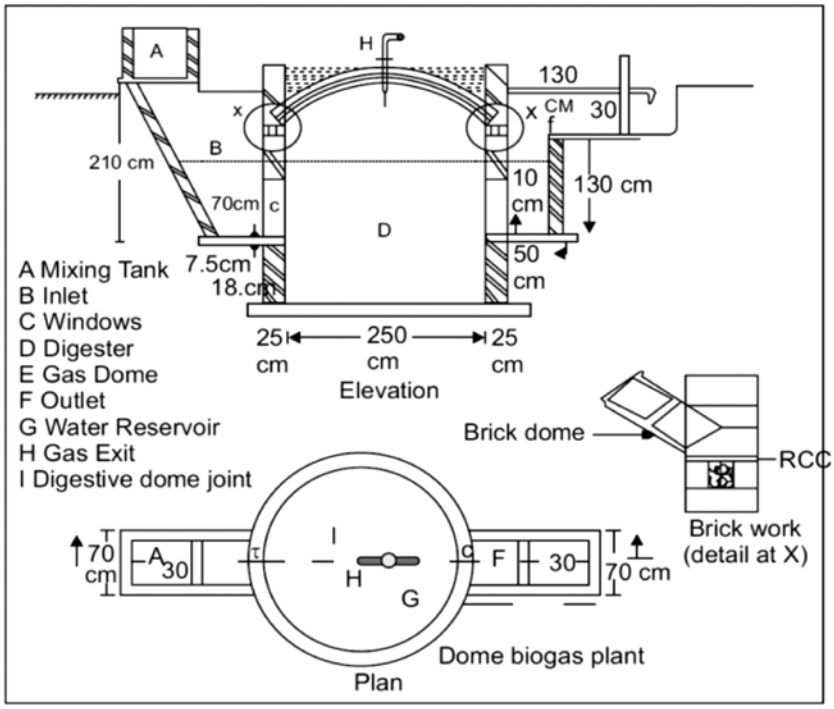


Figure 5: A Small Bio-Gas Plant for Human and Animal Waste



The conversion of the wastes into fuel can be done in following ways:

Bio-chemical conversion: This process is based on enzymatic decomposition of organic matter by microbial action to produce methane gas, alcohol, etc. This process is preferred for wastes having high percentage of organic, bio-degradable (putrescible) matter and high level of moisture/water content, which aids microbial activity. The options under this category are anaerobic digestion (bio-methanation) and fermentation. Of the two, anaerobic digestion is used frequently.

Trans-esterification: Trans-esterification is a process that uses alcohol (like methanol) and reacts it with the triglyceride oils contained in vegetable oils, animal fats, or recycled greases, forming fatty acid alkyl esters (biodiesel) and glycerine. This is a useful technology for converting waste into fuel and energy.

Electro-chemical conversion: Electrochemical conversion in the context of waste to energy refers typically to microbial fuel cells (MFC). These systems are developed to trap energy from wastes, where the reduction-oxidation machinery of immobilised microbial cells is catalytically exploited for the accelerated transfer of electrons from organic wastes to generate

electricity and bio-hydrogen gas. However, this methodology needs extensive evaluation studies and stands at a nascent level in India.

In this process, organic matter of solid waste is segregated and thereafter it is fed directly into a bioreactor, where in presence of methanogenic bacteria, and under an aerobic condition, the fermentation takes place and biogas is produced. In addition, a high quality organic manure is also produced. Energy can be recovered by digesting certain organic wastes and recovering the methane rich bio-gas. Figure 3 shows that producing electricity from methane involves a Receiving Tank, Bio-digester (by Anaerobic Bacteria) and a Combined Heat and Power Unit. Figure 4 shows the process of bio-gas generation from human and animal wastes while Figure 5 shows a small bio-gas plant for human and animal waste.

COMPOSTING OPTION

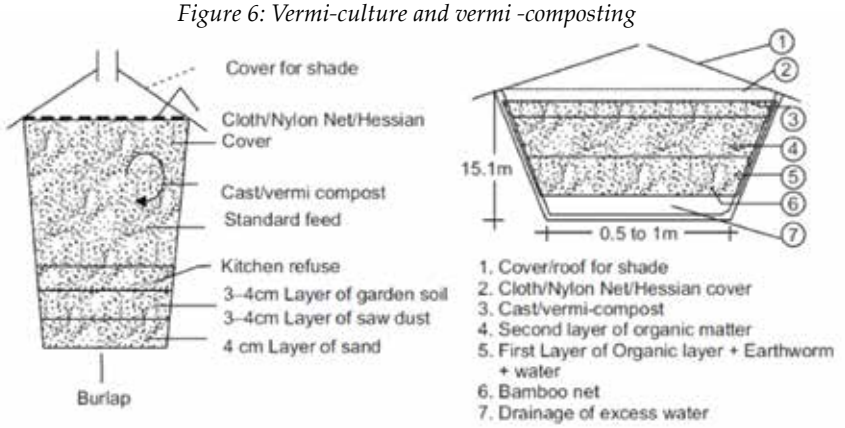
For bio-degradable matter composting is one of the most popular option of garbage disposal. Apart from saving land, valuable products like compost, biogas, heat, electrical power, recycled paper, plastics, glass, metals, etc. are obtained. Composting can be done in different ways: Anaerobic and Aerobic Digestion; Fermentation; and Vermi-composting.

- **Anaerobic Digestion** is the naturally occurring process of breakdown of organic material by micro-organisms in the absence of oxygen. This process can be replicated and accelerated under artificial conditions leading to the generation of biogas.
- **Fermentation:** Organic wastes can be converted to ethanol, the alcohol found in beverages, through bacterial fermentation (enzymes may be used to speed up the process), which converts carbohydrates in the feedstock to ethanol.
- **Vermi-composting:** Composting of biodegradable waste by earthworms, including human excreta, is gaining popularity. Organic waste is allowed to decompose by micro-organisms already present in the waste. The process can be accomplished either in presence or in absence of oxygen known as aerobic or decomposition respectively. During aerobic decomposition, organic compound converted into oxidized to oxides of carbon and nitrogen and temperature of the mass rises to 700°C (Figure 6).

In vermi-composting earthworm species are used for the conversion of organic waste into compost. Selection of appropriate species of earthworms for vermi-composting in India is limited to a few. The best choice for vermi-composting is two worm species, i.e. Eudrilus eugeniae and Eisenia fetida. Eudrilus eugeniae, popularly known as African Night Crawler is found to be the best for vermi-composting. It has excellent growth and high conversion ratio.

Worms use about 5 to 10 per cent of the organic material for their growth and excrete the rest in the form of granular cast which is known as vermi-compost. The granular loose vermin-cast provides oxygen rich, nutrient rich media for aerobic microbes which further accelerate

Figure 6: Vermi-culture and vermi -composting



decomposition process. About 2,000 worms are required for 10 kg of waste.

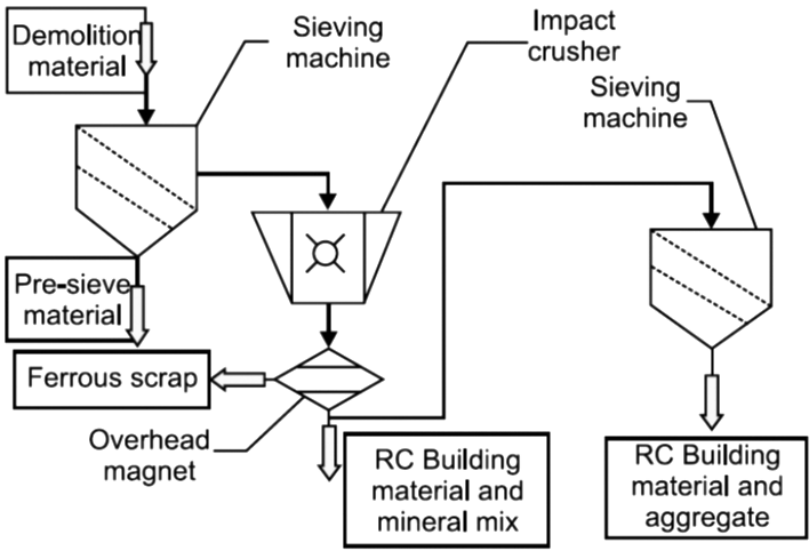
RESOURCE RECOVERY FROM CONSTRUCTION & DEMOLITION WASTE

As per the Construction and Demolition Waste Rules, large waste generators (above 500 MT) are required to recycle and reuse construction and demolition waste at the site (minimum 20%) for reconstruction purpose. Recent initiatives of the Government of India (Ministry of Housing & Urban Affairs/ National Building Construction Corporation) in the Redevelopment of Residential Complexes of New Moti Bagh, West and East Kidwai Nagar (New Delhi) have shown that it is possible to provide for 100 per cent recycling and reuse of C&D Waste at the site itself. Such models obviate the need for transporting the C&D waste to a centralised unit and the reused materials back to the site.

The total available recycled concrete aggregate (RCA) in India is of the order of 18.6 million tonnes annually. This can be recycled into useful products (Figure 7).

Concrete: Recycled Concrete Aggregate (RCA) can be obtained from the Construction and Demolition (C&D) waste, which is taken to a recycling plant and is crushed into the required sizes.

Figure 7: Recycling process for construction and demolition wastes



Recycled aggregates can replace the natural aggregates, which help towards the sustainability.

Bricks: Old bricks can be recycled for construction work. These can also be used as pavers and brick aggregate through screening, crushing, re-screening and blending. These can be used as base material by proper mix with cement and fly ash and can also be used for production of precast elements like paver blocks, kerb stones and interlocking tiles by mixing with cement and concrete.

Tiles: The waste tiles can be reused after the removal of stuck up mortar and then glued with suitable adhesives. Various items like artefacts, table tops, paving for drive ways, pedestrian subways, etc. can be made by recycled tiles.

Timber: The waste timber can be recycled into particle board, fibre boards, etc. Wood chips can be produced from wooden waste.

Metals: Steel and aluminium are the two major products which can be recovered during the construction and demolition of a building. Structural steel waste can be reused directly without much processing, by their sizing as per the requirement. Aluminium scrap can be put into reuse by the solid bonding process. Recycling scrap aluminium requires much less energy in comparison to the energy requirement of new aluminium. Because aluminium is infinitely recyclable, it can be reused for various applications.

Plastics: Waste plastic can be reprocessed and transformed into useful products. Old plastic polymers, plastic HDPE (high-density polyethylene) can be converted into reduced to plastic lumber, tables, roadside curbs, benches, truck/

cargo liners, stationery and other plastic products. Other application of recycled plastic is in the preparation of a road surface that includes recycled plastic aggregate, bitumen (asphalt) with plastic that has been shredded and melted at a temperature around 220°C (428°F) to avoid pollution. Such road surfaces are very durable and rain resistant. Mixed and multilayer plastics can be made into pallets for flooring, waste containers, planks, profiles, railway sleepers, etc. Plastic that cannot be further recycled can be used as the fillers for processing composites, and as fence posts, park benches, pallets, street furniture, etc. as substitutes to virgin timber and concrete products.

Industrial and Agro Wastes: According to the studies conducted by MNRE, C-kinetics and Assocham, there is a huge potential for Waste to Energy (WTE) projects in the industrial/ agro sector.

The industrial and agricultural wastes can also be used for various building and construction products (Table 2) such as: clay fly ash; fly ash/sand

Table 2: Areas of Reuse of Industrial Wastes

Industry	Waste	Areas of Use
Thermal Power Plants	Fly ash	1. Feedstock in the cement industry 2. Making of bricks 3. Structural fill for roads, construction sites, land reclamation 4. Stabilization of soil
Iron and steel	Blast Furnace Slags	Structural fill for roads, construction sites
Paper and pulp, Sugar	Lime Sludge	1. As a sweetener for lime in cement manufacture 2. Manufacture of lime pozzolana bricks/binders 3. For recycling in parent industry 4. Manufacture of building lime
Aluminium Smelter	Red Mud	1. As a corrective material 2. As a binder 3. Making construction blocks 4. As a cellular concrete additive 5. Coloured composition for concrete additive 6. Making heavy clay products and red mud bricks 7. In the formation of aggregate 8. In making floor and wall tiles 9. Red mud polymer door
	Spent Pot Lining	1. Energy savings in the brick and cement industries 2. Beneficial fluxing properties in the brick, cement and steel industries 3. Enhances strength development from cement 4. Recycle into cathodes and anodes for use in the aluminium ramming paste industry 5. Fluorides recovery (cryolite)
Cement	Kiln Dust (Particulate Matter), Waste Heat	1. Feedstock in the cement industry 2. As a soil stabilizer, to create raw materials for road construction 3. Treatment of other waste such as fuel gas and sewage sludge

Source: Assocham & C-kinetics (2015) Value Out of Waste (VOW), New Delhi.

lime bricks; fly ash lime gypsum (Fal-G) products; red mud bricks; honeycomb sandwich panels; fly ash based light weight aerated concrete, pavers, etc.; recycled aggregate; recycled ash; geo-polymer concrete (ground granulated furnace slag); glass fibre reinforced gypsum; bamboo/timber mat-based walls (ekra walling) and panels; partition/ceiling/panels, cement bonded composite paneling, partitioning, false ceiling boards, cladding and panels; gypsum based ceiling tiles, panel blocks, door and window shutters; jute–stalk board; rice husk board; and particle boards.

Red Mud: During aluminium production, millions of tons of a red mud is generated. This, in combination with polymer and natural fibres, can be turned in to Red Mud Jute Fibre Polymer Composite (RFPC), to replace wood and wood-based products. This product uses zero energy by room-temperature processing. Red Mud can also be used for making high quality exposable bricks, tiles, corrugated roofing sheets, and as binder for several useful products, e.g. composite doors, panels, etc.

Phospho-gypsum is produced as slurry in the manufacture of fertilizers and phosphoric acid. After treatment, the purified gypsum can be used as a retarding agent in Portland cement, or to produce gypsum plaster, fibrous gypsum plaster boards or gypsum blocks.

Agro-Wastes: According to the research published by the Building Materials and Technology Promotion Council (BMPTC) agro-wastes can produce variety of low cost, low energy building materials (Table 3):

Table 3: Agro-Wastes as Building Materials

S. No.	Waste and source	Commercial product using natural fibre & agro-waste	Traditional resource fully or partly saved	Energy (%)
1.	Coir Fibre (coir industry)	Coir fibre-cement roofing sheet & panels	Asbestos	10
2.	Rick husk (Rice mill)	Rick-husk-Cement Building board	Resin (PF or UF) bonded particle board timber	20
3.	Ground nut hulls (Oil mills)	Groundnut-hull-cement building board	Resin-bonded particle board timber	20
4.	Jute fibre (Jute mills)	Jute-fibre-polymer bonded panel; door and window	Timber, metal	10
5.	Cotton waste (Textile mills)	Cotton lint-cement bonded board	Gypsum, timber	25
6.	Bagasse (Sugar mills)	Bagasse-polymer bonded boards	Timber fibres (in insulation board)	30
7.	Corn cobs (Corn mill)	Corn cobs-cement bonded boards	Timber, polymer	40
8.	Sisal fibre (Sisal plant)	Sisal fibre-polymer/cement bonded roofing sheet, door, window	Asbestos fibre Timber	20-15
9.	Rice straw & Wheat straw (farms)	Compressed and paper covered board	Timber Polymer	40
10.	Banana fibre (Banana plant)	Banana fibre+cotton pulp/paper pulp and polymer insulation boards	Timber Traditional light weight mineral viz vermiculite or mica	25

Source : Building Materials and Technology Promotion Council, 2018

Table 4: Energy Saving by Recycled Wastes

S. No.	Material	Total energy in primary product (MJ/kg)	Total energy in recycled product (MJ/kg)	Saving (%)
1.	Steel sheet	333.50	21.00	30.00
2.	Aluminium sheet	135.00	11.00	94.00
3.	Paper	28.00	25.00	10.30
4.	Rubber	700.00	56.00	44.00
5.	Plastics (PVC)	54.70	14.50	80.00
6.	Glass	23.00	17.00	26.00
7.	Wood Products	3.00	2.00	33.00

Source : Building Materials and Technology Promotion Council, 2018

The recycled waste reduces not only the cost, but also energy (Table 4):.

CONCLUSION

The analysis above indicate that there is an urgent need to transfer technology from the lab to land, i.e. implementing the concepts of waste to wealth. Technology plays an important role by providing intelligent, smart, performance based and efficient system of digital waste management, sensor-based collection, transportation, pollution monitoring, energy simulation, resource recovery, asset, maintenance, air quality measurements, etc. Mobile and web channels can also help to involve the citizens in waste management for recovery of resources. It is necessary to adopt the alternatives to landfill and the strategies of Refuse, Reuse, Reduce, Recycle and the Recovery of fuels, energy and resources for sustainable waste management. These are emerging frontiers to transform waste into wealth.

REFERENCES

AIILSG (2014) Urban Update, Cleaner Tomorrow, May, Mumbai.

Assocham & C-kinetics (2015) Value Out of Waste (VOW), New Delhi.

Building Materials and Technology Promotion Council (2018) Building Materials and Housing Technologies for Sustainable Development, New Delhi

Centre for Science and Environment (2012) Excreta Matters, 71 Cities Survey, CSE, New Delhi.

CPCB, Status of Municipal Solid Waste Generation. Collection, Treatment and Disposal in Class II Towns.

CPWD (2014) Guidelines on Reuse and Recycling of Construction and Demolition Waste.

CSE (Centre for Science & Environment), India-Environment Report, New Delhi.

Dorom, Assa & Robin Jeffrey (2018) Waste of a Nation-Garbage and Growth in India, Harvard, University Press, Cambridge, USA

Frost & Sullivan (2017), Decentralized Wastewater and Solid Waste Treatment Technologies, Frost & Sullivan's TechVision team, May 2017

Government of India (2014) Guidelines for Developing State Policies on Solid and Liquid Waste Management (SLWM) in Rural Areas, Ministry of Drinking Water and Resources, New Delhi

Hoornweg, D.P. Bhada-Tataand C. Kennedy (2013) Waste Production Must Peak this Country, Nature, Vol. 502, ,pp 615-617

IL&FS ECOSMART, 'Construction & Demolition (C&D) Waste; collection, transportation and disposal system', Project Report for MCD, Delhi Solid Waste Management Program, 38p.

Jain, A.K. (2016) Towards Cleaner and Hygienic Cities and Villages, Discovery Publishers, New Delhi.

MOUD, CPHEEO, Status of Municipal Solid Waste Generation, Collection, Treatment and Disposal in Metropolitan Cities. CPHEEO website. http://cpheeo.nic.in/

MONRE, Technical Memorandum on Waste to Energy Technologies, National Mission Plan on Waste to Energy, Ministry of New and Renewable Energy, Government of India.

NASSCOM (2015). Integrated ICT and Geospatial Technologies, New Delhi

World Bank (2006) India Water Supply and Sanitation: Bridging the Gap between Infrastructure and Service. Background Paper, Urban Water Supply and Sanitation.

WASTE TO BOOST URBAN SPACE

- Learnings from Innovations

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Looking at waste reuse and recovery as possibilities to boost the urban public spaces in a neighborhood or city may be one of the ways to deal with the issues of waste management. Advocacy can bring this concern on the forefront onto public-eye and levitate from the taboo that waste is no good and orient towards the conception of 'waste as wealth'.

Keywords: Municipal Solid waste, Urban art, Public space, Community projects, Place making

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This paper aims to understand the usage of waste materials as resources in public space design specifically. This paper discusses two cases where wastes – plastics & tyres have been effectively reused to create new material that may be used as surface finishes in heavily treaded public spaces such as roads & plazas. Further, ten case studies in India & abroad are discussed where solid waste in general and specific discards such as plastic bottles, bottle caps, e-waste, CDs or left-over PVC pipes have been innovatively used in public projects involving the community at times, to create invigorating installations that enhance imagery and livability of the urban spaces, while being economical & environmental friendly. Hence, the concept of 'reuse and recycle' of the municipal solid waste of the city towards public space design to create awareness amongst citizens on waste management & dire consequences of landfills while boosting the public spaces is likewise enabled. The cases involve execution of works using waste to build art installations, kiosks or organize community events.

INTRODUCTION

What is waste? Why is it becoming a topic of priority in the recent days all over the world? Have humans reached a plateau due to the erratic activities of production & consumption, leading to unscrupulous output of waste? As society focus on these serious questions linked with over the sheer continuance of existence of earthly beings, it becomes a priority concern to address these for sustenance of future generations.

In India, 31% of the population resides in urban areas. Cities are creating tremendous waste continuously and the output is considerably high, amounting to 1,43,449 metric tons per day of municipal solid waste (MSW) as per the Central Pollution Control Board, 2014-15 and these figures keep rising steadily. (MSWM Manual Part II, CPHEEO 2016)

Swachh Bharat Mission (SBM) launched in 2014 aptly aimed to provide basic infrastructural and service delivery with respect to sanitation facilities to every family and including the objective of municipal solid waste (MSW) management in urban areas as well. All Urban local bodies (ULB's) are entrusted with the mission of modulating the MSW in an effective manner.

First of all, waste should not be generated or should be minimized, but since already there is a major output of plastic and other such non-degradable waste, until such time that these are phased out logically, there is a need to introduce concept of reuse/recycling of such materials in the society. The initiative begins at home-level but when deployed at the community scale, interventions and demonstrations on waste management influences the individual thought process on those lines. Then there shall be a cognitive harmony w.r.t waste management & highlighted importance of 3R's of reduce, reuse, recycle. Hence, when these are applied or demonstrated in the public spaces for all to view & perceive, it reinforces the right perceptions towards waste amongst people. If the waste is applied to further add interest or glamour to the public space, it becomes meaningful in value-adding to the space, enhancing imagery & livability while being sustainable too.

This paper aims to understand usage of waste materials as resources in public space design specifically.

Looking at waste reuse and recovery as possibilities to boost the urban public spaces in a neighborhood or city may be one of the ways to deal with the issues of waste management. Advocacy can bring this concern on the forefront onto public-eye and levitate from the taboo that waste is no good and orient towards the conception of 'waste as wealth'. Reusing or recycling leads to prolonged usage of a material to the maximum extent, limiting the discarding which eventually adds to the growing mountain of waste. Public spaces in a city amount to approximately 30% of streets and 10% to 20% of open spaces such as parks, plazas & playgrounds, as witnessed in most master plans of Indian cities. Bangalore has about 10% as open spaces (CDP 2015). Utilization of the municipal solid waste (MSW) generated in the city (management of which is the liability of the city's civic bodies) in an efficient and logical manner in the public space design will aid in routing the waste in being reused rather than adding up to the environmentally degrading landfills.

The objectives thus are mainly:

1. To enhance quality of public spaces
2. To utilize municipal solid waste meaningfully
3. To create awareness in the society towards waste management
4. To aid in an urban system that becomes sustainable & livable while reducing the impact on environment.

Few case studies on innovative initiatives of utilizing municipal solid waste in the design of public spaces are discussed below.

MSW comprise of various types of waste such as plastic, metal, paper, glass & the preferred hierarchy of waste management would be:

- At-source reduction or reuse
- Recycling
- Composting
- Waste to energy
- Disposal.

INNOVATIVE PERSPECTIVES & INITIATIVES IN PUBLIC SPACE DESIGN

Public spaces, the lifelines of a city, are mainly spaces that are owned by the Government and managed by the Public civic authorities in the city; these are the spaces meant to be used by the people for various reasons of transportation, amenities/needs, recreation or so. The public spaces refer to- roads, sidewalks, transit facilities, parks, play grounds, squares or plazas, public buildings & premises, open spaces and such.

Following are two instances where waste plastic and waste rubber tyres have been utilized to create a new material that could be used in the construction of public spaces.

Case 1: 'Plastic waste to Re-tile'

According to Bruhat Bengaluru

Mahanagar Palike (BBMP), Bengaluru generates 4,000 tons of waste every day & plastic comprises about 20% of the total MSW. Plastic waste is a serious & grave concern of the city. This waste also causes significant health & environmental hazards.

In response, the Eco Solutions arm of a Bengaluru-based non-profit organization Swachha in association with BBMP has come up with a solution that can convert discarded plastic waste and convert it into tiles and irrigation pipes. The project called as 'Re-Tile', uses plastic waste to create tiles which can be used on pavements. The tiles can be used in building houses, roads, walkways or swimming pools. (www.thebetterindia.com published on 11/12/2018)

It is claimed that these tiles are heat resistant up to 150 degrees Celsius & fire resistant. When used in public spaces, they are anti-slippery & anti-skid. The Project Lead also expressed that the recycled floor tiles are made of recycled Polypropylene (PP) materials and utilize a unique interlocking edge design to eliminate the need for adhesives, making installation quick and inexpensive. They can bear the heavy traffic and footfall such as on sidewalks or plazas of loads up to 35 tons. They can be installed directly over damaged or problem floors with minimal sub-floor preparations. Moreover, they are resistant to most solvents, chemicals and abrasions, and simple to maintain, reconfigure or remove.

Figure 1: Re-tile may be designed as required & in varied colors (Source: Swachha)

These tiles are claimed to have rainwater harvesting capabilities, are water-proof, anti-microbial, chemical and stain-resistant, besides allowing for the possibility of applying different artwork and design depending on the specific requirements (Figure 1).

Amongst the discarded plastics that go into the manufacturing of these tiles are shampoo bottles, cleaners, disposable restaurant containers, milk covers and water bottles. The project brief gives break down of the amount of plastic required to construct one unit of tile- 15 Disposable Food Containers or 150 Polythene Bags or 150 Disposable spoons or 10-15 cosmetic bottles. These reprocessed plastic granules are then loaded onto a pipe extrusion machine which produces decent quality irrigation pipes for farmers and homogeneous tiles, and hence they are recyclable.

The waste plastic is transported from the community to the city corporation decentralization unit for segregation, after which it is sent to *Swachha's* waste processing unit. To bring in uniformity to the color of the tiles produced, the plastic waste is segregated into different grades and colors. Later, the plastic waste is ground into smaller pieces called as granules in a grinding machine and converted into colorful Re-Tiles. No other element is mixed with the homogenous plastic and hence can be recycled often. It takes 3-4 tons of plastic waste to manufacture approximately 10,000 tiles every day. The pricing is estimated in the range of Rs 70 to Rs 90 per square feet, depending on tile characteristics such as load bearing capacity, color, quality and design. This certainly may prove as a better alternative to dumping or incinerating plastic waste, which further adds to pollution & hazards.

Case 2: 'Waste tyres into Green steel'

Every year tyre wastes account

to over one billion in numbers globally & add to environmental degradation due to the complex mix of natural & synthetic rubber with various structural reinforcing elements such as metals and chemical additives. A Mumbai-born scientist & Director of Centre for Sustainable Materials Research and Technology at University of New South Wales (UNSW) Australia, has invented Polymer Injection Technology that converts old rubber tyres to metal alloys that make 'Green Steel' & address the growing problem of disposal of waste tyres globally. She says in the interview to 'The Hindu' (31/07/2016) that it is ideal for application in India as it is incorporated into conventional electric- arc furnace EAF steelmaking, so it does not require expensive new industrial infrastructure or any large-scale new equipment.

Tyres may be reused or recycled and used in civil engineering works such as retaining walls and highway barriers, the granulated waste tyres maybe used for numerous applications such as sports and playground surfaces and blended into asphalt for road making or as rubberized asphalt concrete.

URBAN 'PLACE MAKING' CONCEPTS

Making cities & their urban spaces livable & well-experienced by all user groups requires creating a sense of place (Lynch, 1960). An urban space must not only induce a feeling of safety & comfort, but an identity and interest as well. Place-making as a concept became popular around 1970s, when urban design as a profession took forefront. One way of creating this, was the emergence of art in urban design by way of installations, street arts or nodes of vibrancy for general public.

One example would be city of Bogota, which introduced a policy recognizing 'Graffiti' as an urban cultural practice through a participatory process as a collective affair amongst various stake holders in an effort to establish Bogota as a heritage city. But the policy also emphasizes on a city free of visual contamination (CII & PwC, Nov 2018).

AESTHETICS OF PUBLIC SPACE- 'STREET ARTS FROM WASTE'

Streets arts or urban arts, a way of expression of interest or advocacy of societal beliefs is gaining importance in current age. The concept started in 1960s in urban areas in dif ferent cities of the world. Street arts are a creative way of adding interest to urban spaces and could become a medium of creating awareness amongst citizens on the concept of waste management or any such societal concerns. Such street arts in recent days are becoming an avenue for artists to utilize the waste into meaningful urban works.

Following are ten case studies which have used solid waste in their projects largely whereas some cases with specifically used discards such as CDs, plastic bottles, cling wraps, bottle caps, PVC pipes, tyres and e-waste.

Case 1: Raipur Kachara Mahotsav

Raipur city became a first in celebrating the garbage festival. The Raipur Municipal Corporation came up with the ingenious idea of '*Kachara Mahotsav*' aimed at spreading awareness about the importance of reusing waste (Indiatimes.com, 21/01/2018). The three-day festival had workshops, talks, performances and also some interesting urban installations. The objective was to grab public attention by doing something out of the box than the usual billboards and notices. The fest had many attractions such as unique installations made from garbage, workshops on garbage and band performances by renowned bands as well (Figure 2).

Figure 2: Raipur 'Kachara Mahotsav' (Source: Tweet@RaipurDist)

Case 2: Mirror culture- Community based art project using recycled CD's in Bulgaria

Bulgarian and NYC-based Bignatov Studio envisioned and executed an interesting but simple community-based project of installing an art sculpture in Varna, Bulgaria using recycled CD's in the city's popular public plaza with the help of 128 volunteers (treehugger.com, 26/03/2014). The installation titled "Mirror Culture" consisted over 6,000 recycled CDs that have been attached by hand to a custom-made fishing net & suspended in the middle of the plaza; it seemed to billow and shimmer with each breath of the wind, creating rainbow refractions of light that made this outdoor space come alive. This initiative created a strong sense of community & an activity which became a key to happiness amongst people and brought the concept of recycling to light as well (Figure 3).

Figure 3: 'Mirror culture' community installation using recycled CD's (Source: Bignatov Studio)

Figure 4: 'Argallios' public installation in Crete using recycled plastic bottles (Source: Kollektivemind)

Case 3: Argallios, Public installation using recycled plastic bottles in Crete

In the city of Chanai, on the Greek island of Crete, came up a public interactive project installation placed on the fence of a Primary school in a less privileged area of the city. It was titled 'Argallios' meaning 'in a different way' (Envisioned by Athenian architecture firm Kollektivemind) (popupcity.net. 07/02/2013).

The creative team along with parents, teachers and students created this local traditional weaving motif using 2100 recycled plastic bottles that were painted in six traditional colors & tucked into the diamond shaped holes of the fence. The installation added color to the school yard and also created awareness on urban aspects of reclaiming public space for people of the neighborhood, children as user groups and sense of ecological and cultural integrity of the area (Figure 4).

Case 4: Milan- Kiosk installation out of waste in a dead public space

In Milan, there is a Public Design Festival promoted by *Esterni* agency with the aim to promote public space & conducted in various public areas of the city. (popupcity.com. 21/04/2011)

In 2011, four places were selected, mainly on neglected and semi-abandoned spots but which had good potential to be successful public spaces. One such installation was a transient piece of architecture that served

Figure 5: The kiosk added life to the dead space in Milan

as a bar & kiosk, totally realized with local waste materials by Stortplaats van Dromen. This added activity, vibrancy & life to the place, was economical using local waste materials and created awareness on the same as well (Figure 5).

Case 5: Odisha's waste to art museum

Odisha created its first open-air waste museum of three acres at Bhubaneswar in November 2018 which displays 21 sculptures & installations by eminent artists made completely out of waste (such as defunct car parts, autorickshaws, cycle parts & drums). It is a public art symposium in collaboration with Bhubaneswar Development Authority meant to attract aged people, creating interest while highlighting the concern on waste generated and ways to reuse it (TOI, 19/09/2018). Though creation of plants and animals such as elephants, lions, peacock, tiger are the prime creations, there are many more creations as well. The museum has become a great public spot of recreation (Figure 6).

Figure 6: Bhubaneswar 'waste' museum (Source: Odisha Sun Times Bureau)

Case 6: Berlin's urban sculptures using waste such as cling wraps

Berlin city seemed to be facing huge waste generation and garbage collection concerns in the last decade. German street art collective Bosso Fataka initiated a project to highlight the impending concerns by using the cling wraps waste and creating elaborate sculptures in public spaces (fastcompany.com. 09/06/2013). Three street artists used rolls of saran wrap to create great sculptures, following which they started it as a frequent affair to collect street trash & convert them to sculptures suspended in plastic such as an old car or big gates & old shopping carts using wraps. The works are one of the technologically impressive and comical impressions of the imagination onto urban spaces (Figure 7).

Figure 7: Berlin street art from waste (Source: Bosso Fataka)

Case 7: Bottle cap waste for paving in urban spaces

Figure 8: Bottle caps to interesting pavements (Source: Pisotapitas napad)

Bottle caps are one of the major contributors to plastic & other wastes in cities, harmful in many ways specially to birds & animals. But they could be collected and reused in various ways in the urban spaces such as placing on concrete for creating interesting, defining and vibrant surface finish on sidewalks & park pavements (Figure 8).

Case 8: Waste PVC pipes form an interactive pavilion for children to play

The project envisioned by Netherlands-based *Hoogte Twee Architecten* explores the idea of using waste PVC pipes as hollow building stones to construct an interactive pavilion for children or an interesting temporary residence. This derived idea from the way building materials are perceived by the poor in developing countries. Hence, the aim wasn't just to provide a place for children to play but to utilize waste materials incurred during construction activity. One example of the same is the ***pavilion for children*** assembled out of waste PVC pipes only. The pipes are stacked parallel to create interactive forms with functional use, while using the transparency factor to gain light filtration and open heads to allow light funnel through (designbuzz.com). This make for great ideas to install interesting public pavilions in urban spaces such as plaza or parks & play areas (Figure 9).

Figure 9: Waste PVC pipes to install public pavilions (Source: Arch daily & designbuzz)

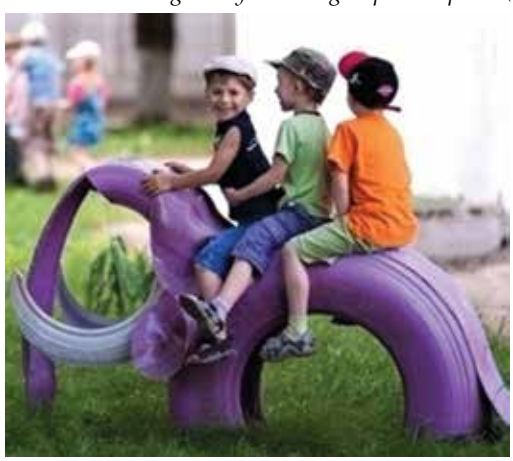
Case 9: Waste Tyres as play installations in public spaces

Cities have abundant tyres as waste outputs. Instead of incinerating them or sending them off to landfills that impact the environment they may be innovatively reused by remodeling with colorful paints & patterns owing to their sturdy nature. They may become installations such as play items for kids in parks & play areas, public bicycle tyre racks. They could become wall murals or modelled into street furniture in public spaces adding a different vibrancy (Figure 10).

Case 10: e-waste to stunning urban sculptures

India is among the top five countries in e-waste generation (ASSOCHAM-NEC study, published in TOI 04/06/2018). It amounts to about 2 million Tons per annum while a mere 5% gets recycled, rest is left to impair the environment &

Figure 10: Tyres as play equipment in play areas (Source: Mark@http://myfixituplife.com) or cool grass tyre seating in public spaces (Source: worldinsidepictures)



be hazardous to health. To counteract the impact, there are few artists & organizations who are striving to avoid this e-waste getting into landfills. Mumbai-based Haribaabu Naatesan works on converting e-waste into works of art as installations since 1999. This includes obsolete walkmans, out-of-date videotapes, blunt saw blades, dead cell phones, floppy discs, fused light bulbs & many such discards (thebetterindia.com. 26/02/2019 by Jovita Aranha). His works include the notable 'Make in India' logo by using 1500 Kgs of automobile scrap mostly mechanical gear wheels. The sculpture, unveiled by the CM of Maharashtra is placed at P D'Mello Road at Carnac Bunder Circle, Mumbai. Till date, he has recycled several tons of e-waste to make over 100 sculptures, which are placed in many public campuses such as airports & city centers; they add interest & curiosity amongst public and are durable as well (Figure 11).

Figure 11: 'Made in India' logo using e-waste

CONCLUSION

The case studies give an idea on how waste may be meaningfully reused to design public spaces achieving three objectives- adding interest to the urban spaces, creating awareness on waste management while effectively reusing the waste and proving economical to the municipal authorities in building & managing better livable places in the city. The urban innovations deal with waste management & awareness involving community cohesion and public space enhancement with interesting applications/ installations. Thus, a sustainable outlook may be incrementally introduced in the society in a creative & exciting manner.

REFERENCES

(In order of occurrence in the text)

Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development. 2016. Municipal Solid Waste Management Manual Part II

Rinchen Norbu Wangchuk. Bengaluru NGO Turns Old Plastic Into Anti-Slippery & Recyclable Tiles You Can Walk On! December 11, 2018, 7:56 pm (Accessed URL on 03/09/2019. www.thebetterindia.com)

Mishra, L. Turning waste tyre into 'Green steel'. July 31, 2016 23:52 IST (Accessed URL on 02/09/2019. www.thehindu.com)

CII Confederation of Indian Industry & PwC. Transforming Urban India: Art and Culture to play a pivotal role. November 2018. pp 35-40 chapter: Emerging waves of Art and Culture – Urban Place making.

KC Archana. India's first 'Kachra Mahotsav' in Raipur wants to teach people the importance of recycling. Jan 27, 2018, 14:41 IST. (Accessed URL on 3/9/2019. www.indiatimes.com)

Mok, Kimberley. Shimmering community quilt of 6,000 recycled CDs woven in Bulgaria. March 26, 2014. (Accessed URL on 1/9/2019. www.treehugger.com)

Doumpa, Vivian. 2100 plastic bottles make a great intervention. 07/02/2013. (Accessed URL on 04/09/2019. www.popupcity.net)

Vedovato, Francesco. Public design festival- 2011, Milan, Italy. 21/04/2011. (Accessed URL on 3/9/2019. www.popupcity.net)

Pradhan, Hemata for TNN. From scrap to sculpture: Story of Odisha's waste to art museum in offing. 19/09/2018. (Accessed URL 02/09/2019. www.timesofindia.indiatimes.com)

Brownstone, Sidney. Berlin street Artists make insane art out of the City's waste. 09/06/2013. (Accessed URL on 04/09/2019. www.fastcompany.com)

https://tojenapad.dobrenoviny.sk/napady-ako-vyuzit-vrchnaky-z-plastovych-flias-v-zahrade/. (Accessed 04/09/2019)

PVC pipes form an interactive pavilion for children to play. (Accessed URL on 31/08/2019. www.designbuzz.com)

24 Cool DIY Ideas How To Reuse Old Tyres. (Accessed URL on 31/08/2019. www.worldinsidepictures.com)

Aranha, Jovita. Meet the Artist who left his job to turn tons of e-waste into stunning sculptures! 26/02/2019 6:56 pm (Accessed URL on 03/09/2019. www.thebetterindia.com)

POLICY LEVEL INTERVENTION ON THE SCIENTIFIC DISPOSAL, REUSE & RECYCLE OF CONSTRUCTION & DEMOLITION WASTE

MR. RAJORSHI CHATTERJEE
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With the rising concern on Climate Change, several factors have been recognized that impact it directly or indirectly. Any kind of unchecked use of any resource needs to be prohibited. Construction and demolition waste consists of huge amount of materials that are often deposited without any consideration, causing many problems and encouraging the illegal dumping of waste.

Key Words: Construction waste, demolition waste, reuse, recycle.

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In our country, the construction debris is regarded as waste material and is discarded. It is usually dumped in wastelands and landfill sites and the spaces thus get cluttered up and become useless. This practice not only takes up valuable space but also ruins valuable resources. This paper aims at creating awareness of the policy level interventions regarding the scientific disposal techniques of construction and demolition wastes which will not only save our valuable spaces but will also aid in wealth generation.

INTRODUCTION

Construction activity leads to generation of solid wastes, which include sand, gravel, concrete, stone, bricks, wood, metal, glass, plastic, paper etc. Demolition activity is referred to the act of knocking down buildings mainly for the purpose of erecting new buildings in its place. The heterogeneous debris thus created is basically the demolition waste. Certain components of demolition waste such as plasterboard are hazardous once land filled, as it is broken down in landfill conditions releasing hydrogen sulphide, a toxic gas. Waste from individual house construction or demolition find its way into nearby municipal bin/vat/waste storage depots, making the municipal waste heavy; degrade quality of municipal waste and makes it difficult for further treatment like composting; and about 10-20 % finds its way into surface drains, choking them. Now, if we combine both kinds of the wastes, we get all the waste that is produced by a building in its entire lifetime and the waste essentially consists of damaged or old and weathered fragile chunks of building components. But this rubble that is deemed useless actually sums up to quite an alarmingly large quantity that can in no way be simply rejected and mindlessly tossed aside. It has real potential if managed and made fit for recycling and reusing. Construction waste is bulky and heavy and is mostly unsuitable for disposal by incineration or composting. The growing population in the country and requirement of land for other uses has reduced the availability of land for waste disposal. Re-utilization or recycling is an important strategy for management of such waste.

The management of construction and demolition waste is a major concern for town planners due to the increasing quantum of demolition rubble, continuing shortage of dumping sites, increase in transportation and disposal cost and above all growing concern about pollution and environmental deterioration. Management of high quantum of waste puts enormous pressure on solid waste management system. Projections for building material requirement of the housing sector indicate a shortage of aggregates up to 55,000 million m^3. Additional 750 million m^3 would be required for achieving the targets of the road sector. Recycling of aggregate material from construction and demolition waste may reduce the demand-supply gap in both these sectors. Government or local authorities should make rules to sort the C&D waste before it is hauled away to landfills or other waste treatment facilities. Hazardous materials may not be moved before the demolition is begun or before the authorities have ascertained that safety guidelines and restrictions have been followed for handling and disposal of toxic elements as lead, asbestos or radioactive materials

The total quantum of waste from construction industry is estimated to be 12 to 14.7 million tons per annum. The estimated quantity of different constituents of waste that arise from Construction Industry in India is given at Table 1 (TIFAC Reports, 2001).

Table 1: Different constituent of wastes generated in Construction industry

Constituent	Quantity Generated in million Tons p.a. (Range)
Soil, Sand & gravel	4.20 to 5.14
Bricks & Masonry	3.60 to 4.40
Concrete	2.40 to 3.67
Metals	0.60 to 0.73
Bitumen	0.25 to 0.30
Wood	0.25 to 0.30
Others	0.10 to 0.15

Source: Utilisation of Waste from Construction Industry, TIFAC Reports,2001

NEED FOR THE POLICY INTERVENTION

With the rising concern on Climate Change, several factors have been recognized that impact it directly or indirectly. Any kind of unchecked use of any resource needs to be prohibited. Construction and demolition waste consist of huge amount of materials that are often deposited without any consideration, causing many problems and encouraging the illegal dumping of waste. In Japan, the annual generation of construction and demolition waste is approximately 80 million tonnes. In the European Union (EU), the annual generation of construction and demolition waste is about 200-300 million tonnes. In USA, the amount of construction and demolition waste is about 250-300 million tonnes per year. Construction waste management needs to be a worldwide concern. Certain countries like Denmark and Netherland have made considerable progress in this matter. There is a need to introduce this concept in India as well. A policy needs to be framed that will deal with the regulation of construction and demolition waste strictly.

AIM OF THE PAPER

The paper aims at reducing the stress from landfill sites by reusing and recycling the construction debris, through its scientific disposal techniques which will prove to be highly economical, easy and beneficial for the waste management and economy generation of the country. The objectives of the paper are: to study the background of the problem regarding the disposal of construction and demolition waste; to device a demolition phase mechanism to carry out demolition in a scientific process so as to reduce the wastage of resources; and to device a policy of scientific disposal that can be applied to every city in country level.

CASE BASED STUDY

History: The reuse and recycling of the construction and demolition waste was first carried out after the Second World War in Germany to tackle large amount of demolition waste caused by the war and simultaneously generate raw material for reconstruction. A number of research studies were carried out in U.S.A, Japan, United Kingdom, Germany etc. for recycling the construction and demolition constituents of waste. In India, work on recycling of aggregates has been done at Central Building Research Institute (CBRI), Roorkee, and Central Road Research Institute (CRRI), New Delhi to stress the importance of recycling construction waste and creating awareness of the problems of quantum of solid waste generation of in our country.

Denmark: The Regulatory framework in Denmark has significantly helped to improve recycling of waste from Construction Industry. The several steps followed are as follows:

- Before demolition of the building, the owner of the structure has to apply for permission by filling in detailed form in which he has to identify each constituent and estimate the quantity likely to arise.
- On-site sorting of potential waste components is done by the competent authorities.
- After demolition takes place, different materials have to be transported separately to different units for its scientific extraction and re-manufacturing process (Like ore extraction process).
- Also, there is a categorisation of the use of waste materials as per their strength and testing.
- While the disposal of waste to landfill sites is taxed at high rates, there is no tax on material sent to recycling.

Netherlands: has developed specifications covering recycled material to be used as aggregate in concrete. Dutch Government has imposed stiff charge on disposal of waste to landfill sites. This charge has risen by seven times since 1988. In the Netherlands the legal framework regarding waste management and Construction & Demolition Waste (CDW) management in particular, is extensively set up. The most important decisions and legislations are:

- It is compulsory that a National Waste Plan is established.
- For the majority of the waste, a landfill ban exists. The tax for landfilling is €13 per tonne.
- Import and export of wastes are highly restricted.
- Currently, an incineration tax is also introduced, in order to decrease the amounts of burned waste.

In the Netherlands, waste management and more specific CDW management are mature. Both an advanced waste management plan and waste prevention plan exist. As mentioned before, over 98% of the CDW is recovered and landfilling CDW is almost non-existent (Deloiite, 2015).

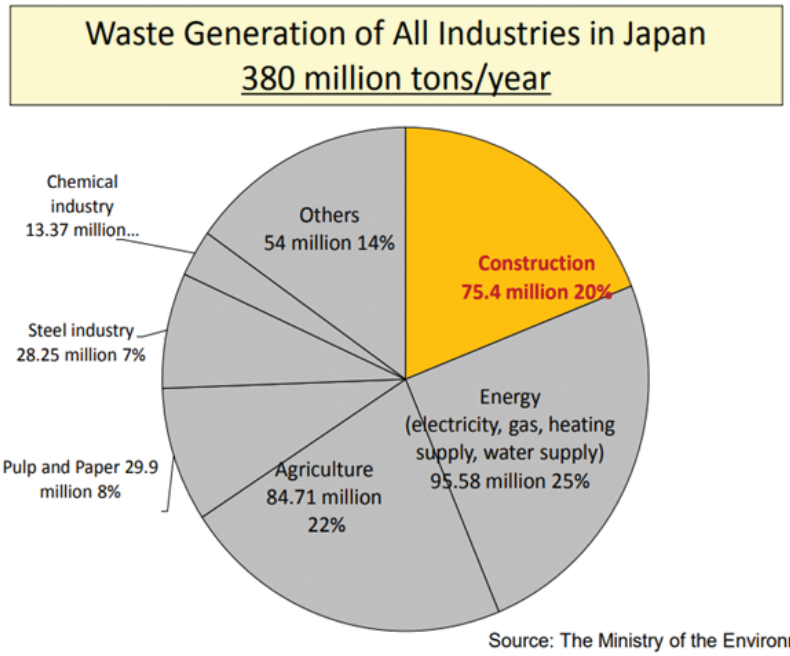
Many governmental entities, building designers, clients, contractors and recyclers are involved in sustainable CDW management. Industry initiatives exist in which buildings or entire districts are built with the use of CDW. Different R&D programs on recycling mono streams from CDW exist.

Japan: After the conclusion of World War II, Japan witnessed the filth and environment degradation because of mass production, consumption and disposal of solid wastes. Japan released an article in 2011 stating that over 20% of its waste production is CDW and stressed on the need of 3Rs. (YONETANI, 2016)

Japan has focussed on the following policies:

a. Construction Waste Management:

Reduce: The use of cast in situ techniques, rather use Precast, Pre-cut autoclaved concrete, on site waste sorting.



Source: The Ministry of the Environment, 2011

Reuse: Construction waste treatment techniques such as crushing, melting etc. treatment by operators, etc

Recycle: Recycling of waste by the manufacturers like Gypsum board, ALC, Glass wool

b. Demolition Waste Management: The demolition waste management phase includes critical stages of segregation and sorting of wastes. The following methodology followed:

- Assessment is essential for determination and proper treatment of hazardous materials.
- Segregation of wastes based on material classification and separate transportation to the respective separation unit.
- Recycling of materials to form raw materials for new products in construction industry.

POLICY LEVEL INTERVENTIONS ON THE SCIENTIFIC DISPOSAL

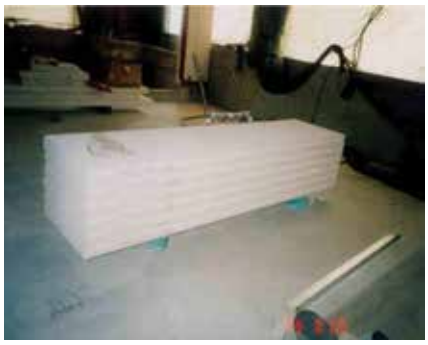
In India as in most of the countries, there is a regulatory phase for the construction/development phase (Development Control Regulations, Building By-laws), for the interim phase (Maintenance/Re-use/Adaptive re-use regulations) and none for the end phase. Demolition is carried out in the most spontaneous and abrupt process available. Therefore, there is need for policy level interventions on CDW, which will mainly focus on the Construction as well as

Table 2: Segregation, treatment and recycling of the waste components

WASTE COMPONENTS	TREATMENT	RECYCLED PRODUCT
Waste Concrete	Crushing	Recycled Concrete Aggregate (RCA)
Waste Asphalt	Crushing/ Melting	Reclaimed Asphalt Pavement (RAP)
Waste Wood	Crushing	Particle Board/ Power Generation
Metal	Crushing/ Melting	Recovered Metal
Cardboard	Melting	Cardboard
Waste Plastic	Melting/ Compression	RPF
Electric Wire	Crushing/ Separation	Copper
Gypsum Board	Crushing/ Separation	Gypsum Board
ALC (Autoclaved Lightweight aerated Concrete)	Crushing	ALC
Mixed Waste	Crushing/ Separation	Recycled/ Landfilled

Source: Central Building Research Institute (CBRI)

Figure 1-2: (Left) Precast concrete, (Right) Pre-cut autoclaved Lightweight aerated concrete (ALC)



Sources: Google images

Demolition Waste Management to complete the phase of cradle to grave cycle in every project, ensuring minimum or no waste generation from its domain to the society.

CONSTRUCTION PHASE WASTE MANAGEMENT

The construction waste management phase looks after the optimisation of building material use so that pre- or post-construction loss of materials are low. Here the main principle to be used from 3Rs is "**Reduce**". Reducing the construction waste from cradle to its construction phase requires treatment of different kind as per the nature of the waste, as given in Table 2.

WASTE COMPONENTS TREATMENT RECYCLED PRODUCT

Typical solutions:

Precast Concrete: Precast concrete solutions for structural and ornamental elements have been extensively used all over the world both for large construction projects such as bridges and stadia, as well as for modest size dwellings. Precast concrete is the most commonly used offsite construction method, precast provides the builders with:

- Quick erection times
- Reduced need for plant on site
- Easier management of construction sites
- Better overall construction quality
- Ideal fit for simple and complex structures

Precast concrete solutions can provide construction elements that are made of recycled materials which generates very small amount of waste through manufacturing and erection phases.

Pre-cut autoclaved Lightweight aerated Concrete (ALC):

Autoclaved aerated concrete (AAC) / Autoclaved lightweight aerated concrete (ALC) is a lightweight, precast, foam concrete building material suitable for producing Concrete masonry unit (CMU) like blocks. Composed of quartz sand, calcined gypsum, lime, cement, water and aluminum powder, AAC products are cured under heat and pressure in an autoclave. Autoclaved aerated concrete (AAC) has been produced for more than 70 years, and it offers several advantages over other cement construction materials, one of the most important being its lower environmental impact.

- Improved thermal efficiency reduces the heating and cooling load in buildings.
- Porous structure gives superior fire resistance.
- Workability allows accurate cutting, which minimizes the generation of solid waste during use.
- Resource efficiency gives it lower environmental impact in all phases of its life cycle, from the processing of raw materials to the disposal of waste.
- Environmentally friendly- It produces at least 30% less solid waste than traditional concrete. There is a decrease of 50% of greenhouse gas emissions.

Policies need to be adopted:

1. Create a manual for methodical disposal of waste (No cost claim) and adding some property tax rebate

scheme to it.

2. Increase the Green credit points for 100% safe disposal of the wastes in the Construction Phase.
3. Contract document with agreement to the Local Municipal Body should be done so that the Government/ Local Body takes care of the demolition and disposal of building materials after the life-cycle of the building gets over.

DEMOLITION PHASE WASTE MANAGEMENT

The demolition waste management phase looks after the in-situ sorting and segregation of building material use so that contamination with the hazardous materials are low. Here the main principles that are to be used from 3Rs are *"Reuse and Recycle"*. Reduction of demolition waste of a building from its cradle to grave requires treatment operations of different kind as per the nature of the waste. The following points should be mandated in the Policy level:

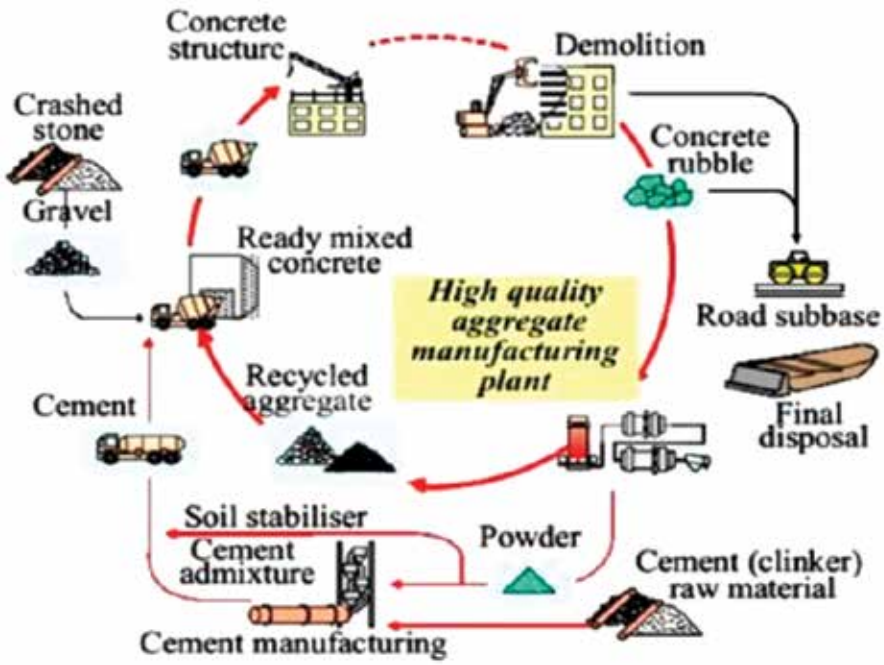
Waste Sorting & assessment: The first and the foremost way of dealing with the demolition waste is the on-site waste sorting and the removal of hazardous materials (Asbestos-containing materials, PCB containing equipment, Freon containing appliances, Mercury in fluorescent lamps) from the

Table 3: Salvage materials from the demolition stage of a project

Architectural salvage	Non-Ferrous Metals	Land clearing residuals
Doors and door frames	Wiring/conduit	Trees, stumps, brush
Windows and frames	Plumbing (pipes, fixtures)	Soil
Millwork	HVAC (ductwork, motors)	**Ferrous Metals**
Furniture and Furnishings	**Asphalt**	Structural steel
Office furniture	**Aggregate**	Steel framing members
Partition systems	Concrete (with & without rebar)	**Porcelain fixtures**
Medical/lab equipment	Brick	Ceiling tiles
Reception/casual furniture	Concrete block	Gypsum Wallboard
Lockers/athletic equipment	Wood	Roofing
Carpeting	Dimensional lumber	Shingles
Broadloom	Panels (plywood, OSB, MDF)	Commercial membrane

Source: Authors

Figure 3: Life cycle of Concrete in a project



Source: Recycling Concrete Debris from Construction and Demolition Waste- Tomas U. Ganiron Jr. Journal - International Journal of Advanced Science and Technology

Figure 4: Recycled concrete aggregates

Figure 5: Recovered copper of electric wires

site. Assessment needs to be done so that the volumetric quantity of the building materials is understood. These processes should be done free of cost by the Local body (if the resident/consumer had signed an agreement in the construction phase of the building).

Reuse: The following table will specify the common salvage materials from the life cycle of any sample project (Table 3).

Recycle: A sample recycling project of Concrete is shown in Figure 3 (full life cycle of concrete).

Recycling by Treatment operators:

- Recycled concrete aggregates (Figure 4)
- Recovered copper of electric wires (figure 5)
- Particleboard made of waste wood
- RPF derived from waste plastic containers

Recycling by manufacturers:

Products like Gypsum boards, ALC, Glass wool are recycled extensively by the manufacturers.

Mixed Waste Processing:

Mixed waste is separated manually and mechanically at the waste processing facility into recyclable/non-recyclable waste. Non-recyclable waste is to be disposed in landfills.

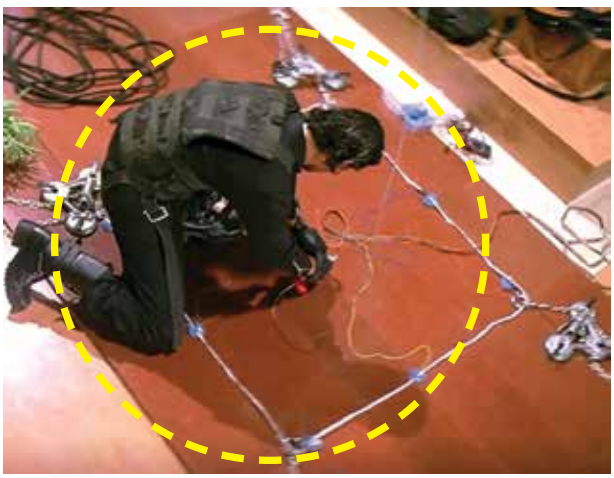
Typical Scientific Solutions: The salvage materials can be reused in some cases if the techniques of demolition used is scientific and neat. Discussed below are two hypothetical scientific methods of demolition:

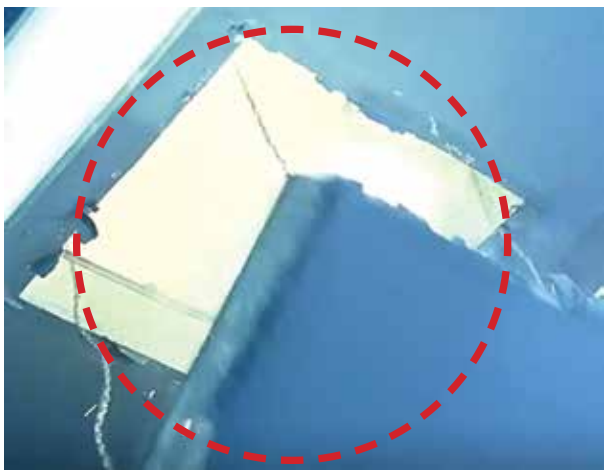
Electromagnetic-Demolition: (Hypothetical concept)

Electromagnets can be made very strong depending upon the number of windings and the quantum of electrical current passing through it and the iron core inside it. The Electromagnets can be used to detach large chunks of walls, slab or a full façade together by the pull of strong electromagnetic fields. Neat cuts with minimum rubble can be obtained in an old and dilapidated structures.

Blasting – Through Circuit:

Figure 6 & 7: Use of circuits and wire mesh with explosives for demolition purposes (Hypothetical concept)





(Hypothetical concept)

This method is shown in many Hollywood movies but the R&D still needs to be done on its practical implementation. It can be used to blast off useful portions of the building so that the sections can be used in totality. For example, slabs, concrete columns, beams are often found to be sound, if the building requires to be demolished and is not of so much age. In this case these sections can be scientifically chopped of without clean bulldozing them. The pictures at Figure 6 & 7 are shown for the purpose of hypothetical reference only.

CONCLUSION

At this age of growing urbanisation, modern innovations play a major role in almost all spheres of our lives. It influences all aspects of our civilisation and thus waste management cannot be left out as it plays a vital role in our daily lives and, in the long run, evening our ecosystem and environment. Proper waste management is essential for the unceasing functionality of our cities and other settlements.This paper presented construction and demolition waste (CDW) as a valuable resource and argued that construction and demolition waste needs to be segregated and recycled in order to conserve energy as well as clear up dump yard spaces. Reusing discarded demolition debris may reduce 20 - 25% of the total waste generated by the country. Thus, it will make a significant impact on the economy of the country, which when tended to, produces many by-products that can be reused in the construction industry. Thus, we want to establish waste management as an integral part of how our cities work and by extension a part of our day to day lives.

As a step forward, recently Delhi has mandated recycled products from construction and demolition (C&D) waste in all future contracts for building works and road works to be taken up by the Delhi government and its agencies. The next step should be a C&D waste policy on improved collection, segregation and handling of waste; decentralised collection and recycling centres; penalty for littering; lower taxes on recycled products and public awareness (CSE, 2015). Developers should be made responsible and accountable for good construction practices, on-site segregation of waste, reuse and disposal; and impose waste tax to minimise waste generation.

REFERENCES

1. Central Pollution Control Board (CPCB 2000), MOEF, India. Retrieved from: http://www.cpcb.delhi.nic.in/index.php
2. Fiksel, J. (2006). A framework for sustainable materials management. J. Mater. 58(8):15-22.
3. Ahluwalia, Patel. (2018). Building from Debris. Construction Materials and C&D Waste in India
4. Deloiite. (2015). Netherlands regulatory waste framework and management of resources
5. TIFAC Reports. (2001). Utilisation of Waste from Construction Industry.
6. YONETANI, H. (2016). Construction and Demolition Waste Management in JAPAN. Japan Federation of Construction Contractors. JAPAN.
7. Raju, P. (2015). Construction and Demolition Waste Management – A Review
8. Appendix 1: Management of C&D waste as aggregate in Denmark. Retrieved from: https://read.nordic-ilibrary.org/environment/end-of-waste-criteria-for-construction-demolition-waste/management-of-c-amp-d-waste-in-denmark_9789289345613-12-en#page1

INTEGRATING URBAN INFORMAL SECTOR FOR SOLID WASTE MANAGEMENT FOR STRENGTHENING URBAN INFORMAL ECONOMY

MS. AMRITA RASTOGI

The informal sector plays an important role in the SWM value chain by recovering valuable materials from waste. It includes both, "kabadi system / scrap dealers" and rag pickers. They help reducing environmental impacts by improving resource recovery and reducing waste quantities. The integration of the informal sector into the formal solid waste management system will contribute to the reduction of the overall SWM costs, provide support to the local recycling industry and create new job opportunities.

Keywords: Informal Sector, Economy, Municipal Solid Waste Management, Recycle, Recovery

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Solid Waste Management has become a major challenge mainly due to the increase in generation of waste, and burden on municipal budget as a result of high costs associated to its management. This paper contributes to a debate on role of informal sector in SWM (Solid Waste Management) by examining the effective outcomes. Informal Sector is active in collection, processing, trading and recycling materials at urban level. The amount of recyclables informally picked out of the MSW stream are unknown, as informal waste workers do not record their activities. This article estimates the existing scenario of informal solid waste management for upgrading the urban informal economy. The informal recovery of recyclables from the solid waste system reduces waste management costs for municipalities, attain recycling objectives and reduce the coverage of landfill area. The inclusion of informal sector will improve resources recovery at initial level. It is also strategic for secured employment opportunities, will help improve the urban informal economy and quality of life of street waste pickers.

INTRODUCTION

Increasing population levels, booming economy, rapid urbanization and the rise in community living standards have greatly accelerated the municipal solid waste generation rate in developing countries. Waste management system (WMS) in most of the cities or growing countries cannot be managed without the informal sector namely; waste pickers, scrap collectors, traders and recyclers etc. Informal sector waste workers as individuals or Small and Micro Enterprises (SMEs) that intervene in waste management, without being registered and without formal existence provide waste management services in door to door collection services within city limits. The facilities are grouped in number of activities such as: collecting, sorting, processing, storing and trading waste materials in the recycling value chain. Tons of municipal waste initially comes via informal channels before being processed through formal channels. Table-1 shows that 15-20% of waste generated is managed by informal sector in SWM in some of the developing countries.

Table 1: SWM recovery in formal & informal Sectors

	BeloHorizonte (Brazil)	Canete (Peru)	Delhi (India)	Dhaka (Bangladesh)	Managua (Nicaragua)	Moshi (Tanzania)	Quezon City (Philippines)
Tons/year (recovered all sectors)	145134	1412	8410	210240	78840	11169	287972
Present recovered (by formal sector)	0.1%	1%	7%	0%	3%	0%	8%
Present recovered (by informal sector)	6.9%	11%	27%	18%	15%	18%	31%

Sources: CWG-GIZ / Scheinberg et al., 2010.

There is a worldwide understanding that the informal sector needs to be integrated with the formal sector for MSW management system. Poor informal settlements support municipalities in cost efficient management of MSW as well as in providng labour who work in MSW.

The main aim of this paper is to determine the significant share of Solid Waste Management in urban informal economy at ULBs level, which is fully integrated with participation of informal sector. The paper proposes a waste management system which is also a good source of economy generation at urban informal stage.

SCENARIO IN INDIAN ULBs

In India 12 million tonnes of inert wastes is generated from street sweeping and C&D (Construction and Demolition) and in the landfill sites, which is about 1/3rd portion of the total MSW (Basu/CSE, 2019). MSWM is governed by Municipal Waste Management Rules, 2016 (MSWM) and its implementation at city level is the responsibility of the ULBs across the India. Public private partnership (PPP) mode implementation usually happens at ground level when neither public services nor private sector can achieve their respective goals and aspirations of stakeholders. MSWM appears to be suitable case for PPP mode for Indian scenario as ULBs alone are not capable to accomplish the task assigned as per MSWM. An amount of USD 5 billion annually is required to provide adequate MSWM services to Indian Cities (Ahmed, 2016) and this level of finance can be met through PPP mode to address MSWM-related challenges. Most of the recyclable waste is collected by the informal sector for the purpose of recycling. Amount of their recyclables collection are generally not accounted. This research article estimates that 21% of recyclables collected formally are separated by the formal sector at transfer station and dumps.

Metros and other big cities in India collect between 70-90% of their MSW. Smaller cities and towns collect less than 50%. The benchmark for collecting MSW is 100%, which is one of the most important targets for ULBs at current. The average per capita waste generated in India is 370 grams per day as compared to 2,200 grams in Denmark, 2,000 grams in US and 700 grams in China. Waste generation rate in Indian cities ranges between 200-870 grams per day, depending upon the region's lifestyle and the size of the city. The per capita waste generation is increasing by around 1.3% per year in India (CPHEEO, 2014).

Table 2 describes the highest and lowest waste generation among metro cities, class 1 cities, States, UTs and North, East, West, South regions of India.

INTEGRATION OF INFORMAL SECTOR

An implication of the comprehensive understanding of ISWM is that it will involve various stakeholders – going far beyond a merely public task for the ULB. Important groups include the private Municipal Solid Waste Management Plan. The informal sector plays an important role in the SWM value chain by recovering valuable materials from waste. It includes both, "kabadi system / scrap dealers" and rag pickers. They help reducing environmental impacts by improving resource recovery and reducing waste quantities for disposal. The integration of the informal

Table 2: Highest and lowest waste generation rates in India.

Category	City/Value	Waste Generation (TPD)		Per Capita Waste Generation (kg/day)	
		Low	High	Low	High
Metros	City	G.Bengaluru	G.Kolkata	G.Bengaluru	Chennai
	Value	3344	11520	0.445	0.708
Class 1 Cities	City	Rajkot	Pune	Nashik	Kochi
	Value	317	2602	0.127	0.765
All Cities	City	Kavarati	Kolkata	Kohima	Port Blair
	Value	5	11520	0.194	0.867
States	City	Arunachal Pradesh	Maharashtra	Manipur	Goa
	Value	19	23647	0.217	0.616
Union Territories (UT)	City	Lakshadweep	Delhi	Lakshadweep	Andaman & Nicobar
	Value	5	11558	0.342	0.867
Regions	Region	East	West	East	West
	Value	696	88800	0.382	0.531

Sources: Department of Economics Affairs, Ministry of Finance, 2009

sector into the formal solid waste management system through RWAs, CBOs, NGOs, SHGs and private sector will contribute to the reduction of the overall SWM costs, provide support to the local recycling industry and create new job opportunities.

Options for enabling conditions and supportive actions for informal sector involvement could include the following:

1. Organization of informal sector workers into legally recognized, membership-based associations and their reflection in relevant policy decisions;
2. Official recognition of these informal associations as viable partner organizations for SWM service delivery;
3. Motivating private sector / NGOs/ SHGs to involve these informal associations in SWM service delivery by upgrading them from being waste / rag pickers on streets to waste collectors from source;
4. Promotion of schemes to provide social security and health benefits to members of these associations;
5. Providing low-interest loans to organizations of waste pickers seeking to bid for tenders and contracts;
6. Providing incentives to encourage participation of informal sector associations through excise and tax exemptions and other fiscal concessions;
7. Giving priority to these associations in taking up small contracts of waste collection and small-scale processing as informal sector enterprises;
8. Reserving land in development plans for decentralized processing of bio-degradable wastes, and for setting up material recovery facilities; and
9. Supporting capacity development programmes for informal sector associations catering to the special needs of women.

GOVERNMENT INITIATIVES

The policy frameworks and regulations for Waste management in India are given by the Ministry of Environment and Forest and Climate Change (MoEFCC), the Ministry of Housing and Urban Affairs (MoHUA), the National Environmental Engineering Research Institute (NEERI), CPCB and State Pollution Control

Boards (SPCBs) and ground level implementation responsibility lies with ULBs. E-Waste Management and Handling Rules of 2011 are applicable to stakeholders associated with the manufacturing, handling, utilizing, processing, and recycling electrical and electronic-related waste items. The role of informal sector in recycling resources was recognized in the last Plastic Waste Rules, 2015 (Management and Handling) that were regulated by the Ministry of Environment and Forest & Climate Change (MoEFCC) and again amendment came in 2018. These rules make ULBs responsible for coordination of all management, including waste pickers. Regulations of this nature are essential in inching towards sustainable waste management and must support in the form of relevant policy modifications at the National level. If the informal sector is institutionalized, then the issues of unreliability can be observed. There is an example of Hyderabad, where the contracts were awarded to organized groups of informal waste pickers and workers. Also, employing Self Help Groups (SHGs) of waste pickers in door to door collection has proven successful nationwide; individuals in these groups have much healthier working conditions compared to those operating without SHGs.

SUGGESTIVE INTERVENTIONS BY THE GOVERNMENT

For better management of solid waste in India through informal sector stakeholders, the following suggestions for appropriate governmental intervention may be considered:

1. Pilot project should be initiated to check reliability of informal stakeholders as partners in official waste management system;
2. Govt. should support and encourage the private companies to recognize the value of using recyclable materials and working with informal sector, thus increasing resource recovery from waste;
3. It should be mandatory to layout the strategic framework which includes informal sector in achieving 'zero waste goal' thus supporting sustainable development of the city with up-grading the urban economy;
4. Political measures at local and national level should be taken to include recycling targets for ULBs or service providers, regulations about contracting organized recyclers etc.;
5. Govt. should influence by the formation of official organizations like co-operatives, companies franchising systems with registered waste collectors etc. and giving formal acknowledgment in order to include informal stakeholders in official SWM system; and
6. Govt. should work to improve social credit of waste recovery events by communication campaigns, partnerships with NGOs and SHGs, other actors to accompany informal stakeholders.

CONCLUSION

It can be concluded that a significant share of SWM (Solid Waste Management) involves the informal sector which gives a growth impetus to urban informal economy. The MSWM system is dependent, inter alia, on a well-planned implementation of the concept of 3Rs, and involvement of the informal sector. ULBs need to chart out well-defined strategies for waste minimization, recovery and segregation involving the informal sector directly or through RWAs/CBOs/NGOs or the private sector. The success of informal recycling in India depends upon leveraging its advantages. The formalization of this sector would help in achieving better resource recovery and much higher growth in urban local economy. This will also increase the opportunities for private companies, which can participate in MSWM, as well as help the informal workers' organizations for better orientation towards economic sustainability.

REFERENCES

Ahmed, R. J. (2016). Status and challenges of municipal solid waste management in India: A review. Cogent Environmental Science , http://dx.doi.org/10.1080/23311843.2016.1139434.

Ar. Raunak Prasad, A. R. (2018). Integrating the informal sectro solid waste management . Urban Panorama , Vol. XVII Jan-June, 71-80.

Basu/CSE, A. (2019). India's challenges in waste management . CSE, New Delhi : Down to Earth, CSE.

CPHEEO. (2014). Municipal Solid Waste Managemnent Mannual, MoUD. Delhi: http://moud.gov.in,GERMAN INTERNATIONAL COOPERATION.

India, C. o. (2001, 2011). Census of India . N.Delhi : Govt. of India.

P.U.Asnani. (2009). PPP in Solid Waste Management. Department of Economic Affairs, 1-70.

Rémi de Bercegol, J. C. (11 December 2017). Waste Municipal Service and Informal Recycling Sector in Fast-Growing Asian Cities: Co-Existence, Opposition or Integration? www.mdpi.com/journal/resources, Resources 2017, 6, 70; doi:10.3390/resources6040070.

PRIME MINISTER'S SCIENCE, TECHNOLOGY AND INNOVATION ADVISORY COUNCIL(PM-STIAC)

Union Government has constituted a 21-member advisory panel on science, technology and innovation called Prime Minister's Science, Technology and Innovation Advisory Council, headed by Principal Scientific Advisor to government K. Vijay Raghavan. It replaced earlier Scientific Advisory Committee to Prime Minister and to Cabinet. Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC) is an overarching Council that facilitates the PSA's Office to assess the status in specific science and technology domains, comprehend challenges in hand, formulate specific interventions, develop a futuristic roadmap and advise the Prime Minister accordingly. The Council will advise the PM on science, technology, as well as innovation but also coordinate implementation of PM's scientific vision. It will actively aid in formulation and timely implementation of major science and technology missions and evolve interdisciplinary technology development programmes. It also advises government on developing 'Clusters of Excellence' in science including city-based R&D clusters. It works to bring together all science and technology partners from academia and institutes to industries near such centres or cities. There are nine missions of the PMSTIAC, including one on waste to wealth. The nine missions of the PM-STIAC include:Natural Language Translation, Electric Vehicles, Artificial Intelligence, National Biodiversity Mission, Quantum Frontier, Bio-Science for Human Health , Deep Ocean Exploration, AGNIi (Accelerating Growth of New India's Innovations) and Waste to Wealth.

WASTE TO WEALTH MISSION

The Objective of the mission is to identify, develop and deploy technologies to treat waste to generate energy, recycle materials, and extract resources of value. The mission will also work to identify and support the development of new technologies that promise to create a clean and green environment. The mission will assist and augment the Swachh Bharat and Smart Cities projects by leveraging science, technology and innovation to create circular economic models that are financially viable for waste management to streamline waste handling in the country.

The Lead Partners are: Department of Biotechnology, Department of Science and Technology, Ministry of Environment, Forest and Climate Change, Ministry of Electronics and Information Technology and the Swachh Bharat Abhiyan.

Expert Opinion of Dr. Bindeshwar Pathak on

SANITATION AND WASTE MANAGEMENT

Dr. Bindeshwar Pathak, Sanitation Crusader, has made contribution for solving problems of open defecation, removal of inhuman practice of manual scavenging associated with untouchability, by inventing appropriate, affordable, technology for household toilets with minimum water use dispensing manual scavenging and maintaining 9000 self-sustaining 'pay and use' based public toilets attached with excreta based biogas plants linked to Sulabh Effluent Treatment (SET) device and constructing 1.5 million household toilets and thereby liberating most of 10 lac scavengers and integrating stakeholders viz. Government, NGOs and Users. At instance of Supreme Court he has ameliorated widows' living conditions. Awarded Padma Bhushan in 1991 by Government of India, The International Saint Francis Prize for the Environment "Canticle of All Creatures" at Assisi, Italy, Global 500 Roll of Honour Award by UNEP at Beirut (Lebanon), Scroll of Honour by UN-Habitat at Rio-de-Janeiro (Brazil), Stockholm Water Prize and LEGENDE DE LA PLANETE Congres Fondateur Jeux Ecologiques at UNESCO, Paris.

Ranked by The Economist amongst the World's Top 50 diversity figures in public life along with US President Barack Obama, Angelina Jolie and Bill Gates (November 2015).New York Global Leaders Humanitarian Award was conferred to Dr. Pathak in April 2016 at New York. Mr. Bill De Blasio, Mayor of the City of New York, declared April 14, 2016 as DR. BINDESHWAR PATHAK DAY. Dr. Pathak received the 'Gandhi Peace Prize-2016' from the Hon'ble President of India, Shri Ram Nath Kovind at Rashtrapati Bhawan, New Delhi on February 26, 2019, in the presence of Hon'ble Prime Minister Shri Narendra Modi. 'Gandhi Peace Prize' recognizes the contribution of Sulabh International Social Service Organisation in improving the condition of sanitation in India and emancipation of manual scavengers.

Q. The World Habitat Day this year is being celebrated worldwide with the theme of 'Frontier Technologies as an Innovative Tool for Waste to Wealth'. In this context, please shed some light on the Sanitation and Waste generation scenario in our country.

Sanitation is an essential factor for healthy life and aesthetic living. When I came to this sector in 1968, the situation was quite vulnerable. The prevalent methods of human waste management were either very expensive or not safe from environment and health points of view. There was need for an appropriate technology, which could fit into our socio-cultural and financial framework.

Existence of sewerage system was few and far between (partial sewerage in 723 cities out of 7935 cities and towns). The available funds and the per capita water use required for a sewer line along with proper treatment in a sewage treatment plant was not available with most of our local bodies. People with money could build a septic tank in their houses but its proper design, desludging arrangement etc. were crucial issues, which inconvenienced people. Properly designed septic tank should have a secondary treatment facility in the form of UAF (up-flow anaerobic filter) or at least soak pits. In the absence of a hygienic system of desludging, the job was done manually, which was a big health risk for the workers and below human dignity.

After studying the situation and the alternatives available in those days, I developed an appropriate system called 'Sulabh Shauchalaya', meaning a toilet which is affordable and available. This is environment friendly and hygienic composting toilet with two leaching pits. One of the pits is used at a time and the other remains closed to the flow of human waste. Each pit is designed for a minimum period of 3 years. When the pit under use is filled, the connecting channel is closed and the other pit is opened to the flow. The filled pit is allowed to get stabilized for 2 years. The gases are absorbed / dispersed in the adjoining soil so that there is no requirement of a vent pipe. Consequently, there is no odour and additionally it has a positive impact on global warming.

After 2 years, the pit is opened to take out the stabilized material which is a rich organic manure preferably during the dry seasons. The material inside the pit becomes pathogen free in about one year but we give a safety margin of 100% and allow the material to be stabilized for two years. Therefore, members of the household can do the job themselves so that there is no need to call someone from outside to empty the pit. This way dignity of labour and human dignity – both are maintained.

'Sulabh Shauchalaya' has a brilliant track record in cold climate. In the winter of year 1984, Srinagar had a temperature of -14°C when the sewerage system and septic tanks became non-functional as they were frozen. However, about one thousand 'Sulabh Shauchalaya', constructed in Srinagar (1980-'84) were perfectly functional. As an appropriate technology with so many attributes, 'Sulabh Magic Toilet' would be an apt name. It is a frontier technology for on-site sanitation and my work has brought about a paradigm shift.

Q. **What, in your opinion, is the progress achieved through the Government of India Urban Transformative Missions such as Swachh Bharat Mission, Smart Cities Mission, etc. towards addressing the problem of inadequate sanitation and waste management in urban India?**

Swachh Bharat Mission (SBM) has brought in a big push in the sanitation sector. The keen interest and involvement of the hon'ble Prime Minister has given huge strength and direction to projects like SBM, AMRUT and Smart Cities Mission. The resultant progress is remarkable. There has been a quantum jump in construction of toilets. 2nd October, 2019 is going to be a landmark date in the sanitation history of India.

Q. **Sulabh International is actively engaged in improving the sanitation culture in India. Could you please elaborate your organisations involvement and future roadmap for improving the sanitation sector in India?**

This is a very pertinent question for our involvement in the sanitation sector. Our involvement can be fathomed by our principle of approaching and working on the issue. I have thought of a very systematic approach which has been termed as 'PRISACA', which is the essence of our working philosophy and methodology.

My PRISACA theory:

P – Problem

R – Research

I – Invention

S – Strategy

A – Action

C – Collaboration

A – Appreciation

We have had support and collaboration of WHO, DANIDA, UN-HABITAT,

AIIH&PH (All India Institute of Hygiene and Public Health) which has helped in popularizing 'Sulabh Shauchalya' throughout India and in other countries.

We would like to see the whole of India as a clean, hygienic, healthy and environment friendly country, which means each household, whether in urban or rural area, will have access to potable water and safe hygienic toilet, each public place will have clean and comfortable public conveniences and each slum will have access to potable water and safe hygienic toilet / community toilet.

Q. How is Sulabh International supporting the Government of India flagship Missions such as 'Swachh Bharat Mission'?

This is a great opportunity for the sector and we are moving full throttle for construction of household toilets (Sulabh Shauchalaya) and public toilet complexes (Sulabh toilet complex). We have launched a massive campaign for weeding out 'single use plastic'. Across India our branches and offices are carrying out door to door campaign and processions. We do hope with the push from the Prime Minister, the hitherto 'laid back attitude' would be replaced by a strong positive movement for drastically reducing single use plastic items.

Q. What are the traditionally practiced methods in our culture which maybe incorporated in the frontier technologies and innovative tools for sanitation and waste utilization?

Traditionally Indians believe in personal cleanliness. This mindset has a direct relationship with sanitation. For more than a decade, 'WASH' campaign has got a lot of attention and support. In Sulabh, we have gone several steps further. We have started 'clean body campaign', wherein the emphasis is on the whole body from head to toe for overall health and wellbeing. This campaign has been effective in changing the mindset of children in our schools and in turn becoming healthier.

In case of waste management, traditionally we practice thrift. We practice and teach our children to be aware about consumption on the principles of 'simple living and high thinking'. Use of old items and material has been there including bartering through scrap chain merchants. In fact, in the industrialized countries it is getting introduced in many places during the last one decade. Carrying cloth bags is not new to us. Many of the modern campaigns were embedded in our culture and practice.

Q. Community mobilization for adopting sustainable practices is considered essential for greater outreach to villages and remote areas. What governance structure would you recommend for adopting this approach?

Education, communication, motivation, training and follow-up are essential for making a project sustainable. The planning, designing and implementation must be done appropriately for success of a project. To me it appears that NGOs are the best suited for this task as they can build the bridge between the Government programs and the beneficiary.

Q. World Toilet Day is being celebrated worldwide on 19th November, which is about taking action to ensure everyone has a safe toilet by 2030. Do you see India achieving the SDG 6 targets on sanitation and SDG 12 targets on Waste management?

I am very hopeful on this. I do believe that with the kind of emphasis and mega programs from the Central

and the state Governments, both SDG 6 for clean water and sanitation and SDG 12 for responsible consumption and production should be able to close in on the targets. Additionally, there is a lot of emphasis and programs for 'Resource Efficiency' which would have synergistic effect on waste management.

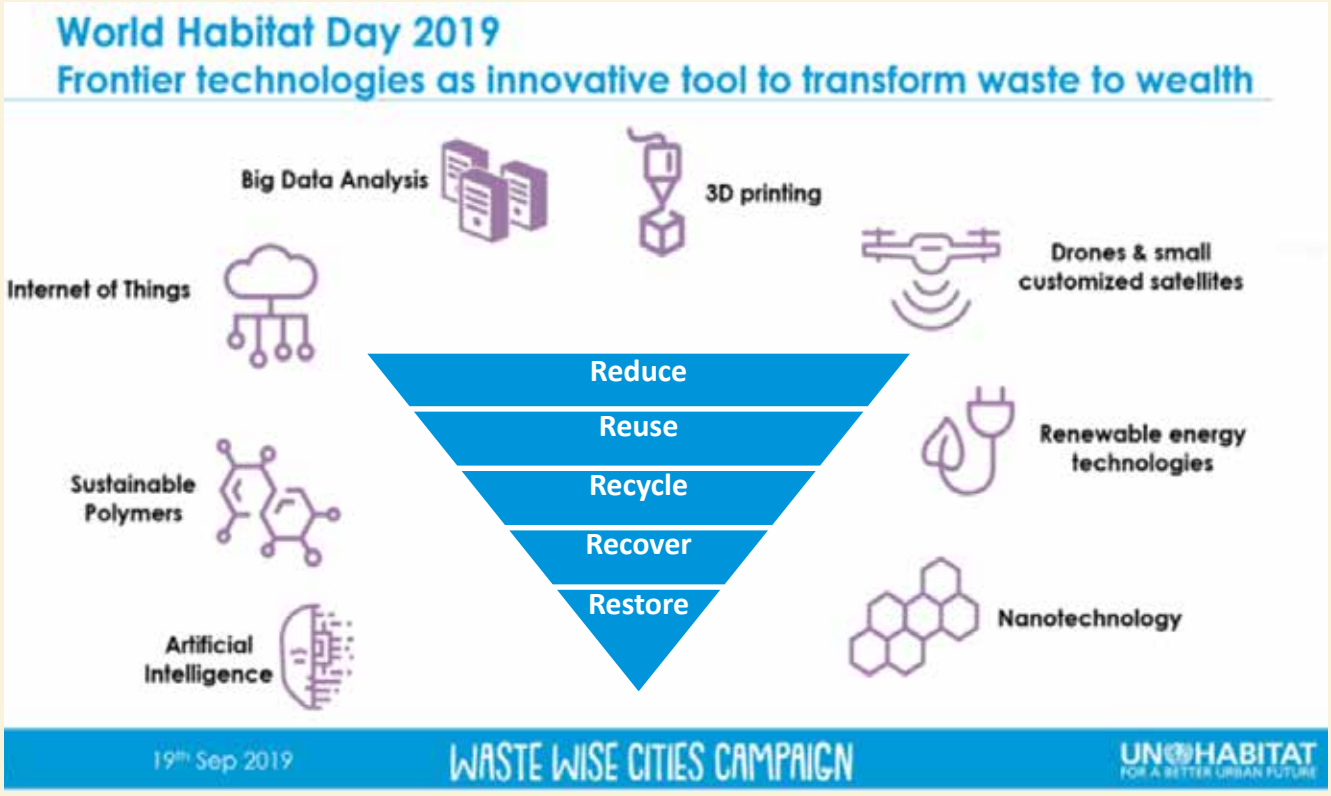
Q. What, in your opinion, are the key changes required to improve Sanitation and Waste management in India?

To answer this question, I would again like to flag 'maintenance' and 'follow up'. These must be accompanied by stakeholder involvement, awareness generation and capacity building.

Q. What should be the focus of future efforts in Sanitation and Waste management in India?

My brief and emphatic reply is comprehensive planning for water and sanitation as they are deeply linked and also for waste management as per ground situation. The next prescription is a repetition – proper implementation and follow up.

UN HABITAT WASTE WISE CITIES CAMPAIGN- FRONTIER TECHNOLOGIES



Source: UN Habitat Webinar held on 19th September 2019

INTRA-CITY MODELS FOR DECENTRALISED WASTE MANAGEMENT

DR. K.K. PANDEY

Karnataka High Court (KHC) and BBMP city have adopted a decentralized system of waste covering Dry Waste Collection Centres (DWCC) for each of the wards (198) and seven compost plants for wet waste. KHC has constituted a committee of experts to coordinate with stakeholders to achieve goals of segregation and also instructed BBMP to constitute ward committees and requested them to prepare micro plan for 750-1000 households within the ward.

Key Words: 4R, Ground Souring for Waste Management, composting Santhe, Suchi Mitra App, waste processing, BBMP

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This paper presents a typology of intra-city models/user friendly technology for waste management in the overall context of safe environment, quality of life, poverty alleviation and sustainability. It is noted that decentralized management is emerging as a successful tool to minimize quantum of waste and achieve the status of 4R (reduce, recycle, reuse and make it a resource).

INTRODUCTION

Solid Waste Management (SWM) in a decentralized manner assumes special significance in the context of UN Sustainable Development Goals (UNSDG) particularly SWM is linked to five goals[i]. Accordingly, the theme for 2019 for Habitat Day is devoted to Frontier Technologies as an innovative tool to Transform Waste to Wealth. Despite remarkable success on clean India Mission during last five years, the scope for improvement is fairly wide. Ninety two percent wards have achieved D2D (Door to Door) Collection, yet, only 56 percent garbage is treated[ii]. All the garbage treated is not scientifically done and leads to contamination of land or pollution of rivers and lakes[iii]. This also leads to piling up of garbage sites and issues of NIMBY (Not in My Backyard). Further, compost prepared from unsegregated garbage has relatively lower demand from market. It is also noted that as against the installed capacity of 15 lakh tons, the waste to compost generation is only 5 lakh tons per annum. Further, the quantity of compost sold is stated to be only 2 lakh tons. Waste management, therefore, has issues of collection, segregation, composting and other appropriate treatment.

It is widely believed that such a large amount of gap in the solid waste management cannot be attended by a city-wide centralized high cost-high tech approach. It can be attended through a wider application of decentralisation to use full potential of 4R- reduce, reuse, recycle and (make it a) resource.

INTRA-CITY MODELS: BENGALURU

The city of Bengaluru ranked at number three in terms of most populous cities in India, with estimated population of 10.21 Million (1,02,07,063) persons in 2017[iv]. It has eight zones (3 in erstwhile municipal area and 5 zones covering extended areas)

and 198 wards. The Bruhat Bengaluru Mahanagar Palike (BBMP) is the city municipal corporation responsible for urban services except for water and sewage which are handled by Bengaluru Water Supply and Sewage Board (BWSSB). As per city government estimates 5760 tons of solid waste is generated daily covering 64% wet waste whereas 28% waste includes dry waste and 8% reject/inert and domestic hazardous waste[v] .

As elsewhere in India, the city had a centralized and conventional system of collection and disposal of waste. However, due to emerging focus on urban governance and stakeholder coordination covering civil society and Hon'ble court of laws, Karnataka High Court (KHC) and BBMP city have adopted a decentralized system of waste covering Dry Waste Collection Centres (DWCC) for each of the wards (198) and seven compost plants for wet waste[vi]. (Box 1) KHC has constituted a committee of experts to coordinate with stakeholders to achieve goals of segregation and also instructed BBMP to constitute ward committees and requested them to prepare micro plan for 750-1000 households within the ward. On the request of Honorable High Court, the ward committees are functioning in the city and prepared micro plan to collect and treat solid waste locally.

Box 1
Civil Society Activism and Court Intervention/Protection

As a result of civil society activism and protection /direction by Hon'ble Karnataka High Court (KHC) the city has achieved distinction to become first or initial example in India (i) To constitute ward committees in December, 2018 with clear agenda to prepare micro plan for 750-1000 household and slum waste process within the households RWA/ward itself; (ii) To implement Segregation at Source through 3 way Segregation of Wet: Dry: Sanitary waste; (iii) City to have state of the art SWM Plants having a processing capacity of 2300 TPD; (iv) City to set up 198 Dry Waste Collection centres (DWCCs) showing a participatory method of operation, (v) The First City to identify Bulk Generators and the system of Empanelled Destinations/ Service Providers; (vi) Ward Level Composting and Bio methanisation, Leaf Shredder facilities and leaf composting with the goal of minimizing long distance secondary transportation; (vii) The First State to ban the Single Use Plastic, (viii) enumerate and issue ID cards to 7500 Waste Pickers and further integrate them into SWM by entering into a direct MOU with them for operation of the DWCCs; and (ix) The installation of Bio filters in the Composting Plant .

Expert Committee

Civil Society Activism and Cognizance by Court of Law on Solid Waste related issues in Bengaluru is fairly high. Successive PIL (Public Interest Litigations) or suo-moto cognizance by Honorable Court of Law have effectively engaged BBMP and other stakeholders to initiate follow up. Hon'ble Karnataka High Court (KHC) in 2012 appointed a twelve-member committee of experts to monitor, handhold, guide, SWM operations in the city. The members include functionaries of Pollution Control Boards, Civil Society and other stakeholders. The committee since then has effectively engaged stakeholders and monitored SWM activities at different levels of operations. The committee members have a close coordination with municipal leadership and are also active on a couple of WhatsApp groups to engage community through a systematic network of local leaders and municipal functionaries.

Hon'ble High Court on a PIL dated 07 December, 2015 instructed BBMP to implement segregation at source by individual HHs (Households) and Bulk generators (RWA's, Societies, Institutional Housing, Commercial Establishments etc.). The Hon'ble Court inspected landfill sites, DWCC (Dry Waste Collection Centre) and observed the need to Reduce, Reuse and Recycle waste so that quantity of final disposal is minimized.
Accordingly, it was suggested two bins and one bag approach whereas Green Bag is for wet waste, Blue bin/ bag is for dry waste and Red bin for hazardous waste. It is noted recently that two lakh households have adopted the approach and are also processing the wet waste locally either individually or at neighbourhood level. (refer to 2bag1bin. in) This has saved 180 tons of waste from city level collection, transportation processing network. Further it is recently informed by BBMP in October 2017 that nearly 40 percent of city garbage is segregated at source.

In addition, efforts have also been made to further decentralize disposal of kitchen waste through local treatment at different levels and technological options. Individual households are encouraged to treat wet waste within house or neighborhood through Resident Welfare Association or society. The city also has 9 Biomethanisation plants for kitchen waste. These are producing gas converted to electricity for street lighting in surrounding areas. Four other such plants are under construction[vii] . As per BBMP, these efforts have reduced the quantum of solid waste to the tune of 1000 tons per day.

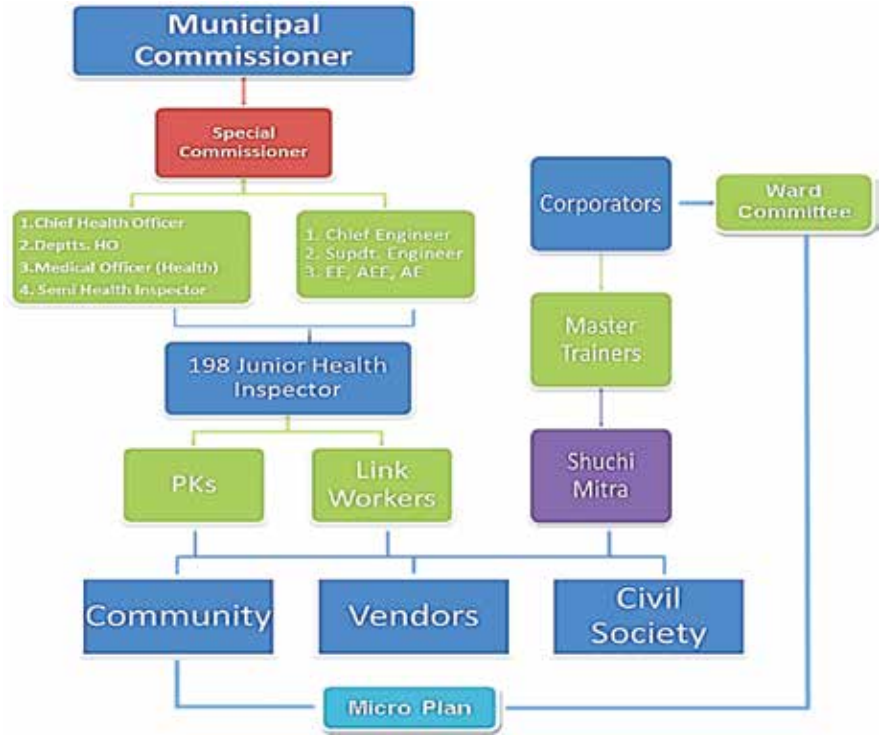
Institutional Frame work for Stakeholder Convergence & Synergy

As a result of support from multiple stakeholders and directions from Hon'ble High Court, BBMP has developed a systematic institutional frame-work for SWM covering SMW cell under the leadership of Special/Joint Commissioner to effectively coordinate the activities under Solid Waste Management (Chart I). The Cell monitors the activities of BBMP team and its coordination with civil society.

Community Interface and Convergence

In order to diversify the complex system of waste collection, the BBMP has established a close association with local community in the form of a bottom-up support from 'Suchi Mitra' (Community Volunteers) selected from community and Master Trainers selected from Suchi Mitras who monitor/ supervise the SWM activities from community side and establish links with the municipal system, contractors, vendors and also political leadership (28 MLAs, 68 Corporators, etc. and Members of Parliament) and civil society. BBMP has also decided to deploy Marshals to check littering in the public places. Marshals are already deployed among 174 wards to check literers and monitor sanitation workers and garbage tippers. They have collected 3.74 lakh as fine from 1 to 10 September 2019[viii]. In addition, expert committee set up by Hon'ble KHC since 2013 is acting as a driving force to have optimum community interface and convergence. Further, the ward committees have prepared micro plan for waste management.

Chart I- Municipal System for SWM



TYPOLOGY OF INTRA-CITY MODELS

The successive initiatives applied in the city present a typology of innovations at different levels of application. Specific initiatives cover: (i) City Scale/ Zonal/ Inter-ward; (ii) Ward / Community level Initiatives; and (iii) Household level Initiatives.

City Scale/Zonal/Inter-ward Initiatives

The city level activities include policy formulation & planning for the entire city region/inter-ward management, awareness campaign, monitoring system, exposure to Municipal Team and Handholding of stakeholders. This includes BBMP cell and communication network/WhatsApp groups and Composting Santhe (fair).

Dedicated cell and Communication Network

(i) A dedicated cell has been established to attend to solid waste of city under the supervision of Special/ Joint Commissioner.

The cell has municipal staff from health and engineering at different levels of experience & expertise (Chart 1).

(ii) A dedicated link is given in the BBMP homepage which provides necessary information on waste management in the city website . The website has three specific links namely (i) Citizen Services (view zone/ward wise SWM information & facilities) (ii) Departments; and (iii) Vendor (Unit/ward and delivery reports). There is a dedicated SWM link in the BBMP website which covers (i) data available to public, (ii) data entry on processing & (iii) progress report. This link also has clean Bengaluru App, Suchi Mitra App, Backend Dash Board and Suchi Mitra Reporting. These Apps and other applications have a regular update on follow up at grass-root level (Box-2).

(iii) The city level Apps, Bengaluru Eco Team (BET) and Composting Santhe Vendors (CSV) have shown appreciable outreach in terms of engaging expert committee Members, Vendors and Civil Society along with senior and middle level Municipal Functionaries. These Apps have shown tangible results in the form of local treatment of waste, plastic seizure etc.

(iv) Community is engaged through registration of Suchi Mitra (Friends of Sanitation) and identification of Master Trainers who represent forward looking community volunteers covering professionals, teachers, volunteers /suchi mitra.

(v) Capacity Building of Suchi Mitra and Master Trainers is done through ID (Identity)-Cards and training about their potential role. Master Trainers have backward and forward linkages upon their training to impart training for specific exposure to Suchi Mitra, Pourakarmiskas and link workers. They also interact and establish mutual feedback among community, civil society and political leaders as well as municipal functionaries from SWM cell.

(vi) City schools are contacted to provide necessary awareness and maintain segregation at source to adopt the practice and demonstrate the follow-up. This includes larger awareness among children about SBM.

(vii) Specific circulars and publications are issued to educate stakeholders about their role and responsibilities.

(viii) Bulk generators having 50 DUs (Dwelling Units) and more are identified to segregate garbage at source and also encouraged to process the wet waste or both wherever feasible. Similarly, bulk producers with >10kg of garbage are identified to segregate at source. These include Hotels, Cinema Halls, Petrol Pumps, and Markets etc.

(ix) Plastic ban covering use of plastic (>40 micron) is enforced since 2013 and penalty is being levied by Link Workers/Suchi Mitras. A sum of Rs. 52 lakh were collected since inception up to June 2016. Similarly, penalty is charged on non-segregation by bulk generators (reported to be Rs. 62 Lakh by 21.06.2016).

(x) Vendors are identified, listed and contacted to provide necessary service in different areas of collection and processing of SW.

(xi) City level Whatsapp groups with Joint Commissioners (MSW)/ Chief Engineer on board are formed to engage

stakeholders for more effective implementation.

(xii) These WhatsApp groups include (a) City level stakeholder group such as 'Bangalore Eco Team', (b) city level vendor interface group such as Composting Santhe Vendors, (c) Festival waste management group as per major festival arriving in due course and (d) zonal level stakeholder groups such as Yelahanka Eco Group (YEG) and (e) grass roots municipal employees/ workers group such as Yelahanka MC Group (Box 2 and Chart II).

Figure 1: Pamphlet for Santhe, Bangaluru

(xiii) These city level groups have yielded positive results in terms of engagement, support, motivation guidance and handholding of stakeholders. They have successfully contacted couple of bulk generators such as police department for segregation of garbage for more than 7000 flats. In the month of July, 2017 the city and zonal level WhatsApp groups (members) have also contacted CRPF (Central Reserve Police Force) colony to ensure follow-up. Similarly, plastic

Box 2
WhatsApp Group/Crowdsourcing for Waste Management

BBMP is successfully using social media/cloud sourcing to engage stakeholders to share information and experience to monitor the progress and expedite the implementation of waste management plan in a participatory manner. It has initiated city level Apps and zonal level Apps to address respective issues and target groups.

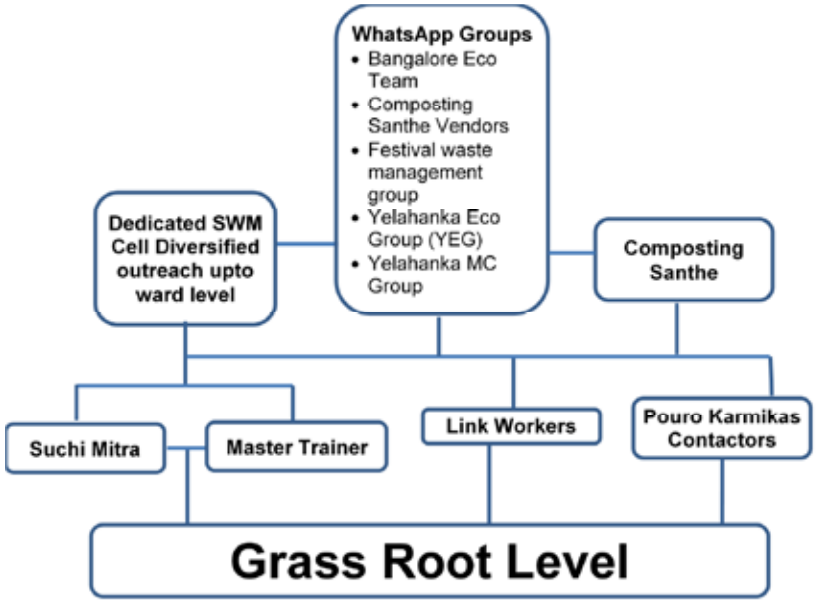
There is a dedicated SWM link in the BBMP website which covers (i) data available to public, (ii) data entry on processing & (iii) progress report. This link also has clean Bengaluru App, Suchi Mitra App, Backend Dash Board and Suchi Mitra Reporting. These APPs and other applications have a regular update on follow up at grass-root level.

The city has a website (http://bbmp.gov.in/BBMPSWM/Forms/Home.aspx) and city level Apps namely Bangalore Eco Team (BET), Ramzan Waste Management (RWM), converting into Ganesha/Diwali Fest Management (GFM) after Ramzan is over, Composting Santhe Venders (CSV) whereas ward/zonal level Apps cover applications within respective wards. One of the front running zone is Yelahanka which has Yelahanka MC Group, Yelahanka Eco Group (YEG). The zonal level group YMCG and YEG etc. include Suchi Mitra, Link Workers, Master Trainers and others senior officers.

The city level Apps have shown appreciable outreach in terms of engaging expert committee Members, Vendors, Civil Society and community along with senior and middle level Municipal Functionaries. Tangible results are observed in the form of plastic seizure, reporting on garbage dump and exchange of information on technology innovations on segregation and treatment at HH (Household) or local level.

Source: BBMP

Chart II; WhatsApp groups and BBMP outreach for Decentralised SWM



free Ramzan feast was organized during the festival.

(xiv) Another city scale innovation, which is taken up at ward level on rotation, is the organization of composting Santhe (fair) to provide a platform to vendors and other stakeholders to showcase their products and promote awareness in the respective ward. Santhe is organized on each Sunday in a participatory manner using effective communication through WhatsApp groups where in BBMP, private vendors, civil society, schools, RWAs and their members / local community, religious groups etc. participate for knowledge and experience sharing on the subject.

(xv) It is a regular feature now and 'Sundays' beginning from February, 2017 booked for one ward or other. A range of vendors namely Ramky Infrastructure, BHEL, Aaga Composter, Daily Dump, Swachha Graha, Quantum Leap, Prudent Eco System (Marigold Composter – Solar Composting Bin) etc. participate in the fair along with Civil Society and BBMP.

(xvi) The fair attracts a range of vendors who provide specialised equipments for waste processing. These include as many as 38 vendors namely: 1) Balaji Organics, 2) Brics LLP, 3) Devaki Organics, 4) DialyDump, 5) Eco Clocks Conservation, 6) Eco Gifts, 7) Ecobricks energy, 8) Esave Promoters, 9) Gen111, 10) GiftMyGift Innovations, 11) Green utsav, 12) Green The Red, 13) Grow2Share, 14) Hasiru Dala Innovation, 15) MK Associates, 16) My Dream Garden, 17) Nutrimax Organic Lounge, 18) Oncrop agro, 19) Pranapoorna, 20) Prudent ecosystems, 21) Quantum Leaf, 22) Reap Benefits, 23) RentACutlery, 24) Repair Cafe, 25) Restore, 26) Rimagined, 27) Saahas, 28) Sakhya Organics, 29) Shubd Labh, 30) Soil & Health, 31) Sri Skanda Solar Composters, 32) Stones pup, 33) SwachaGraha, 34) Swachcha bengaluru, 35) Trashonomics 2bin1bag plastic ban, 36) Urban greens, 37) Vethon and 38) Waste Crafts. These vendors are actively facilitating households in the mutual interest. Some wards like Koramangla are benefitting significantly and have installed their local processing units for waste management.

(xvii) The fair provides a range of options for processing of wet waste. The households/ neighbourhood committees can select the equipment as per affordability.

Ward/Community Level Initiatives

These initiatives include ward committees, monitoring, Dry waste collection centres, Local waste processing, green leaf composting, colony /society level processing and Bio-methanisation.

Ward Committees

(i) The BBMP, in continuation and follow up of Hon'ble KHC order dated November 10 has issued couple of documents to strengthen process of ward committees. These committees include10 members such as: Local Corporator as chairperson at least two SC (Scheduled Caste)/ST (Scheduled Tribe), three women & two members belonging to resident associations (registered within the ward/ three years old) and should represent majority of residents, civic groups or commercial/industrial groups, Representatives from RWAs/Civil Society Designated municipal officer as secretary

(ii) The committee as per

the direction by KHC is expected to carry out waste management in a time bound manner which includes: Prepare ward micro plan for SWM; Identify land for treatment facilities; Prepare action plan for decentralised waste management at ward level and give due cognizance to solid waste management rules 2016

Monitoring

(iii) Ward level initiatives involve practical approach by municipal team and civil society in a participatory manner. This approach covers adoption of 2 bin 1 bag segregation and access to vendors to the households.

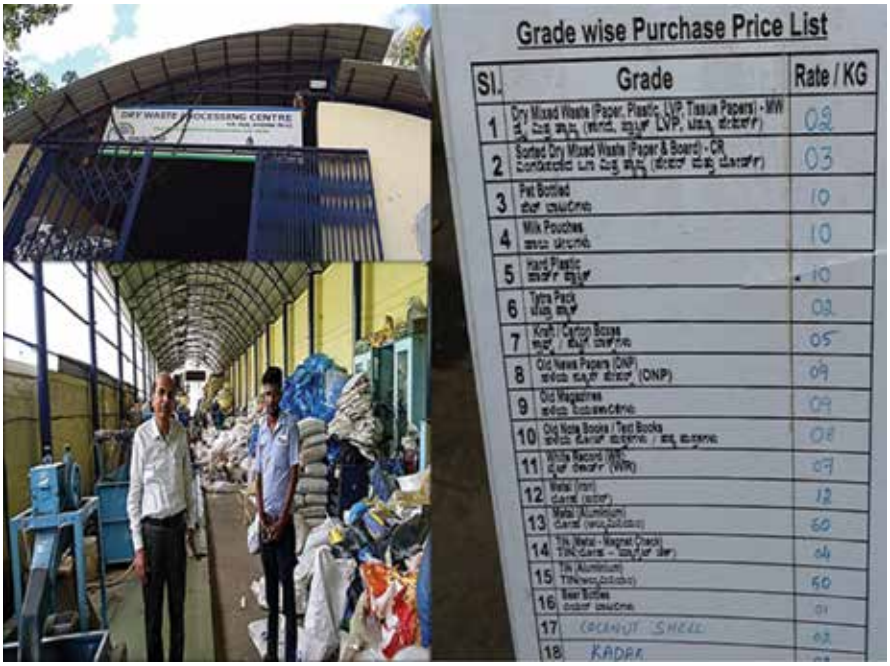
(iv) BBMP has also started Marshals to coordinate waste management at grass root level.

Figure 3: Ward Level Processing of Kitchen Waste and Green Leaf Composting

Dry Waste Collection Centres

(v) Dry waste collection centres (DWCC) are used at ward level to process dry waste collected from vendors and recycle in a most economic manner. These centres include waste brought by contractors, rag pickers, in their Auto tipper, who get it from PKs/HHs directly. DWCC segregate the dry waste among various items and sell them at pre-determined rates. DWCC is a CSR initiative of ITC (Indian Tobacco Company) implemented as BOW (Well Being Out of Waste) and is maintained by E SREE Foundation. Therefore, it is a tripartite arrangement involving a range of stakeholders to have convergence and synergy for processing of dry waste. The segregated waste is sold at a pre-determined rate.

Figure 2: Purchase price list of Recycled Waste



Box 3
Kormangla – Local Waste Management

Kormangla a posh colony is one of the areas which have taken appreciable steps and has demonstrated ability of civil society to effectively join hands with city government.

Block-1: RWA (Resident Welfare Association) has successfully installed leaf composters at different parts of the block to process green waste from Tree & grass etc. for composting. These composters also include temple waste (flowers etc.) to make manure within three weeks. This is a low cost small scale solution and it costs nearly Rs. 1500/- to 7000/- to install one composter depending upon guage of the material.

The RWA has also engaged local councilor to provide more leaf composter from his constituency fund so that all the eligible spots can have a composter. The display on the composter indicating that put only leaf/grass/temple waste etc. is designed and gifted by a local resident.

Further Kormangla 3 RWA is managing a processing unit for wet waste and also displays the equipments for in-house processing of kitchen waste. Many households do follow the suite. In addition, the processing units also have various posters to educate local about implementation of solid waste management plan of BBMP and segregate and process the waste at household level.

Source: Visit to Koramagla Block

Local Waste Processing

Koramangla (3B) Resident Welfare Association is operating a processing unit to prepare compost from the wet waste and also showcase/encourage household level processing of kitchen waste to motivate residents to segregate and process kitchen waste at source. The project site also demonstrates knowledge information and equipment's for processing. This has become a model processing centre to demonstrate and replicate local processing of wet waste (Box 3).

Green Leaf Composting

Kormangla has another unique feature on Green Leaf Composting wherein composters are provided at the X-ings, Parks, streets and roadside points at footpath to enable Paurakamikas /community to process compost from Green Leafs & Temple Wastes (flowers) in a most economic, environment friendly and participatory manner. Cost of composters ranges from Rs 1500 to Rs 7000 depending on the gauge of material used from the fabricator. It can hold 2800 litres of dry leaves - equal to two tractor loads approximately.

Colony/Society Level Processing

Yelahanka zone also has a couple of innovations in the decentralization at ward level that need special mention. One important example is local processing of solid and liquid waste by Purva Venezia Residents. Whereas dry waste is processed through segregation, the wet waste is treated through composting with the help of organic waste convertors. The Society also has liquid waste processing plant to provide clean water being used for gardening and maintaining a small canal within the apartments (Box 4).

Another example of decentralised processing of wet waste is at Dollar Colony which has its own equipments to process wet waste from the entire neighborhood. They are using

Figue 4:Use of Treated Water within Purva Venezia Apartment

community composting through 38″ each width and depth and 40″ height equipments of community composting. It costs nearly Rs 30000 for one pair which can process wet waste from 30 homes.

Biomethanisation of Kitchen Waste from Bulk Producers

Biomethanisation is another unique method adopted in Bengaluru to process kitchen waste mainly from bulk producers. These are operated by private operator on BOT (Build, Operate & Transfer) basis. Nine such plants are operating and four more are under process. These plants buy kitchen waste and sell compost/leachate and generate electricity for street lightning in respective areas.

Household level Initiatives

Several innovations are used at household level to decentralize the process of SWM for quick processing. These include:

(i) The basic activity that forms the basis of entire decentralization is segregation at source. Households in Bengaluru have taken a lead to segregrate garbage under two methods: three bins (Green, Yellow and Red) or Two Bins (Green & Red) and one bag. Whereas the sanitary pads and hazardous waste are put in the red bin, wet/organic waste is kept in green bin and blue bin/bag is used for dry waste.

(ii) As per a recent estimate, 2 lakh households have already adopted this method combined with local treatment which has enabled the city to divert 180 tons of waste to go to land fill/composting sites .

(iii) This waste is used for composting locally within respective neighbourhoods. The compost is used for gardening, sale and also to promote flower pots for self-use or gifts (Box 4). A range of vendors are also active to promote household level processing of waste within the neighbourhood.

(iv) These household level initiatives are significant and have a multiplier effect to improve overall hygiene and efficiency of waste management in a wider context of adaptation and replication in the city and elsewhere. The initiatives show commitment and synergy among various stakeholders to apply 4-Rs (Reduce, Recycle and Reuse waste to make it a Resource) for solid waste management.

Box 4
Local Waste Management at Purva Venezia Apartment

Purva Venezia Apartment (PVA) in Yelahanka zone of BBMP has shown a model of decentralization of waste management. A dedicated team of BBMP officials under the leadership of Joint commissioner promoted a bottom-up and top down convergence successfully in the zone. A network of Suchi Mitra, Master Trainers and Link Workers was used efficiently to engage PKs (Pourakarmikas), Contractors and local community for segregation, collection and processing. PVA has a strong team of civil society led by Ms. Padma Patil (who is also a master trainer) who is actively involved in the city level WhatsApp groups and awareness and experience sharing activities.

PVA is located on Major Sandeep Unnikrishnan Main Road with a 21.5 Acres of plot having 1332 flats divided in 16 blocks. The PVA has its own processing system for kitchen (wet) waste and dry waste. It also has its own treatment plant for sewage and using the treated water for beautification in the form of gardening and watering a canal giving environment friendly look to the society.

Source: Visit to PVA

ADAPTATION AND REPLICATION

The innovations to localise solid waste management as noticed in Bengaluru need wider recognition and cognizance. They present a choice of models to achieve overall objectives of 4-R (Reduce, Reuse, Recycle and make it a Resource). A dedicated team (such as SWM Cell at BBMP) needs to be established at ULB level to examine the waste management, identify the issues and effectively engage stakeholders to have optimum synergy and convergence. It is also noted that crowdsourcing and social media have vast potential to communicate, consult, plan, implement and monitor follow up actions. A parallel system of community representatives in a bottom

up manner as developed in Bengaluru is also needed to enhance adaptation and carry out SWM activities at different levels of actions.

Intra city decentralisation models need wider understanding and adaptation among other cities:

(i) Most of the city waste (more than 90-95%) can be converted into a gainful resource, provided we adopt a management/processing strategy at different levels of generation and spatial division of city.

(ii) A city level dedicated 'Cell' for SWM should be created to develop vertical and horizontal coordination among concerned stakeholders.

(iii) City government should simultaneously develop a bottom-up and top-down convergence and synergy among various stakeholders.

(iv) Mobilization of link workers and community volunteers (Suchi Mitra in Bengaluru) is needed to integrate municipal system and civil society. It should also include Master Trainers (Select Suchi Mitra/ Community Volunteers) as a link between the two segments.

(v) Formal structure of ward committee needs to be created in line with provision of 74th CAA of 1993. The committee should further sub-divide the ward into smaller units of 750-1000 HHs to prepare a micro-plan in a particularly and bottom up manner.

(vi) City scale information and communication through cloud sourcing and social media (website, WhatsApp groups) should be established. As most people have access to cloud sourcing it will yield positive results.

(vii) Inter-ward, community, RWA Level initiatives should be taken to segregate, process and recycle waste in a scientific, economic and environment friendly manner.

(viii) Vendors, Civil Society, RWAs and Municipal Staff should join hands to establish a network.

(ix) Weekly (Sunday in Bengaluru) meet should be a regular feature to engage stakeholders in the respective ward to extend and share knowledge & experience, skills and motivate community and individuals to adapt good practices on segregation and processing at source.

(x) Cost effective and environment friendly methods of leaf composting, select waste processing and dry waste processing at community level should be adopted. There are several vendors active in this area whose potential need to be explored and used.

(xi) Local processing applies 4-R, bring community/ private investment but also reduce overall public expenditure on SWM. This also spares funds for others essential services.

(xii) CSR (Corporate Social Responsibility) funds to join hands with local community need to be brought by ULB through its own channels/network.

(xiii) City leadership has immense potential and corporators/ MLAs and experts living in the city should be engaged for this potential for their contribution in cash, kind and management responsibility.

(xiv) Change NIMBY (Not in My Backyard) to YIMBY (Yes, in My Backyard).

(xv) Decentralisation will also open up circular economy by making available output (compost etc.) as input for new product compost etc.

Finally, decentralization of waste management is a low cost, environment friendly, productive and sustainable option to deal with the growing challenges of waste management. It will also open up opportunities

for circular economy.

CONCLUSION

It is observed that well-planned strategy as applied in various Indian cities is given a consolidated shape in the city of Bengaluru. It involves suo-moto cognizance by court of law, proactive municipal system, civil society participation, community awareness, and private sector participation. These stakeholders are also referred as 7 C (Consumer/Citizen, Court of law, Civil Society, Community, Commissioner, Councilor, Contractor). It is important to note that the court of law, municipal system (councilor, commissioner) and civil society have created a conducive environment to engage, facilitate, motivate, guide and support citizen to trigger a process of decentralized treatment.

REFERENCES AND NOTES

[i]Goal 1: End poverty in all its forms everywhere, Goal 6: Ensure availability and sustainable management of water and sanitation for all, Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all and Goal 11: Make cities inclusive, safe, resilient and sustainable, and Goal 13: Take urgent action to combat climate change and its impacts.

[ii]Mission Dashboard, Ministry of Housing and Urban Affairs, as reported on 15 September 2019. Treatment of 56% in June 2019 is indicated in the table in website of Ministry of housing and urban Affairs.

[iii]Moud.gov.in, Times of India 28 May 2017

[iv]BDA estimates –BDA Master Plan 2031(Draft)

[v]As defined and classified by the HC Directive and BBMP notification

[vi]http://bbmp.gov.in/BBMPSWM/Forms/Publicaboutus.aspx?Page=Aboutus

[vii]Discussion with BBMP in June 2017

[viii]Deccan Hereald 14 September 2019.

[ix]bbmp.gov.in/home op.cit.

[x]BBMP Note on SWM

[xi]Site visits

[xii]Site visits

[xiii]http://www.2bin1bag.in/ (as on 26 September 2017)

UN HABITAT WASTE WISE CITIES CAMPAIGN- KEY PRINCIPLES

Source: UN Habitat Webinar held on 19th September 2019

DECIMATING THE COLOSSUS
-SOLUTIONS FOR GHAZIPUR DUMPSITE

DR. N B MAZUMDAR

Usually some soil is spread over dumpsites after levelling, followed by planting of grass and small shrubs. From outside the place looks good and green. But the real problem of leachate generation and containment / removal of the leachate is not practised. Actually, this is the most serious problem of a garbage dumpsite leading to contamination of the ground water.

Keywords: Ghazipur dumpsite, remediation, SeWAC, RDF

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This article is about looking at options for tackling the humungous Ghazipur dumpsite and trying to find out the best solutions. It is shown that possibly the best solution would be to plan and demonstrate how to recover maximum land by processing and utilizing the old dumped waste by using appropriate technologies. The fresh waste directed to the Ghazipur dumpsite would be segregated at source into three components and sent to the respective recycling / processing industries. This example could be replicable for thousands of similar dump sites across the country.

INTRODUCTION

While entering the National Capital from the eastern side, one can't miss this colossal sentinel with kites hovering over it. This is one of the three operational garbage dumpsites in Delhi and the largest and tallest one, possibly the largest in India. Estimated over 14 million tons of garbage is stacked in a footprint of 29 hectares at Ghazipur dumpsite (Figure 1). Apart from the sheer size of the dump, it is very important to consider the unique and unbelievable location. One side of the dumpsite is surrounded by whole sale markets which supply about 80% of vegetarian and non-vegetarian food of Delhi. Substantial quantity of poultry waste and vegetable waste are being generated from these wholesale markets.

This gives rise to extreme risk, accentuated by additional deposit of the paunch waste from the only organized abattoir of Delhi. The markets are visited by more than ten thousand people daily on an average including the truck drivers and the poor manual workers who have to face lots of difficulties and insanitary conditions. Nearby, there is a slum of rag pickers with more than 300 families, who have a marginal existence.

Then there are more than hundred small dairies, generating substantial quantity of cattle manure. Just around the corner there is a colony built by the Delhi Development Authority for low income families. Thus, the whole area is sitting on a 'pollution bomb'.

There is a waste to energy plant (thermal type, through RDF# route), which is located close to the dumpsite. This plant was installed with a capacity to utilize 1300 TPD (tons per day) MSW (municipal solid waste) with expected generation of 12

RDF – refuse derived fuel

MW electrical power. MSW is first converted to crude RDF (refuse derived fuel) and then subjected to combustion in a single boiler.

This area called Ghazipur Pocket 'B', with an area of about 68 hectares is bound by – Ghazipur drain, Hindon cut canal and the National Highway No. 24, forming a triangular shape. Important developments have been planned for the area beyond this triangular shape and in the adjacent Ghazipur Pocket 'A' and Pocket 'C'. These planned developments make the polluted triangular area more conspicuous.

Immediate solution for this sensitive area is an imperative as it involves the whole of Delhi through the wholesale food chain, ground water pollution, air pollution, vector borne diseases and chances of bird-hit for low flying aircrafts.

OBJECTIVE OF THIS WRITEUP

It would be interesting to look at options for tackling this mega issue and then to see which one may be better or the best option. Let us first consider the challenges:

(i) In spite of the fact that the dumpsite has crossed all safety norms, everyday 2200 tons of fresh waste comes to this dumpsite.

(ii) About 1300 tons per day is supposed to be taken by the waste to energy (WtE) plant but actually much less is taken. The rest is simply dumped.

(iii) Therefore, any steps for managing Ghazipur dumpsite would have to deal with the question of the daily waste coming to the area.

(iv) Hence there are two parallel issues to be dealt with: (a) dealing with the legacy waste dumped on over 29 hectares; (b) managing the fresh waste coming to this area, 2200 TPD on an average.

(v) The fifth and the most important objective is the expected improvement in wholesale food hygiene, health and environment.

After looking at the challenges, let us consider the possible solutions and the opportunities for remediation of this dumpsite. Basically, there are two options:

Figure -1: Ghazipur- the 14 million ton dumpsite

(a) to cover the dumpsite scientifically after planning all the aspects including post care; and

(b) to recover the land blocked by the 14 million tons of dumped waste material.

However, in both the cases, the plan has to include a solution for the huge quantity of fresh waste coming to the dumpsite every day.

METHODOLOGY AND TECHNOLOGY APPLICATION

Let us deliberate on the two above mentioned options now. Each one has its advantages and limitations.

Covering / capping of the dumpsite planned and executed scientifically

Usually some soil is spread over dumpsites after levelling, followed by planting of grass and small shrubs. From outside the place looks good and green. But the real problem of leachate generation and containment / removal of the leachate is not practised. Actually, this is the most serious problem of a garbage dumpsite leading to contamination of the ground water.

The first scientific covering of the garbage dumpsite in India was planned and executed at Gorai by the creek side in the year 2008-09. The author was associated with designing of this project. Due to the precarious location the municipal solid waste actually rolled down to the creek and the copious amounts of leachate mingled with the creek water. The mangroves were damaged considerably and the neighbourhood had to bear the brunt of unbearable stench when the wind direction was towards their habitat.

Since it was not possible to go below the dumpsite, the only way was to restrict entry of rain water, so that leachate formation reduces and over a period of time, almost stops along with stabilization of the dumped waste material. Ingress of the leachate was arrested by putting a barricade consisting of 8 meter long concrete blocks, sunk 5 meters in the creek bed. The 3 meters above water helped in stopping the rolling down of the garbage. Peripheral drains and leachate collection pipes were provided. The huge mass of the dump was levelled and compacted in turn till satisfactory gradient (height: length in the ratio of 1:3 to 1:4) and compaction were achieved.

For arresting ingress of rain water in the dump, a composite cover was put over the compacted and levelled top surface. Actually, for this the bottom containment liner of the sanitary landfill (SLF) as per MSW Rules, 2000 was placed top side down. With this arrangement, percolation of rain water was stopped and at the same time, the intermediate layer with gravel and coarse aggregate facilitated the movement of landfill gas generated by the fermenting mass.

Gas collection wells were made (32 numbers) with even spread and perforated pipes were placed horizontally as well as vertically to make a grid for gas collection. The landfill gas was to be flared initially and later utilized as per actual quality and volume generated. However, the production of landfill gas was far less than the predicted value and percentage of methane was also lower. Post care for 15 years was recommended. Grass was planted over the surface. Post closure maintenance is often not given enough importance and the project suffers.

Another crucial aspect was the receipt of MSW while covering of the dumpsite was going on. The workface was planned in a manner that the covering work was carried out from one end while fresh waste was dumped from the other side and was tapered off gradually till fresh waste was stopped. The whole dumpsite was thus covered completely.

Covering Ghazipur dumpsite:

A similar plan can be made for the Ghazipur dumpsite, as the situation is similar to Gorai except for the absence of the creek and less rainfall. A piece of the dumpsite measuring 4

hectares was handed over to IGL for exploring methane generated in the dumpsite about 6 years back. The portion was covered and gas wells were sunk. However, like the results of Gorai, gas production was not satisfactory – both in terms of volume and percentage of methane, thus limiting the scope of any use for the gas or revenue generation. For unorganized dumpsites receiving mixed waste including inert debris and having regular bouts of fire, it is very difficult to predict or model the production of landfill gas.

Another important factor is that it is very difficult to predict the situation underneath the existing dump. Possibly the base could be slushy and highly contaminated. Once the leachate generation stops due to stopping the rainfall and stabilization of the biodegradable matter, some improvement is expected.

Maximum recovery of the land from under the dumpsite

The other option is to recover the land, for which two steps would be needed:

(i) to vacate the land by mining of the dumpsite to the extent possible; and

(ii) to utilize the fresh waste almost completely, so that the dumpsite does not have to receive fresh waste on a daily basis.

These are elaborated below.

Vacating the dumpsite area to the extent possible

Mining of the dumpsite would result in a mix of materials – soil, inert aggregates of different sizes, remnants of organic material in different stages of stabilization, soiled plastics, fabric, rubber, pieces of FRP, etc. If the dumped material is dried and segregated into different material types, it is possible to get four types of material – combustible materials (paper, plastics, leather, rubber etc), metal, glass and aggregates of different sizes. In the opinion of the writer, combination of the following two technologies would be the best possible combination from techno-economic consideration.

(A) Central Road Research Institute (CRRI) Technology

To explore the potential application of these inert aggregates, a detailed study was carried out by the Central Road Research Institute (CRRI), New Delhi to investigate the possibility of utilizing this as an embankment fill material. This material was proposed to be utilized in the widening of National Highway 24. About 200 ton samples of Municipal Solid Waste were collected from Ghazipur and size-graded in an existing compost plant. The different fractions were studied for their suitability for use in embankment construction. A segregation methodology was proposed. The segregated fractions were characterised for Geotechnical characteristics. Design cross-sections were arrived at for 3m and 5m height embankments based on detailed stability analysis. Settlement analysis was also carried out to investigate its feasibility for embankment construction. CRRI summarized the findings as follows:

1. About 65-75% of segregated municipal solid wastes can be used for embankment construction.
2. Other than soil, plastics and textiles were the major constituents in different segregated materials (The percentage content of metals, wood, paper, rubber, glass is observed to be less than 1% in different segregated fractions). There was no notable variation in soil content or other constituents with the age of the dumped material.
3. Leachate studies indicated that the material was non-hazardous material because the concentration of heavy metals was found to be within the permissible limits.
4. Certain fractions were seen to be good for direct use for embankment construction. The selected fractions were non-plastic, non-swelling coarse-grained material classified as a silty gravel material.

5. Important indices were found to be suitable, for example, the angle of shearing resistance, low value of permeability, the value of compression index, etc.
6. Total settlement for 3m and 5m MSW embankment including primary and secondary consolidation was found to be less than the allowable settlement. The total settlement is expected to be uniform and shall occur slowly over a period of time. The stability analysis indicated factor of safety values for critical draw down conditions under seismic conditions, which is more than the minimum value required as per IRC-75 specifications.

At the end of the study, CRRI recommended that an experimental test track be made for validating the findings and recommending for wider applications. A pilot phase test track of 300-500 meter length and embankment of 3 meter height using this technology can be made as it is felt that there is sufficient merit in this finding. The work would be done under the guidance of CRRI.

(B) Disposal of combustible material and waste plastics recovered from mining of the dump

There may be different options for using this mixed combustible material:

(i) It can be cleaned and converted into RDF (possibly grade II or grade III as per the Guidelines on Usage of Refuse Derived Fuel in Various Industries, MoHUA, GoI, September 2018). Grade III material can be used in the neighbouring WtE plant, whereas Grade II can also be sold to cement plants.

(ii) According to some opinion, the mined material can be subjected to Plasma Pyrolysis Vitrification (PPV) for energy generation and leaving vitrified material as residue, which can be used as construction material.

However, in the light of the failed large PPV project at Tees Valley in UK, one needs to thoroughly analyse the situation and examine all relevant data before embarking on such highly expensive projects.

A third option is emerging. There is an innovation from an entrepreneur based in Indore. The technology targets two fractions of the material mined from an old dumpsite – hard inert aggregates and plastics. They have successfully used different types of waste plastics.

The aggregate / grit is desilted mechanically and coated with molten plastics and then cooled. The coated aggregates are cooled before use. This coated material can be put to different uses, such as, in road works, making blocks, landscaping etc.

A pilot plant to handle 5 tons of plastics per day can be set up, which would use the aggregates and the waste plastics mined

Figure -2: Levelling of Ghazipur dumpsite

Courtesy: Dr Akshaya Kumar Sen

from the Ghazipur dumpsite. This way it would be a supplementary facility for the Solid waste management using CRRI technology.

Diversion of 2200 TPD fresh waste from the landfill

As per the MSW Rules, 2016 if the MSW is properly segregated at source into 3 constituents: (i) wet waste or bio-degradable fraction, (ii) dry waste or non-biodegradable fraction and (iii) domestic hazardous waste fraction, then efficient collection and transportation and proper processing is facilitated. The resultant recycled products are cleaner and can comply with the quality norms at lesser cost of production.

Attempts for segregation at source was attempted by the then MCD (Municipal Corporation of Delhi) soon after publication of the report of the Supreme Court appointed Committee (1999) headed by Mr Asim Burman. Red and black coloured garbage bags were distributed in selected colonies for facilitating segregation at source and separate collection. However, this move was not successful. Subsequently similar acts have been tried at several colonies. For example, good quality plastics bins with covers of red and green colour were distributed to each household in the Asiad Village, an elite housing colony in the year 2000. The activity was monitored for a year, during which it was found that more than one third of the households used these bins for alternative use (e.g., storing grains).

The lesson from the above efforts is that without cooperation of the stakeholders, it is difficult to succeed. Therefore, awareness generation and follow up meticulous plan is required to implement segregation at source, followed by segregated collection and transport to the respective destination for further recycling.

An effective way may be to follow this meticulously as per the following plan:

a. Sustained awareness generation using different tools and methodologies, such as, focussed group meetings, Nukkad Natak, printed material, community mobilization and training on waste management, workshop for RWA etc.
b. Application of app-based collection of segregated items such as, 'Segregated Waste Accounter' (SeWAC). This app is attached to a weighing scale. All the data would be saved on cloud and no one can fudge the data.
c. The catchment area of the 2200 TPD waste that comes to Ghazipur may be chosen for this system. Each of the households would be targeted with the awareness generation tools and capacity building of the members of the households and also of the waste workers and supervisors.
d. These waste workers would be given appropriate recognition and they would also do additional jobs like collecting e-waste, getting municipal notices to their identified household etc. They would have a close interaction with the citizens for better performance with respect to waste management.

With effective segregation at source, the different streams of materials would be channelled to the respective processing / recycling facilities. There would be very small percentage of residual material which may require landfilling in a SLF. At present the WtE plant is unable to take the designed quantity of the waste material. Once segregated combustible material is made available, the plant would function much more efficiently with smaller quantity of feed material.

The organic fraction would be sent to the nearest compost plant. The segregated material would be a better substrate for composting with more biodegradable material and less contaminants.

The domestic hazardous waste would be further segregated and sent to the respective recycling industry. Similarly, segregated

e-waste would be sent to registered recyclers.

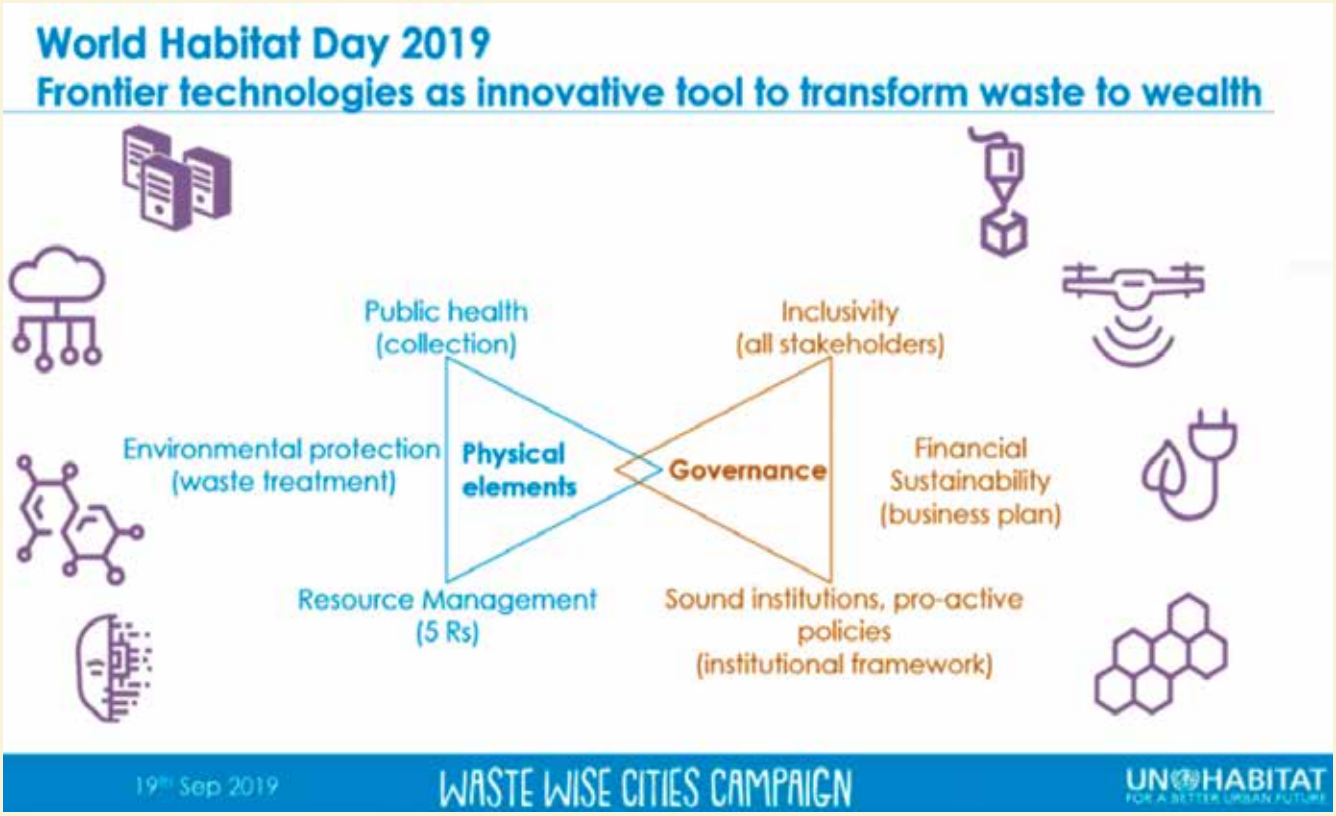
This way, very little ultimate waste would remain to be disposed in a small sanitary landfill.

CONCLUSION

As discussed above, it is possible to decimate the colossus of Ghazipur dump with appropriate meticulous planning although the total expenses would be huge and a time frame of 4-5 years would be required (the work would be slow during rainy season). There would be possibility of only small revenue from product sale. However, even 80% of the land freed (23 hectare or 2,30,000 m^2) would have considerable value at the present circle rate of Rs. 45000 per m^2.

A word of caution: the huge scale of the work and the proximity of habitat would warrant utmost care and careful planning. The health, hygiene and environmental issues would be crucial during the whole tenure of the work.

UN HABITAT WASTE WISE CITIES CAMPAIGN: KEY INTER-LINKAGES



Source: UN Habitat Webinar held on 19th September 2019

EFFORTS MADE BY URBAN LOCAL BODIES OF INDIA TOWARDS WASTE TO WEALTH

-UNDERSTANDING THROUGH CASE STUDIES

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ULBs in general, lack adequate capacity to manage solid waste collected in terms of affordability since there is low ability of households to pay for a certain level of management service. Polluters in India are also not yet fully ready to bear the costs of managing it to prevent damage to human health or environment.

Key Words: Municipal Solid Waste Management, Urban Local Body (ULB), Informal Sector

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Efforts have been made by some Urban Local Bodies of India to manage Municipal Solid Waste through various interventions to fulfill their aim of processing the waste materials to materials with some economic value. Innovative practices include intervention from management as well as from citizens. In this regard, several ULBs have made attempts to make efficient management of waste materials by involving non-government stakeholders and by changing people's mindset. This paper intends to explain those innovative attempts through award winning case studies and other entries considered under the best practice of HUDCO during last decade.

INTRODUCTION

Urbanization and economic development go hand in hand with generation of waste. Waste is characterized by various factors like sources, type, composition etc. Quite a number of definitions are available internationally, which define waste. Emphasis has been given on diverse aspects in different definitions.

"Any substance or object the holder discards or intends to discard or is required to discard" is waste. Once a substance or object has become waste, it will remain waste until it has been fully recovered and no longer poses a potential threat to the environment or to human health (European Directive: 2008/98/EC). It can be argued that waste is the refusal from the different social sectors like household, commercial, industrial etc, which may not be useful for the thrower, but may become useful for the other one. Solid wastes may be defined as any solid material that is produced by various activities of the society, have lost their value to the first user and rejected. Municipal Solid Waste is defined as waste or refuse from households, hazardous solid waste from industrial and commercial establishments, refuse from institutions, market waste, yard waste and street sweeping (World Bank, 1999).

Municipal solid waste includes commercial and residential wastes generated in a municipal or notified area in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes [Municipal Solid Wastes (Management and Handling) Rules, 2000].

DIMENSION OF SOLID WASTE MANAGEMENT

India is experiencing rapid population growth and improvements in living standards. With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste (MSW) generation has increased rapidly and its composition has also undergone change. Moreover, diversity with many different religious groups, cultures and traditions is associated with major challenges in solid waste management.

Residents in India, especially the urban poor, are more severely impacted by unsustainably managed waste. Waste is often disposed in unregulated dumps or openly burned. These practices create serious health, safety and environmental consequences. Managing waste properly is essential for building sustainable and livable cities, but it remains a challenge for Indian cities.

Since solid waste generated have direct impact on the health, environment, quality of life of the citizens and on the aesthetics of the urban areas, in 2000, a set of rules has been framed from the side of union government for Pan India application titled 'Municipal solid wastes (management and handling) rules, 2000'. Since there was not much improvement, Ministry of Environment, Forest & Climate Change (MoEFCC), Govt. of India decided to revisit the rules and has come up with 'Solid Waste Management Rules, 2016'. The applicability of the new Rule has now increased to cover, besides 4041 ULBs in the country, all urbanized census towns, villages having a population of over 5000 and declared census towns as per national census 2011.

Urban Local Bodies are responsible for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW. Chandigarh is the first city to develop SWM in a planned way and has improved waste management compared with other Indian cities (Narayan T. 2008).

ULBs, in general, lack adequate capacity to manage solid waste collected in terms of affordability since there is low ability of households to pay for a certain level of management service. Polluters in India are also not yet fully ready to bear the costs of managing it to prevent damage to human health or environment. Thus, the total process of SWM is not sustainable.

INTERVENTIONS OF ULBs – ANALYSIS THROUGH CASE STUDIES

Innovative practices regarding MSW management by ULBs have been demonstrated which could succeed to manage the waste through interventions at different levels. Most of the interventions have been taken at management level which led MSW management process towards economic sustainability as the processes have resulted in some output having market value, i.e, waste becoming resources.

Case studies have been chosen from the award winning ULBs and a few other ULBs for their practices considered as the best from the last decade, identified by HUDCO. Attempt has been made through this article to classify them according to their intervention.

Intervention 1 - Involvement of informal sector in waste collection and processing:

Efficiency of collection is a very important step. Among the steps of municipal solid waste management, collection of solid waste is the process which costs maximum amount for employment of workforce. On the other hand, people working in informal sector in urban area always have interest in collection of solid waste. If given an opportunity, they are ready to work in a low profit margin. This helps ULBs to complete the collection process in low cost. As a result, there is also opportunity for employment generation for urban poor.

Pune Municipal Corporation (PMC) of Maharashtra state has taken step towards incorporation of informal sector in the process of solid waste collection through authorization of SWaCH, a co-operative organisation under PMC for door to door collection of waste and other allied waste management services. Approximately 100 staff members of cooperative have been engaged in this process who have earned money from user charges, fixed salary from PMC and sale of recyclable items to market. In the process, the members have collected the segregated waste from source and they have further segregated the waste, sold the recyclables to market and drop the non-recyclable to feeder point. They have been further engaged in composting process of wet wastes in the landfill sites provided by societies. Through these processes, they have succeeded to reduce the amount of solid waste and the process also has resulted in reduction of transport cost. In the year 2012, SWaCH has collected more than 600 tons of MSW per day, out of which about 130 tons of waste has been sent for composting and 150 tons have been recycled (Figure 1). Composting of bio-degradable waste has further resulted in reduction of methane gas emission in landfill sites. Several engineering colleges, schools, local cooperatives have been engaged with the initiative to assist in better design of equipment, training of staff and waste pickers. The initiative has been supported by Woman in Informal Economy Globalizing and Organizing (WIEGO) to disseminate the learning of the model as well as learning from experiences around the world. In the year 2013, it costed Rs. 3/ month/household only towards administrative expenses to the PMC as compared to an average of Rs. 25 incurred by other cities in India that have adopted professional waste management systems. The contract with SWaCH has helped PMC to save more than Rs. 12 crores per annum in waste handling costs.

Rajgarh Nagar Parishad, a town of Dhar district of Madhya Pradesh, has appointed an NGO named Celestial Waste Management Group in the process of collection of solid waste. The responsibility has been shared by the ULB with the NGO. The ULB with the NGO has developed an innovative technique to monitor the entire system using WhatsApp Messenger through creation of a group with the volunteers and local people as its members. In the year 2015, the ULB has paid around Rs. 35,000/- per month to the Celestial Waste Management for this contract (Figure 2). A collection vehicle with voice alarm at pre-decided time has been introduced for collection process. The sanitary workers have been allowed to sell the waste, which has increased their income, making the system more efficient and viable.

Integrating the informal sector only is not adequate to implement the approach. Support infrastructure is also needed which has been done by Municipal Corporation Jalandhar of Punjab State in

Figure 1: staff member of SWACH

Figure 2: On duty Celestial Waste Management Group member

the year 2015 by providing covered Secondary Collection Point (SCP) in certain wards of the city. Through this initiative it has been able to achieve segregation at secondary stage by the rag pickers at secondary collection point. Segregation of MSW by rag pickers also has provided them livelihood and promoted recycling industries. By constructing the concrete platform for the secondary segregation, it has been ensured that segregation, loading, unloading in Municipal vehicles happens behind screens and is not visible to public.

Further, involvement of community through creation of Self Help Groups (SHGs) has worked well in small ULB like Notified Area Council (NAC), Patnagarh of Uttarakhand state. NAC Patnagarh has successfully carried out the task of community managed solid waste management by involving women in the year 2011 (Figure 3). NAC has privatized the sanitation system through involving Non Governmental Organisation (NGO) which has provided one green and one red dustbin to each household for door to door collection. Different awareness camps have been organized to make people aware about environment, pollution and use of dustbins in a proper manner. To make the system financially sustainable, SHGs have been directed to collect user fee and to charge fine/ penalty for polluting areas. Further incentives have been given for keeping streets/wards clean and prizes have been distributed on Local Self Government Day.

Figure 3 Members of women Self-Help Group

Intervention 2 - 'Marketing of output' driven processing of waste

In traditional process of treatment of solid waste, the approach is to process the waste materials with best possible way so that some useable output can be extracted and then sell the output. In this process, it appears sometime that the output does not have demand in the local market or there are other issues in marketing the output. So, it has been felt that there is necessity to ascertain demand for products which is processed from the waste. This problem has been overcome by some organizations by planning the process and the output from waste according to existing or potential market demand.

In the year 2015, Cashutec Building Centre of Raichur District of Karnataka has taken the initiative of environmental protection activity with scientific disposal of waste materials for productive activity and at the same time to obtain economical benefits with production of building materials from wastes (Figure 4). Cashutec primarily manufactures high volume fly ash building products using fly ash and pond ash from the Raichur Thermal Power Station. Further with municipal solid

Figure 4: Sildwaste processing by Cashutec Building Centre

waste, recycling of dry waste has been done and recycled aggregates from Municipal Solid Waste have been used for the secondary application in construction of low cost and small houses and buildings.

Greater Warangal Municipal Corporation (GWMC) of Telangana has taken up bio-methanization and vermi-composting (Figure 5). It has handled approximately 240 MT waste per day in the year 2015. Sanitation workers have been asked to collect the dry and wet wastes separately from the households. Wet wastes have been taken to a resource park and converted into manure through the process of vermi-composting and compost has been made available to farmers at a cheaper rate. GWMC has also established bio-methanization plants and generated power from the solid waste and the same has been used to light the administrative offices of Warangal.

Figure 5: Composting by Greater Warangal Municipal Corporation

A large scale initiative has been taken by Directorate of Town Panchayats, Tamil Nadu regarding waste recycle and its marketing. Through technological support and behavioral change strategies for the citizens, commendable progress has been made in waste management of its 528 towns. Bio-composting has been successfully done in 466 Town Panchayats. In the year 2016, 100.17 M.T per day of bio-compost has been produced and a sum of Rs.39.42 lakh has been earned by Town Panchayats every month by selling bio compost. Vermi-composting has also been done successfully in 188 Town Panchayats. 16.21 M.T per day of vermin compost has been produced by Town Panchayats which has given an earning of Rs.10.29 lakh to Town Panchayats every month by selling vermin-compost (Figure 6). In addition, vermin-wash has also been produced in few of the Town Panchayats. Compared to the Bio-manure and vermin-compost manure, vermin-wash has got very high demand.

Intervention 3 - Community involvement in behavioral change

Apart from all the efforts made by ULBs for MSW through implementation of rules, regulations and guidelines, behavioral change of citizen at large is also felt inevitable. It is felt that otherwise all the efforts made, may result in having no outcome as a whole. However, behavioral change of the people is not easy to be done in a smaller span of time and cannot be taken

Figure 6: Windrow Composting at Vadipatti Town Panchayat

up through desk level planning only. Direct contact with people is necessary for this task, and hence association of SHGs, NGOs etc. is more important. Several ULBs has taken initiative in this regard in associating the common citizen through awareness generation.

Towards implementation of MSW Rules 2000, Siddipet Municipal Council of Telangana has taken appropriate steps in the year 2015. Apart from deploying the required sanitation staff, it has planned pin point programme among the sanitation staff, utilized the optimum services of Mahila groups, NGOs and made wide propaganda among people of the town to create best possible awareness. Also, it has conducted meetings periodically with the categorized professionals such as businessmen, schools, colleges, mahila groups and to penetrate the minds of resident public with the ideas.

Tenali Municipality, Guntur District, Andhra Pradesh has adopted various measures to install an effective method for municipal waste collection. An innovative approach has been adopted to deploy local people in monitoring process in a systematic way. In the year 2011, women volunteers from local groups, one from each of the 40 municipal wards have been employed as local supervisors for 100 per cent door to door garbage collection. It has helped in providing an efficient waste collection system in the area.

Intervention 4 - Differential user charges

Differential user charge has been considered as one of the options to maximize revenue from user charges. Tenali Municipality of Andhra Pradesh State has adopted this approach to maximize its revenue from user charges in the year 2011. It has implemented differential user charges for households and commercial establishments, as commercial establishments, in general, produce more waste materials than households. It has been found that there is willingness to pay more user charge by commercial establishments.

CONCLUSION

ULBs have key responsibility for municipal solid waste collection and disposal. However, for sustainability, ULBs need support from stakeholders to carry out integrated solid waste management. In this regard, the citizens are the most important stakeholders in waste management activities and they must actively participate by modifying their behavioral patterns. ULBs may focus primarily on residential waste collection and can include public, private and informal sectors in the waste management plan. For managing waste from non-residential sources, ULBs can involve the private sectors as the process can be financially sustainable.

To make an environment friendly municipal solid waste management system by coping up with rapid growth of urban population in India, it is necessary to prepare an economically sustainable system running on profit, based on market driven approach to obtain wealth from waste.

REFERENCES

Compendium, HUDCO Awards for Best Practices to Improve the Living Environment, 2011-12; 2012-13; 2013-14; 2014-15; 2015-16; 2016-17

Directive 2008/98/EC of the European Parliament and of the council of 19 November 2008 on waste and repealing certain Directives, No. L 312/3, Dated 22.11.2008.

Municipal Solid Wastes (Management and Handling) Rules, 2000, Published on 25th September, 2000.

Solid waste management Rules, 2016, Publised on 8th April, 2016.

The World Bank, 1999, What a waste: Solid Waste Management in Asia.

Narayan T. 2008. Municipal solid waste management in India: from waste disposal to recovery of resources? Waste Manage. 29, 1163–1166.

WASTE TO WONDER PARK, DELHI

Implemented by South Delhi Municipal Corporation

The seven wonders were replicated from 150 tonnes of waste products including scrap iron such as old benches, typewriters, discarded automobile parts, age-old appliances, broken metal utensils, metallic waste like fans, rods, iron sheets, nut bolts, bicycle, defunct sewer lines and pipes. South Delhi Municipal Corporation (SDMC) has succeeded in reducing its carbon footprint not only using waste material, but also harnessing energy such as wind and solar energy to light up the park.

Keywords: Solod waste mangement, source quality, dry risk

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South Delhi Municipal Corporation is responsible for undertaking an initiatives to process waste, under meaningful projects and add aesthetic value to the city. It has recycled about 150 tonnes of industrial waste and other waste from landfills to make renowned seven wonders of world. The 'Waste to Wonder Park' features the structural replicas of iconic Seven Wonders of the World, created from waste materials like scrap metals, discarded automobile parts , procured from the landfills of the city. Seven wonders are built with eco-friendly, self-sustainable material, and the park has its own solar and wind power generation. The park is a Clean India Project which is a part of SDMC's waste to art initiative and also provided a boost to the 'Swachh Bharat Abhiyan'.

INTRODUCTION

The 'Waste to Wonder Park' featuring the replicas of seven iconic edifices from across the world has been opened for the public in the national capital in February 2019. It is the world's first theme park with all the seven wonders replicated using waste products. That is why this park becomes an attraction point for everyone and yet it is unique in itself. The park looks like a tiny island developed in the congested surroundings of the Sarai Kale Khan Inter-State Bus Terminus and Outer Ring Road located near Nizammudin Metro Station. The entire park has been lit up solely through renewable energy like solar power and wind energy. The Waste to Wonder Park is inspired from the 7 Wonders Park in Kota, Rajasthan, a project that was born out of a "filmy" idea. The park has amazing structural replicas of Seven Wonders of the World which has been developed by utilizing the waste items such as iron scraps, automobile parts and other such material of metal, broken metal utensils and pipes. The park houses miniature replicas of Taj Mahal (India), Eiffel Tower (France), Leaning Tower of Pisa (Italy), Statue of Liberty (USA), Christ the Redeemer (Brazil), Great Pyramid of Giza (Egypt) and Colosseum (Italy).

WASTE TO ART PROGRAMME

South Delhi Municipal Corporation (SDMC), the governing body behind the construction of this park, has harnessed wind and solar power to light up the Wonders of the World Park, which is essentially

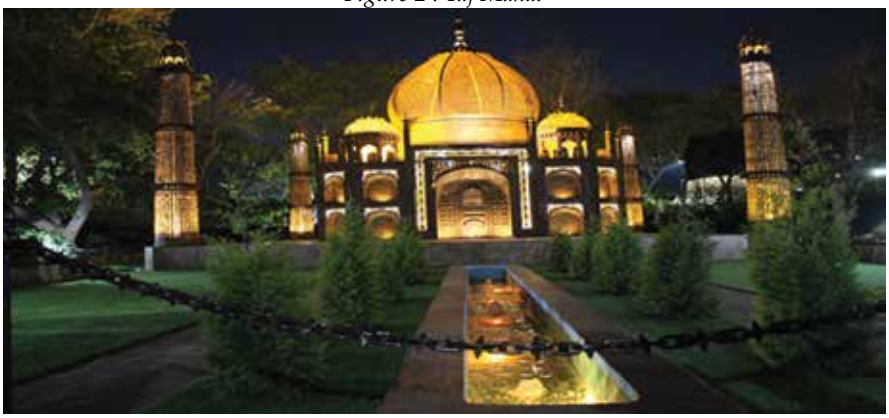
Figure 1 : Waste to Wonder Park, South Delhi Municipal Corporation

a waste-to art project. The park is a Clean India Project which is a part of SDMC's waste to art initiative (Figure 1). It is a completely eco-friendly park. 150 tonne of scrap and waste has been used to create the "architectural wonders for the city", out of which 90 tons was industrial waste and junk automobile parts. The park "sets an example of 'waste-to-wealth' for other agencies", as scrap has been used to create the "wonders of the world". Appearance of the replicas of these seven wonders made out of waste have been given a bright and finished look with old sodium lights installed within them, to highlight their features. This has created a breathtaking sight during evening and night hours, marking it as a captivating tourist spot. These seven wonders are briefly described below.

Taj Mahal - This iconic structure, considered one of the most beautiful structures in the world - is built here using more than 16 tonnes of scrap waste. The structure at the Waste to Wonder Park is 37 feet high (Figure 2). 4 doors and 24 windows were carved out of concrete moulds. All the carvings have been laser cut using a design that was first created on computer. Each and every dome, minar, window, door, pole are separately created and assembled one by one. The scrap material used in the erection of this monument includes angles, truck/cupboards sheets , nuts and bolts , 1600 Cycle rings, electric pole pipes, cooking pans, park Benches, swings, while all domes are made of 2" pipes (cut into pieces. The, Jaalis for doors and windows were taken out of benches, Railings from park and truck sheets that have been used to create intricate designs. The window and door frames have been made by using benches.

Eiffel Tower – A structure inspired from the most romantic city in the world to a replica in

Figure 2 : Taj Mahal

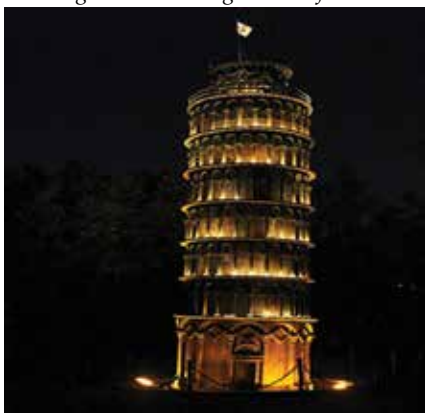


New Delhi, this structure was built using more than 15 tonnes of scrap metal. The structure at the Waste to Wonder Park is 70 feet high (Figure 3). Material used for the construction of this tower comprises mostly automobile waste such as truck petrol tanks, automobile parts, clutch plates, C channels and angles. All the three floors of the replica were created separately and then assembled with the help of a crane.

Figure 3 : Eiffel Tower

Leaning Tower of Pisa – A world renowned phenomenon of the leaning tower from Pisa, Italy is recreated using scrap metal, here in New Delhi with more than 9 tonnes of scrap metal. The structure at the Waste to Wonder Park is 39 feet high (Figure 4).

Figure 4 : Leaning Tower of Pisa



Various scrap materials used for the construction of this masterpiece included cable wire rings, automobile parts, truck metal, sheets, clutch plates, C channels and angles. Bell is made out of pipes. It is tilted at the angle of 86 degrees exactly replicating the tilt of the original structure. The structure comprises of 182 columns in total, 26 columns at each floor. The replica consists of about 211 arches spread out in eight storeys which have been fabricated from cycle rim, diamond designs in between the arches that are made from metal sheets and pipes to look like a pillar.

Statue of Liberty – The pride of New York is recreated here in New Delhi using 6 tonnes of scrap metal. The structure at the Waste to Wonder Park is 17 feet high (Figure 5). During the construction process , a mould was used to give proper shape of the structure. The replica was born out of waste materials such as angles of rickshaws, slides and swings from children's park, tea stall benches, electric metal wires. While the pedestal has been created using old pipes, metal railings and angles, giving the look of bricks, circular rings on it have been created using car rims. In her left hand, the Roman liberty goddess holds a tablet carved from a MCD bench and metal sheets and in the right hand, she holds a torch fabricated from old bike and its chain. Lastly, her hair has been made using cycle chains.

Christ the Redeemer– This beautiful statue of Christ the Redeemer towering over the city of Rio de Janeiro is rebuilt in New Delhi using seven tonnes of scrap metal. The structure at the Park is 25 feet high (Figure 6). The process was time consuming; it took almost 5 months to build. Metal cast and mould were used to give proper shape to the sculpture. The waste materials used in the process were electric pipes, automobile scrap, bike chains, spring, cycle

Figure 5 : Statue of Liberty

rickshaw angles. While square pipes from benches have been put horizontally to make the pedestal, electric poles have been placed vertically to make lower part of the statute's dress. Also, engine parts have been used to replicate the detailing in the hands and motorbike chains have been used to create hair.

Great Pyramid of Giza – One of the world's oldest man-made structures is recreated here in New Delhi using more than 10 tonnes of scrap metal. The structure at the park is 24 feet high mainly made up of pipes and angles (Figure 7). Around 110 layer structure has been generated by using 10,800 feet scrap angles weighing 10-12 tonnes.

Figure 7 : Pyramid of Giza

Colosseum - Massive stone amphitheatre known as the Colosseum was commissioned around 70-72 A.D by Emperor Vespasian of the Flavian dynasty as a gift to the Roman people. Taking inspiration from the same, SDMC commissioned 17 ft replica of the Colosseum in Delhi using 11 tonnes of waste including electric poles, metal railings, bench, automobile spare parts and other scrap metal (Figure 8). Also, 162 pillars, scrap from children's park (slides, swings, see-saw) and 410 car wheels have been used to make arch in each pillar.

Figure 6 : Christ The Redeemer

SETTING UP

The seven wonders were replicated from 150 tonnes of waste products including scrap iron such as old benches, typewriters, discarded automobile parts, age-old appliances, broken metal utensils, metallic waste like fans, rods, iron sheets, nut bolts, bicycle, defunct sewer lines and pipes gathering dust in 24 municipal stores of SDMC. Since the clones are made from scrap metal, anti-rust enamel has been applied on them (Figure 9).

The Corporation has installed solar trees and rooftop panels that generate 50 KW power and the surplus power will be sold to the power distribution companies to earn revenue. In the development of the park 5 artists, 7 supporting artists, 70 welders and helpers worked to accomplish the most coveted project. According to SDMC, the park was built at a cost of Rs 7.5 crore. It is an eco-friendly park. It consists of 3 windmills (1 KW each), 3 solar trees (5 KW each)

Figure 8 : Colosseum

and rooftop solar panel (10 KW each) for generation of power. Therefore, SDMC has made this theme park self sufficient for running on its renewable energy. Nearly 18 sun-tracking panels have been installed to generate electricity in the illuminated replicas. Another nifty feature of this park is that solar trees installed in the park will also be using the mist cooling technique which will allow the water to pass through tiny nozzles. The water droplets will absorb the heat from the environment and will be evaporated which will ultimately help in counteracting the pollution in the city. Even wash rooms have been made from obsolete shipping containers. The replicas have been fabricated artistically and the park has been commissioned in a period of six months despite the expected time of completion being eight months in view of the vast waste material available.

ACCOMPLISHMENT

South Delhi Municipal Corporation (SDMC) has succeeded in reducing its carbon footprint not only using waste material, but also harnessing energy such as wind and solar energy to light up the park. In an effort to make the park self-sustainable, solar panels have been installed on the rooftops of the washroom. There are three solar trees in the park, which capture energy from sunlight and wind for producing energy. Apart from solar panels, there is also a wind mill that adds to the park's capability to generate electricity for itself.

The waste turned into artistic masterpieces transform into breathtaking installations in the evening, when each of these replicas are lit up. Apart from soaking in the beauty of these world–renowned monuments, authorities hope that the visitors also absorb the message that the park imbibes – recycling waste and embracing renewable energy for sustainable and environment-friendly future.

REFERENCES

South Delhi Municipal Corporation (1029), Waste to Wonder Park, information available online at http://mcdonline.gov.in/tri/sdmc_mcdportal/Waste_to_Art_park/

https://m.economictimes.com/news/politics-and-nation/wonders-of-the-world-park-opens-for-public/worlds-first/slideshow/68111985.cms

https://www.jagranjosh.com/general-knowledge/waste-to-wonder-theme-park-1555590899-1

https://swachhindia.ndtv.com/delhi-seven-wonders-of-the-world-park-made-from-waste-renewable-energy-31294/

Figure 9 : Waste scrap materials used for the monuments of seven wonders of world

LEVERAGING RESOURCES FOR IMPLEMENTATION OF PMAY (URBAN)

-HOUSING FOR ALL BY 2022

MR. K.K. CHAUHAN

On behalf of HUDCO, the Regional Office-NCR has signed a tripartite agreement 'MoA' (Memorandum of Association) with MoHUA, GoI and BMTPC for extending funds raised by HUDCO through Bonds, in the form of loan assistance to BMTPC for onward transmission to the State Govt. agencies & CNAs for eligible beneficiaries across the country.

Keywords: PMAY, CLSS, Fully Serviced Bonds,

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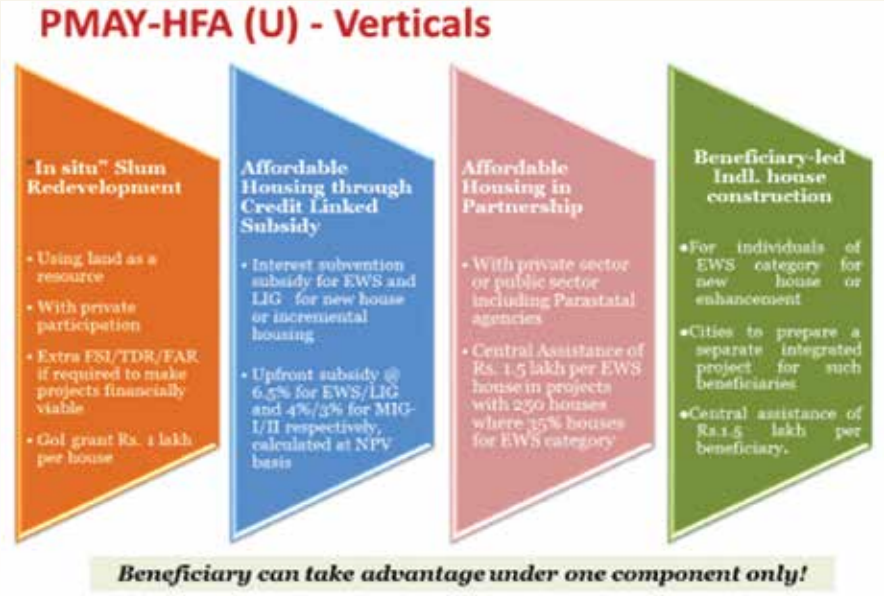
The Pradhan Mantri Awas Yojana (PMAY)-Housing for All (Urban) Mission, launched by the Government of India in June 2015, seeks to address the housing requirements of all sections of urban poor including homeless population, slum dwellers for more equitable living conditions for all. For PMAY, HUDCO is acting as the Central Nodal Agency for channelization of interest subsidy for the Credit Linked Subsidy Scheme (CLSS) vertical of this flagship Mission as a Central Sector Scheme. HUDCO through its network of Regional Offices all over the country, is making sincere efforts for implementation of the said vertical popularly known as CLSS-PMAY(U) Scheme. Besides extending the interest subsidy to the eligible beneficiaries under CLSS-PMAY(U), HUDCO is leveraging its key strength for raising resources through innovative ways. This paper discusses about the role of HUDCO and its Regional Office-NCR for leveraging resources for implementation of PMAY-HfA Mission.

With a mission to provide Housing for All by 2022, the year when the Nation completes 75 years of its Independence, the Govt. of India, through its Ministry of Housing and Urban Affairs (MoHUA), launched the Pradhan Mantri Awas Yojana (PMAY)-Housing for All (Urban) on 25th June 2015. The Mission, launched by the Hon'ble Prime Minister of India, seeks to address the housing requirements of all sections of urban poor including homeless population, slum dwellers for more equitable living conditions for all through four programme verticals as mentioned in Figure 1.

Figure 1: Housing Options under PMAY-HfA (Urban)



COVERAGE, DURATION AND BENEFICIARIES

The coverage of the PMAY-HfA(Urban) includes all (4446) Statutory Towns as per Census 2011 and all Towns notified by State Governments. States will have flexibility to include the Planning area as notified w.r.t. the Statutory towns and which surrounds the concerned municipal area. The duration of the Mission is upto 2022. A beneficiary under the Mission is defined as a family comprising of husband, wife and unmarried children. The beneficiary should not have any pucca house anywhere in India to be eligible to receive support under the mission. The different categories of beneficiaries include economically weaker section (EWS) family with income upto Rs. 3 lakh and housing unit size of 30 sqm; and lower income groups (LIG) family with income from Rs. 3-6 lakh and housing unit size of 60 sqm. However, the States/UTs have the flexibility to redefine the annual income criteria as per local needs. For the Credit Linked Subsidy Scheme (CLSS) vertical of PMAY-HfA(U), the benefits have been extended to Middle Income Groups (MIG) whereby MIG-I & MIG-II are categorized as having annual household income of upto Rs. 12 lakh and Rs 12 lakh-Rs.18 lakh respectively.

HUDCO'S SUPPORT FOR IMPLEMENTATION OF PMAY-HFA

The Housing & Urban Development Corporation Ltd (HUDCO), a premier Techno-financial Institution under the Ministry of Housing and Urban Affairs (MoHUA), Govt of India is involved in shaping & implementation of the strategies of the Govt. of India in the Housing & Infrastructure sector. For PMAY, it is acting as the Central Nodal Agency(CNA) for channelization of interest subsidy for the Credit Linked Subsidy Scheme (CLSS) vertical of this flagship Mission, as a Central Sector Scheme. HUDCO through its network of Regional Offices all over the country, is making sincere efforts for implementation of the said vertical popularly known as CLSS-PMAY(U) Scheme.

Besides extending the interest subsidy to the eligible beneficiaries under CLSS-PMAY(U), HUDCO is leveraging its key strength for raising resources in the form of "GoI Fully Serviced Bonds" for onward transmission to the State Govt. agencies & CNAs through the Building Material Technology Promotion Council (BMTPC - the Nodal agency designated by the Govt. of India) on the advice of the MoHUA, Govt. of India. On the one hand, HUDCO is adopting pro-active approach to encourage the beneficiaries to go for Pucca Houses/Flats and avail benefit of interest subsidy @6.5% for EWS & LIG beneficiaries, @4% for MIG-I and @3% for MIG-II for CLSS component; on the other hand, it is engaging itself in mobilization of funds through "GoI Fully Serviced Bonds" by leveraging its balance sheet strength and extending loan assistance through its Regional Office-NCR to BMTPC with strong commitments to match the time-lines as per the requirements & expectations of the MoHUA, GoI.

ACHIEVEMENT OF HUDCO REGIONAL OFFICE-NCR

HUDCO's Regional Office- NCR (National Capital Region), is committed to actively involve itself in this endeavor and is making all-out efforts in implementation of PMAY(U) across the country with specific focus on CLSS component in the Delhi & National Capital Region. On behalf of HUDCO, the Regional Office-NCR has signed a tripartite agreement 'MoA' (Memorandum of Association) with MoHUA, GOI and BMTPC for extending funds raised by HUDCO through Bonds, in the form of loan assistance to BMTPC for onward transmission to the State Govt. agencies & CNAs for eligible beneficiaries across the country.

For CLSS component, HUDCO's

Table 1: Upfront benefits available under CLSS-PMAY(U)

(All figures in Rupees)

Category	Loan Amount (1)	Interest Subsidy (2)	Balance Loan (3)	Initial EMI @10% (4)	Emi AFTER Subsidy (5)	Monthly Saving (6)	Annual Saving (7)
			(1-2)			(4-5)	(6)×12
EWS Category	3,00,000/-	1,33,640/-	1,66,360/-	2,895/-	1,605/-	1,290/-	15,480/-
LIG Category	6,00,000/-	2,67,280/-	3,32,720/-	5,790/-	3,211/-	2,579/-	30,948/-
MIG-I Category	9,00,000/-	2,35,068/-	6,64,932/-	8,685/-	6,417/-	2,268/-	27,216/-
MIG-II Category	12,00,000/-	2,30,156/-	9,69,844/-	11,580/-	9,359/-	2,221/-	26,652/-

(Loan Tenure-20 Years/240 Months)

Regional Office-NCR has signed MoU with Sarva UP Gramin Bank for channelizing the interest subsidy available under PMAY(U) and extended all support for implementation of the programme. HUDCO has been successful in emphasizing that the interest subsidy benefits under the scheme are available from the Govt. of India through HUDCO as one of the two Central Nodal Agencies. The interest subsidy benefits are available upfront on the basis of Net Present Value (NPV) calculated on a discounted rate of 9%, which works out to Rs. 2.67 Lakh on a loan amount of Rs. 6.00 Lakh for a tenure of 20 years for EWS & LIG, Rs. 2.35 Lakh for MIG-I and Rs. 2.30 Lakh for MIG-II. The loan component may vary as per requirement of the beneficiary, and the interest subsidy benefit are calculated accordingly on actual loan amount with a ceiling of maximum loan limit of Rs. 6.00 Lakh for EWS/LIG and Rs. 9.0 Lakh for MIG-I and Rs.12.0 Lakh for MIG-II. The abstract of sample calculations showing upfront benefits available under the scheme is depicted in Table 1.

HUDCO's Regional Office-NCR is persuading the Development Authorities to dovetail the benefit of interest subsidy in their on-going/ upcoming projects from the beginning for construction of Pucca Houses/ Flats for EWS/LIG categories. It is also establishing dialog with beneficiaries through joint efforts of its borrowing agencies (Development Authorities) through Workshops cum- Melas and enlightening them about the programme. It is witnessed that the beneficiaries who were allotted flats by the Development Authorities on "hire-purchase basis" for a tenure of 5 years and 10 years for EWS and LIG beneficiaries respectively, have accepted HUDCO's ideas & persuasions and converted their existing "hire-purchase" allotments of flats to the "cash-down" mode by availing direct loan from the Primary Lending Institutions (PLIs) so as to become eligible/entitle for interest subsidy benefits under the programme. This has resulted in a win-win situation for both the Development Authorities which used to wait for 5 to 10 years for their repayment and the beneficiaries who got upfront benefits by becoming eligible for interest subsidy and enjoying easier repayment terms from PLIs. Figure 2 depicts HUDCO financed EWS/LIG housing scheme covered under

Figure 2: HUDCO financed PMAY-HfA Housing Project at Hapur

CLSS- PMAY(U) housing project at Hapur undertaken by the Hapur-Pilkhuwa Development Authority.

For all the 4 verticals, HUDCO through its Regional Office-NCR has extended a loan assistance of Rs 20,000 crores to BMTPC in the financial year 2018-19 for onward transmission to the State Govt. agencies & CNAs on the advice of the MoHUA, Govt. of India. A large population across the country has been benefitted from these resources and their dream for owning a house have come true as envisioned in this flagship Mission of the Govt. of India.

CONCLUSION

The PMAY-HfA (Urban)Mission aims to substantially improve the access of the urban poor for formal sector housing finance as well as making the houses affordable to the urban poor segment. Towards this, HUDCO is committed to extending its continued support to bring faster implementation of PMAY(U) through its strong network of Regional Offices. HUDCO stands committed to enabling a large section of population across the country to reap the benefits of the programme and support the Government of India in fulfilling its 'Housing for All' Mission within the Mission period.

REFERENCES

Government of India (2015), Pradhan Mantri Awas Yojana-Housing for All (Urban) Scheme Guidelines, Ministry of Housing & Urban Affairs, GoI.

HUDCO(2019), Data on CLSS, PMAY-HfA, Regional Office- NCR, Housing & Urban Development Corporation Ltd. 2019

CMD, HUDCO FELICITATED BY HON'BLE HOME MINISTER OF INDIA FOR HUDCO CSR ASSISTANCE

HUDCO Board in its 605th Meeting held on 20.02.2019 had sanctioned CSR assistance of Rs. 75 lakhs to Education Deptt., U.T. of Dadra & Nagar Haveli, Silvassa for Construction of Centralized Kitchen facility under Mid Day Meal Programme for supplying nutritious mid-day meal to Children of Govt. & Govt. aided Schools of Dadra & Nagar Haveli, Silvassa, Daman, Anganwadi and industrial labourers at Silvassa to be implemented by Akshay Patra Foundation.

The Hon'ble Home Minister of India Sh. Amit Shah inaugurated the Centralized Kitchen in a function held on 01.09.2019. In the programme, the Hon'ble Home Minister of India felicitated Dr. M. Ravi Kanth, IAS(r), Chairman & Managing Director, HUDCO in recognition of HUDCO's financial support under CSR activities to the U.T. Administration to enable them to build and operate the Kitchen for supplying mid-day meal to 57,000 no. of school children.

Hon'ble Home Minister Sh. Amit Shah felicitating Dr. M. Ravi Kanth, CMD HUDCO

CMD HUDCO at Centralized Kitchen facility under Mid Day Meal Programme at Silvassa

On 31.08.2019, the Secretary (Education), Dr. (Ms.) A.Muthamma, IAS met CMD and expressed her gratitude for sanction and release of CSR assistance to U.T. Administration. CMD also visited the Centralised Kitchen on 31.08.2019 and appreciated the construction of the facility and the noble initiative behind the implementation of the Project. The Akshay Patra team also thanked CMD for HUDCO's support for the project.

WASTE MANAGEMENT

BEST OUT OF WASTE AND DOOR TO DOOR COLLECTION OF SANITARY NAPKINS & DIAPERS IN PETLAD, GUJARAT

Implemented by Petlad Municipality

The Petlad Nagarpalika is responsible for waste management in the area under its jurisdiction. Petlad has undertaken several initiatives to improve waste management practices in the town. Two of these initiatives are the "Waste to Best" project and "Door to Door collection of Sanitary Napkins and Diapers". The Municipality has recycled Iron scrap material to make items such as dust bins, open drain grill, gates, frames, rafts (for Ganesh Mahotsav), etc. The municipality undertook a programme of door-to-door collection of bio-hazardous waste such as sanitary napkins and diapers, as well as their segregation and processing.

BACKGROUND

Petlad is a Class B municipality of Anand district located in the state of Gujarat in India. Petlad Nagarpalika, with population of about 55,000 (Census 2011), is Petlad sub-district's only municipality as well as sub-district head quarters. Total geographical area of Petlad municipality is 9 sq.km. with a population density of 6021 persons per sq.km. Petlad Municipality have nine wards. Many renowned scholars, including Sardar Vallabhbhai Patel, the first Deputy Prime Minister of India, studied in Petlad. The town has a very rich historical importance which dates back to Mughal era. The municipality of Petlad was established in 1876.

Petlad Nagarpalika is well equipped in handling sold waste. It has its own Plastic Pyrolysis plant which works on the principle of waste to energy for the management of solid waste. Organic waste / food waste is converted into manure and plastic is used to generate energy from waste, i.e. making petrol alternate fuel. The Municipality has installed a Sewage Treatment Plant of capacity 10.37 MLD which is maintained by the ULB. There is 100% door-to-door collection of wet waste & dry waste and these are disposed off in a scientific manner through incinerator. Also there is one Commercial Waste Collection Vehicle to collect commercial waste from all commercial areas twice in a day. Two notable initiatives of the Nagarpalika in waste management are detailed below.

WASTE TO BEST PROGRAMME

Petlad Municipality has successfully undertaken a "Waste to Best" programme for reusing iron scrap material. The initiative aimed at utilizing

Figure 1: Litter bins installed in public place

the iron waste scrap to make different equipment for waste management (Figure 1). The basic idea of this initiative is to collect and segregate waste, followed by treating and processing it in pyrolysis plant.

Under this initiative, the plastic and rubber waste has been recycled as a resource, turning waste into wealth. Generally, government grants are used for waste management works, but Petlad Nagarpalika thought of not utilizing the grants for the waste management and using waste scrap as a resource instead. Petlad became the only municipality in Gujarat who was using scrap for making equipment out of waste material.

Process

Petlad municipality would earlier dispose off iron scrap material by selling it. This scrap, which included items such as containers for garbage, broken railings, hospital scrap beds, rods, etc were usually sold to the scrap vendors at a very low cost.

The municipality decided to reuse this scrap to make useful items like small dustbins, litterbins, open drain grill, gates, frames, raft (for Ganesh Mahotsav), etc., which was achieved at a very low cost (Figure 2). For this purpose, they hired a fabricator for welding and a painter on daily basis.

Figure 2: Scrap material used for recycling

Petlad municipality has its own workshop for welding and glass cutting. But the workshop often had a heavy workload, with vehicles coming for small welding and repairing work for days or for weeks. So the municipality decided to take the help of self help groups. Thus, a workshop for the initiative came into existence. In this workshop, workers made items from scrap as per the instructions. First they made wall-mounted small dustbins from waste scrap followed by litterbins later which

Figure 3: Litter bins made out of scrap material

Figure 4: Litter bins beautified with painting

Figure 5: Wall mounted litter bin

were installed at 50 various places (Figures 3 -5). The results were achieved at only 10% of cost of new infrastructure. About a 100 litterbins were installed in the town in approximately 3 km of area.

After these litterbins were installed at various places, the municipal employees including President, Members, Chief Officer, students of the school were involved in *"Shramdaan"* to paint them and make them aesthetically pleasing.

Results Achieved

This simple but innovative initiative saved lakhs of rupees for the Corporation and achieved results in only 10th part of cost in comparison of new litterbins. The *"Shramdaan"* for Swachchhta Abhiyan also caught the popular imagination , inspiring citizens to contribute their effort in making Petlad clean and beautiful.

DOOR TO DOOR COLLECTION OF SANITARY NAPKINS & DIAPERS

Petlad Municipality has also undertaken a very innovative initiative to collect bio-hazardous waste, segregate at source and dispose scientifically through incinerator. Petlad municipality is the first in Gujarat to start a home-to-home service for collecting used sanitary pads and diapers and disposing it off scientifically (Figure 6).

Figure 6: Dustbins installed for collection of sanitary napkins and diapers

Since bio-hazardous waste such as sanitary napkins and diapers, remains intact till 400 yrs on land and further becomes the cause of land pollution, it is imperative that such type of waste be disposed off scientifically. Generally people throw or dump bio-hazardous waste with common household waste which becomes very difficult to segregate and manage as well. Solid waste segregation is the prime requirement.

Process

Initially, the Nagarpalika was provided a grant to purchase hand-cart, tricycle, and dustbins. However, the Nagarpalika decided to purchase e-rickshaws (Figure 7) instead to collect waste for the purpose of segregation at source. The Board of the Municipality gave sanction to the proposal of purchasing rainbow colored seven e-rickshaws. Among them, yellow colored rickshaw was designated for collection of sanitary napkins and diapers only. Further, Petlad

Figure 7: E-rickshaw for collecting sanitary napkins and diapers

Figure 8: Incinerator to dispose sanitary napkins and diapers

Municipality also purchased 10 incinerators (Figure 8) and installed them at ten public places like railway station, bus station, schools, colleges, shopping complexes, etc. for disposing sanitary pads & diapers. 2 Self Help Groups and a couple were engaged for this activity.

An Awareness Campaign of disposal of Sanitary Pads and Diapers was done by the Petlad Nagarpalika. Advertisement of collecting, segregating and disposing sanitary pads & diapers was done by distributing pamphlets door to door (Figure 9). Promotion of the campaign (Figure 10) was also done widely by WhatsApp and other social media, in which a mobile number and a helpline number was provided for collecting such bio-hazardous waste. The word spread all over for not throwing the sanitary pads and diapers in dustbin with rest of the domestic waste but to collect it in yellow colored E-rickshaw "Sanitary Napkin Collection Vehicle" which was designated for collection of bio-hazardous waste. Further, scientific disposal of that waste was done in the machine called 'Incinerator' which was also made out of waste scrap to perform the said task. Self Help Groups were engaged in the initiative.

Figure 9: Advertisement by distributing pamphlets

Figure 10: Awareness program to spread the word

Challenges

The biggest challenge for the campaign was the social stigma involved in the discussions regarding sanitary napkins. In the beginning, only 20 to 25 calls per day were made for collecting sanitary napkins and diapers but later on, it increased to more than 200 calls per day within the service of 4 months. Initially, women were ashamed of the subject but the municipality was successful in making them understand that they need not feel ashamed of the natural and scientific human processes.

One major problem that arose in this initiative was the defamation of the couple who collected those pads across the society. Among the couple, wife was even boycotted and treated like an untouchable by the community and they also started maintaining distance from her because of their mindsets as she was doing the work of a lower class. Later on, the Chief Officer, a woman herself, wrote a beautiful story regarding the subject which was published in "Matrubharti" app named "Aabhadchhet" (Untouchability) in Gujarati language. The Nagarpalika also worked hard to make females understand about the cause. Eventually the women understood that the lady's work is not shameful and she was no longer ostracized for her work.

KEY TAKEAWAYS

The Petlad Nagarpalika has managed 100% collection of solid waste, and segregation of waste at source with the help of Rainbow colored E-Rickshaws. The Municipality achieved status of ODF++ in Swachchh Sarvekshan - 2019. Petlad is the municipality where all inspected toilets were categorized excellent and aspirational category. The simple and innovative approaches adopted by Petlad in two aspects of waste management, as demonstrated in the examples above, are cost effective, people friendly and can be easily replicated by any other municipality.

HUDCO's HSMI Training Calendar 2019-2020

I. Training Programmes for Internal & External Participants

S. No.	Name/Theme of Training Programme	Duration & Dates	Venue/ Institutions	Target Group
1	Training Programme on Awareness of Operational Risk Management: Discussing Key Risk Indicators (KRIs)	1 day 27th June,2019	HSMI, Delhi	for HUDCO officials only
2	Management of NPAs: Effective Strategies for Prevention, Recovery, Valuation etc.	3 days 26-28 Aug.,2019	HSMI, Delhi	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards & other agencies/ Authorities/ Institutions/ NGOs and HUDCO officials
3	Leadership Development & Team Building	5 days 2-6 Sept.,2019	IIM Campus	for HUDCO officials only
4	Training Programme on Insolvency & Bankruptcy Code-2016 and Practical Aspects on Resolution along with other Legal Issues pertaining to NPA Management	2 Days 12-13 Sept., 2019	HSMI, Delhi	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards & other agencies/ Authorities/ Institutions/ NGOs and HUDCO officials
5	Training Programme on IND-AS for Finance Executives	2 days 23-24 Sept.,2019	HSMI, Delhi	
6	Project Appraisal Techniques & Credit Risk Management	5 days 23-27 Sept.,2019	IIM Campus	for HUDCO officials only
7	Empowering to Change: Programme for Young Women Professionals	2 Days 26-27 Sept.,2019	HSMI, Delhi	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards & other agencies/ Authorities/ Institutions/ NGOs and HUDCO officials
8	Workshop on team building, creativity and problem solving	3 Days 9-11 Oct., 2019	HSMI, Delhi	
9	Finance for Non-Finance Executives: Essential accounting/budgeting, taxation and audit etc.	3 days 15- 18 Oct., 2019	HSMI, Delhi	
10	Training Programme on GST for Finance Executives	3 days 29-31 Oct., 2019	HSMI, Delhi	
11	Training Programme on GIS for Project Officers	5 days 4-8 Nov., 2019	SPA	
12	Financial Statement Analysis for Lending Decisions (Including New Accounting Standards under IND-AS)	5 Days 2-6 Dec., 2019	NIBM, Pune	for HUDCO officials only
13	Training Programme on Digital Payment & Cyber Security	1 day 9 Dec., 2019	HSMI, Delhi	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards & other agencies/ Authorities/ Institutions/ NGOs and HUDCO officials
14	Risk Based Internal Audit	3 Days 18-20 Dec., 2019	NIBM, Pune	
15	GFR and Public Procurement including GeM & Basics of Contracts Management	3 days 2-4 Jan., 2020	HSMI, Delhi	
16	GFR and Public Procurement including GeM & Basics of Contracts Management	3 days 17-19 Feb., 2020	HSMI, Delhi	
17 TO 26	Training Programme on ERP (10 Nos of 1 day each) Covering 200 Participants	1 day each (Dates TBD in consultation with ED(IT) and ROs)	HSMI, Delhi/ ROs	for HUDCO officials only

*For Nomination form, fee and other details of programme please contact:
Phone: 011-24308611, 24308608|Fax: 011-24365292 |Website: www.hudco.org
Email: edthsmi2013@gmail.com

All are fee- based programmes, fee is required to be borne by sponsoring departments/ concerned officials. There will not be any fee for HUDCO officials

** Dates are tentative, subject to change

Venue is subject to availability and will be finalised at the discretion of HSMI

CIN : L74899DL1970GO1005276

HUDCO's HSMI Training Calendar 2019-2020

II. Training Programmes for External Participants

S. No.	Name/Theme of Training Programme	Duration & Dates	Venue/ Institutions	Target Group
1	Programme for PLIs under PMAY(U): Housing for All	3 days 2-4 Sept.,2019	Nainital	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards & other agencies/ Authorities/ Institutions/ NGOs
2	Managing Cities work – Imperatives for Cleaner, Greener and Sustainable Cities	3 days 11-13 Sept.,2019	Shimla	
3	Achieving the Sustainable Development Goals – The Way Ahead	3 days 25-27 Sept.,2019	Chandigarh	
4	Training Programme on Planning & Implementation of Sustainable Affordable Housing – Perspective on PMAY(U)	3 days 15-18 Oct., 2019	Goa	
5	Zero Waste – Decentralized Solid Waste Management	3 days 25-27 Nov., 2019	Indore	
6	Public Private Partnership in Urban Infrastructure and Service Delivery	3 days 28-30 Nov., 2019	Shimla	
7	Programme for Housing Finance Companies	3 Days 20- 22 Feb., 2020	HSMI, Delhi	

III. Training Programme for Real Estate Professionals

1	One-week Training Programme on Real Estate, Valuation, Marketing, Financing & Legal Framework with Focus on RERA.	One Week 19-23 Aug., 2019	HSMI, Delhi	Open for Officials of CPSUs/ Central/ State/ ULBs/ Housing Boards / Authorities/ Institutions/ NGOs/ Builders and Real estate agents

IV. Training Programmes for Officials of MP Housing & Infrastructure Development Board

1	Capacity Building Programme for officials of MPHIDB on Construction & Planning Management	3 Days 2- 4 Jan., 2020	HSMI, Delhi	Officials of MPHIDB

V. Customised Programmes for North East Officials (Under MDP Budget)

1	Training Programme on Cost Effective Technology for ULBs for the State of Assam	3 days 19- 21 Nov.,2019	Guwahati	Officials of NE Region

VI. CITYNET Training Programmes [Under MDP Budget]

S. No.	Name/Theme of Training Programme	Duration & Dates	Venue/ Institutions	Remarks
1	Training Programme on "Making Cities Disaster Resilient-Challenges and Approaches" for CITYNET (India National Chapter) members	3 days 2-4 Sept., 2019	HSMI, Delhi	Participation open for ULB's and CITYNET member institutions
2	Training Programme on "Climate change and cities-way forward for adaptation, mitigation and resilience" for CITYNET members (India & Overseas)	5 days 21-25 Oct., 2019	HSMI, Delhi	

Sponsored Training Programmes for the Year 2019-20

VII. Ministry of External Affairs sponsored Programmes(International Training Programmes)

S. No.	Name/Theme of Training Programme	Duration & Dates	Venue/ Institutions	Remarks
1	Formal Solutions to Informal Settlements	06 Weeks 4 Nov. - 13 Dec., 2019	HSMI, Delhi	Nomination of International participants available through MEA - ITEC portal. Fee, allowances etc are as/ Sanction order of MEA
2	Planning & Management of Sustainable Cities	06 Weeks 6 Jan. - 14Feb., 2020	HSMI, Delhi	
3	Realising the right to adequate housing in the context of Habitat III New Urban Agenda-Policies, Planning and Practice	06 Weeks 24 Feb. - 3 Apr., 2020	HSMI, Delhi	

VIII. Department of Personnel & Training (DoPT) sponsored Programmes:

S. No.	Name/ Theme of Training Programme	Duration & Dates	Venue/ Institutions	Remarks
1	Financing Urban Infrastructure and Services in India	One Week 16 -20 Dec., 2019	HSMI, Delhi	Nomination from All India services through DoPT portal

GENERAL GUIDELINES: CHECKLIST FOR SUBMISSION OF ARTICLES

The following checklist should be used when preparing an article for submission Please be sure to follow the specifications exactly and completely to ensure that your article is reviewed a timely manner and any delays avoided further along in the publishing process should your article be accepted for publication.

1. The paper should be created using a word-processing program (such as Microsoft Word) and should be between 3,000 and 5,000 words in length. The file may be in .docx or .doc format.
2. The paper should be typewritten, double-spaced, and formatted to print on 8.5" x 11" (or A4) size paper. It is written in the third person in a clear style, free of jargon.
3. The first page of the article includes the following:
   i. the paper's title and
   ii. an approximately 200-word abstract that emphasizes the paper's contribution to the field and its practical architectural/ planning social/ economic implications.
   iii. the name(s), position(s), professional or academic affiliation(s), and email address(es) of the author(s), as well as the full postal address of the corresponding author;
4. The body of the paper should include the following:
   i. an introduction to the subject,
   ii. background information,
   iii. discussion of procedure,
   iv. results,
   v. conclusions,
   vi. implications for practice and advancement of research,
   vii. references,
   viii. acknowledgments (optional; if funding for the research was received from non-personal sources, the sources must be identified in this section), and
   ix. an autobiographical sketch.
5. Please ensure that:
   i. References are complete, have been arranged alphabetically by author surname and checked for accuracy.
   ii. Reference citations in the text are referred to by author name and year. If there are more than two authors, the name of the first author followed by "et al." has been used.
   iii. References contain the following information, in the order shown: names of all contributing authors (last name followed by first initial), date of publication, title of article, names of editors (edited books only), title of journal or book, volume and issue numbers (journals only), location and name of publishing company (books only), and inclusive pages (journals and articles in edited books).
   iv. Figures/ pictures/ graphs submitted are:
      a. Large enough to be readable when reduced to fit the journal page size (approximately 5.25" x 8.25").
      b. A brief caption is provided for each figure/ picture/ graph.
      c. The figure is cited in the text.
      d. Please ensure that scanned images are of a high resolution to ensure good quality printing (not less than 640 x 480)
   v. All tables are included either in the original manuscript file or as a separate Microsoft Word document and have been checked to ensure that they can be easily reproduced on the journal page (size approximately 5.25" x 8.25").
      a. A brief caption is provided for each table.
      b. The table is cited in the text
6. If your paper is accepted for publication, you will be provided with information on where to send the hard copies of any figures if required.
7. The manuscript and any table/picture files should be sent via email to hsmishelter@gmail.com ONLY original works neither published nor under review elsewhere will be considered.

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