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INTERNATIONAL COUNCIL FOR CIRCULAR ECONOMY
with
INDIAN PLASTIC INSTITUTE

BUILDING A SUSTAINABLE FUTURE

IN FOCUS
TÊTE-À-TÊTE WITH
PRABHJOT SODHI

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EDITOR'S NOTE

Journey of a thousand miles begins with one step!

Welcome to the latest edition of the Journal on Circular Economy, where we continue our journey in exploring and disseminating valuable insights into the transformative realm of circular economy practices. With each edition, we aim to illuminate pathways toward a sustainable future.

In this edition, our contributors delve into a spectrum of critical topics, echoing the theme of "Building Sustainable Futures through Circular Economy." The diverse range of articles includes a comprehensive review of the Indian policy framework for circular economy in the context of building and construction, shedding light on the strides and challenges in this pivotal sector.

One of the focal points of this edition revolves around the nuanced discussion on transitioning toward a circular economy, encapsulating both the opportunities and challenges that this paradigm shift entails. We explore how circular economy principles can be strategically integrated into India's landscape, offering sustainable solutions for resource efficiency.

Furthermore, our contributors dissect the intricate relationship between circular economy practices and two vital sectors – Solar Photovoltaics and Telecommunication. The articles provide deep insights into policy imperatives and sustainable resource efficiency, unveiling the potential for circularity in these rapidly evolving industries.

As we embark on this intellectual journey, we extend our gratitude to the authors, researchers, and thought leaders who have contributed their expertise to enrich this edition. Their invaluable perspectives contribute to the ongoing discourse on circular economy principles.

Looking ahead, we invite scholars, practitioners, and visionaries to contribute to the next edition of our journal. The Manthan platform awaits your insights, research findings, and reflections on the multifaceted landscape of circular economy practices.

Thank you for being a part of our commitment to advancing knowledge, fostering innovation,and catalyzing change through the Journal on Circular Economy.

Shalini Goyal Bhalla

> "With the fast changing policy landscape during the decade of action, collaboration and knowledge updation is the key to meet individual as well as collective cumulative goals.

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READERS SAY

"In a circular economy mindset we care how we do our products and what we do with them. Journal on Circular Economy is an important forum for circular ideas to spread.

Ester Lovsin-Barle,
Head of Product Stewardship & Health,
Takeda Pharmaceutical Company

"Journal on Circular Economy is a unique Indian knowledge product at intersection of climate, sustainability and institutional innovation. A unique scholarship platform to find breakthrough ideas in an accessible format. Accomplished contributors further make the Journal a compelling reference to targeted circularity issues

Pooran Chandra Pandey
Resident Representative, Climate Scorecard

"Well-compiled journal on circularity, most relevant in current times

Kishore Sampat,
Former President – AIPMA

PRABHJOT SODHI
Centre for Environment Education
Sr Program Director

TÊTE-À-TÊTE

SHALINI GOYAL BHALLA
Managing Director
International Council for Circular Economy

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Can you provide insights into the current landscape of Material Recovery Facilities (MRFs) in India and their role in waste management? How have these facilities evolved over the years?

Decentralized MRF signifies the future of dry waste management in India. It is a semi-automated processing facility need to be seen as a factory for dry waste operations and management. A Material Recovery Facility (MRF) seen as a space/area with a covered shed which receives pre- and post-consumer non-bio-degradable, non-compostable (dry) materials, that are recyclable. Largely, collected from residential and commercial sources. Its primary function is to separate, sort, and prepare these materials for sale to end buyers, but strategically it enables to take better business decisions with inventory tracking; operational insights with material flow analysis; real-time customized reports on the incoming (for processing) and outgoing materials (for recycling); and what price; process optimization with comprehensive planning and digital control. Once all aspects are looked in an integrated systems approach then it leads to a business model-profit centre. The area, designs started to happen defining the contours from anything between 2000 sq. ft to 8000 sq. ft. areas. Everyday discussions led with stakeholders on what is the most optimal size and what machinery need to be put up. Ideas emerged differently for different cities; and also for both rural and urban landscapes in India.

This ecosystem approach started around the 2006-08 when dry waste was considered and seen as an emerging problem. Plastics were already in the mainstream and communities of practice across the ecosystem i.e. producers, brand owners and fast-moving consumer goods companies (FMCGs) saw this wonder material as a material which is cheap, durable, attractive (encourages consumer sales) for packaging. The human greed capitalised quick buck and it quickly seeped so deep through the use of small formats (below 50 g or 50 ml in size) and sachets (below 10 g to 10 ml in size) and nearly half of these small formats are sold in the form of sachets[i]. Today it is difficult to find the right solutions and we are grappling still to find the right design and packaging alternate materials.

Thin and flexibles started to litter, people started to burn in rural areas for heat energy without knowing the after-effects and health hazards. By the time the rules on plastics happened in 2016 the mess was already created. Entrepreneurs emerged as small aggregators-kabadiwallahs and they started collection, segregation of materials into different fractions. Many saw this as an opportunity; investors and funders like UNDP GEF Small Grants Program (SGP) anchored through the then Ministry of Environment and Forests (MOEF) supported innovative process-ideas in Bhopal and Indore in partnerships with urban Local Bodies[ii]. Many Non-governmental and Governmental institutions started investing in collection systems, incentivising collection of small formats, consumer behaviour change happened for consumption and identifying viable systems and markets in cities like Bangalore, Mysore, Delhi, and others.

New approaches and challenges started

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to find solutions to an emerging problem. The waste pickers-WPs (safii sathis) also saw a ray of hope to better their livelihoods and collect better. But the WPs did not find the thin, flexibles be weight an economical exciting proposition. Thus, it all ended up in drains, landfills, and in the stomach of the 'holy cow'. The cost of collection per kgs was much higher than the price offered by market. No recycler was ready to take. Initially the cement kilns were interested for MLP, which had a higher calorific value with no ash content (in contrast to traditional coal) when used as a fuel in clinker units for co-processing. Amidst all the confusion, recycling of plastics gained more impetus. Informal recycling centres in the country emerged a good boost to the economy; the circularity steps started to set in plastics. Although there is no mapping available on how many of the decentralised MRFs are functioning as of today, some figures in rural areas on infrastructure is available at Jal Shakti Ministry website state wise. But this concept has gained importance; a greater emphasis in fact through the Swachh Bharat Mission Grameen (SBM-G) guidelines by the Ministry of Jal Shakti 2019; which makes mandatory to set up one MRF every block in the country. A much thought over excellent opportunity and right step towards sanitation. The allocation of Rs 16 lacs per block for setting up the machinery and infrastructure for decentralised MRFs. The guidelines are encouraging to club blocks and this combined way between 3-4 blocks to put an MRF and also have convergence with peri-urban and small towns included is setting the trends in better collection of dry and plastic waste. This flexibility is creating better results in pooling financial resources from 15th pay commission. Many states have planned in different ways pushing for sustainability a priority. But a trained workforce remains a BIG requirement and a challenge. Small steps are creating systems approach adopted in both rural and urban spaces at MRFs; this will give greater opportunities for better incomes and jobs to stakeholders in the ecosystem in coming years. All in all, it would be fair to say that a firm beginning has been made in the right direction.

Considering the vast diversity in urban local bodies (ULBs) and cities across India, what notable measures have been taken by them to integrate MRFs into their waste management strategies? Are there any successful models or best practices that stand out?

As mentioned above, the guidelines for setting MRFs got integrated into the SBM-G. Ministry of Housing and Urban Affairs (MOHUA), in 2019-2020 drafted national guidelines for functioning of the MRFs. Wider consultations through the Niti Aayog's circular economy committees gave birth to the first formal steps towards decentralised MRFs[i] management and operations. Yes, the focus of MRF was seen more in a semi-automatic system put in place, recognising the role of the informal sector of safaii sathis in laying strategic foundations. The local bodies started to tow the line of partnerships with UN agencies, and good civil society institutions to implement and manage MRFs.

The MRFs kept the principles of minimum internal movement, process sequencing, occupational health and safety, flexibility, decent working conditions for the safaii sathis working, optimum investment and sustainability.

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The MRF focuses on all types of materials, including low-grade waste to ensure complete recovery. As mentioned by SAHAAS - the objective is to move closer to a circular economy and achieve the global goals around sustainable development. Each category of waste is first compressed, then stored and finally dispatched to authorised recyclers. These recyclers are able to recover value from the waste by transforming them into products such as stationary, chipboards, and t-shirts to name a few. [i]
CEE has put greater emphasis in ensuring a complete business model. This figure © below shows the path of financial transactions occurring during the inflow and outflow of materials at the Material Recovery Facility (MRF).
The Weigh Bridge Slip, issued for both inbound and outbound movements, along with Purchase and Sales, Tax invoices is a necessity and results in a path to analyse business strategy. This also encourages a more systems led approach for transparency and traceability, ultimately a requirement for better plastic extended producer responsibility (EPR).
Therefore, every NGO, waste processing companies have laid common mutually beneficial systems approach.

Can you highlight some success stories where the establishment of MRFs has significantly improved plastic waste recycling rates in certain regions of India? What factors contributed to their success?

Yet early stages for gauging the success, but yes, some principles need to be adopted as best practices. Firstly, the MRF management and operations needs to be looked as a project (clear detailed ways of working, traditionally as a detailed project report {DPR}) and not ticking boxes. Over the last 8 years we have set up many MRFs in cities and towns in partnership rural and urban landscapes.Many have worked well; while a few riddled with personnel issues, lack of supportive systems, and dynamic plastic market conditions. Learnings led to develop CEE-HDFC BANK supported program in every city. Where clear emphasis has been for a systems-approach of developing an 'entrepreneur' (service provider) for operations, with clearly defined and agreed roles and responsibilities between the urban/rural bodies and CEE. Flexi-process approach for efficiency in materials handling,

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people, skilling, systems & processes, sustainability pathway and knowledge-information as shown in the figure © below has delivered results in the ecosystem. These simple systemic processes promote integration, optimal-use of resources, all-inclusive circularity methods of no-waste as shown below in Figure 1 ©. Simple steps are combined together with stress on quality, quantity in a time frame (QQT) approach. This encourages in each city community participation & ownerships which has led to:-

a. **Improved** Source Segregation and collection – urban, rural and peri-urban areas

b. **Optimization in management of dry**, plastics of all types in waste, transportation mechanism

c.**Maximize** resource recovery by facilitating establishment of the Integrated Facility - MRF

d.**Encourage** backward linkages (collection, purchase from informal sector, aggregators, institutions, RWAs etc.) in the supply chain to enhance collection of good type and quality of waste.

e. **Establish** market (recyclers, bulk waste generators {BWGs}) linkages, refurbishes etc.

f. **Promote** community engagement and ownership (“Jan-Andolan”)

g.**Develop** sustainable profit-based (not profiteering) business models, help social security, job creation and impact the livelihoods of the local women SHG groups and other informal sector stakeholders.

Yes, the success of any initiative lies when ‘all stakeholders in the ecosystem’ taking ownerships; and processes determine desired results. The fear factor of Government at times actually enhances performances and fiasco (at times) reinforces the service providers to keep the ecosystem healthy through traceability, transparency and accountability. Today, Governments – as policy makers and regulators (largely happening in EPRs) need to fast realize that policy layout, facilitation and monitoring can be a state function; but certainly, with changing paradigms implementation of programs need professionals-play. Such sharing of roles provides better efficiency, learnings and checks conflict of interests-defensive approach. We need to move fast on the global agendas, where debates are all in pull factor. Of course, there cannot be one fit for all. Therefore, many models of MRF management have been working with different degrees of success, show and sharing best practices – to name a few institutions like Hasirudalla, Stree mukti sangathan, Rekart, Trashonomy, Kabadiwallah, Sarthak, Recircle, Recity, AAsraa, Paperman, Hindustan SWM, RAMKY, Dalmia, and many more have shared sustainable ways of working and impacting sustainable development goals and checked carbon emissions from burning of plastics.

Success emerges when we understand what it takes to sort waste throughout the day. Analise the type of waste which comes to the MRF and its quality. Observing how the workforce in jobs are being treated. Getting to know sorting staff and their job satisfaction is heart-rendering. In my last 15 years I was able to connect with our team, staff learnt about their stories, challenges and what it takes them to get to there. I take pride in what

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I do and talk to others to adopt, adapt, scale it. In my journey I have seen amazing impacts in waste management all across the ecosystem. This is very near to my heart when safaii sathis gain respect and dignity from stakeholders. In the last 10 years Government at all levels has played a great role in ensuring this. We are not looking back and now we know this model approach is working and at CEE with partners shall aim for creating thousands such Jobs while fast forwarding the transition to Circularity Approach, that's the only way to go.

Despite the positive strides, what challenges do MRFs typically face in India when it comes to waste management? Are there regulatory, infrastructural, or awareness-related hurdles that need to be addressed?

In this dynamic world life co-exists with challenges; sometimes we are driven by a greed to access funds than service delivery; other times we have stringent rules and systems which do not favour; the very production-design challenges in packaging become a limitation; simple, easy-to-adapt low-cost technologies at times do not have the required material efficiency and trained manpower.

Many cultural habits and processes across a mega-biodiverse country like India too have limitations. Increasing incomes, rapid urbanisation, and high consumption lifestyles are generating more waste in urban cities and rural landscapes. Limited knowledge of machine operations, knowledge about the functioning, capacities, spares required and not the least the revenue-based models. The very habit of littering and plastic burning too becomes a challenge. The introduction of biodegradable, and compostable plastics getting mixed with polymer-based products are creating recycling issues. In the absence of the respective conditions and knowledge for biodegradability and composting etc this is again a step demanding attention and we may not end up like single-use plastics fate. Therefore, need of the hour is to have different international colour coding for the biodegradables and compostable plastics. Safe working conditions in terms of machine mechanics & fire & safety are required and need to be stressed in every MRF. Plastics is nothing but heat energy. Machine breakdowns and long idle times in repairs is another issue. Here we need a pro-active approach and all the listed challenges have answers and locally adaptable solutions.

The solid waste sector is seen as a major source of emissions that contribute to climate change, especially methane and black carbon. Although they remain for shorter times in atmosphere but the carbon dioxide emissions are becoming a challenge. Government of India's strong message 'danda' (through National Green Tribunal-NGT) has led city commissioners and states to reduce the waste dumping sites, in turn reduce emissions. More emphasis on recycling and circular economy systems approaches is creating an exciting 'opportunity' for all.

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In your opinion, what future developments or innovations can further enhance the role of MRFs in creating a circular economy for plastic waste in India? Are there untapped opportunities or areas that require more attention and investment?

Firstly, we should not get deterred from the challenges and problems. The future innovations are emerging in the space of production, consumption and disposal of waste. Researchers, academic institutions are working tirelessly in developing

- Design changes in terms of bottles happening; so that no wraps of PE or PP needs to be put around the bottles, and the labelling can be embossed during the bottle manufacturing.

- The caps on the bottles are designed to ensure ease in recycling and no wastages take place.

- We are moving back into our earlier sustainable ways of lifestyles. The ideas of refills are being introduced by the producers and brands; more discounts are given if you bring your refills. Mother diary milk is sold Rs 2-3 cheaper if taken in refill cans. Similarly, Hindustan Levers, Dettol (has introduced) refill mounted dispensers on vehicles for liquid soaps, floor cleansers etc. which sell 20-25% cheaper than the market prices. These are the consumer level innovations happening.

- More artificial intelligence (AI) methods are introduced to avoid losses.

- Government is encouraging more policies pro-recycling, refurbishing. The present guidelines on RRR centres, Lifestyles for Environment (LIFE) are leading choices for building circular economy.

- Engaging stakeholders for critical thinking in waste management is implementing strategies to reduce waste generation.

- Field based actions on waste characterisation, waste topology is helping in building a need based solid and plastic waste planning.

Lastly end up concluding that a firm start has been made in the country; and in the next five years the recycling of plastics figures presently from 5 million tons/year will increase to 30-35 million tons/year for plastics by 2035. Vigorous policy guidelines by MOEFCC for using recycled plastic content by producers, importers, brands, in their products is a very positive step. The GOI think tank needs to be congratulated for this 'SOOCH'.

ABBREVATIONS:

[1] INDIA PLASTICS PACT REPORT ON SMALL FORMATS AND SACHETS. MANAGED BY CII AND SUPPORTED BY WRAP.
[1] UNDP GEF SGP IMPLEMENTED BY CENTRE FOR ENVIRONMENT EDUCATION (CEE) GRANT IMPLEMENTED BY IMTEYAZ ALI, CEO SARTHAK
[1] MOHUA MRF GUIDELINES
[1] SAAHAS ZERO WASTE IS A SOCIO-ENVIRONMENTAL ENTERPRISE WITH 18 YEARS OF EXPERIENCE IN THE WASTE MANAGEMENT SPACE. WE BELIEVE IN A CIRCULAR ECONOMY WHERE ALL WASTE IS CONVERTED TO RESOURCES AND HAVE WORKED WITH 80+ CLIENTS ACROSS INDIA TO MOVE THEM CLOSER TO ZERO WASTE ASPIRATIONS.

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Mr. Sodhi is a seasoned professional with over 40 years of experience. Currently serving as the Sr Program Director for Circular Economy at the Centre for Environment Education (CEE), Sodhi has held key positions such as Head of UNDP Circular Economy. His expertise spans various sectors including plastics, climate change, and natural resources management. Sodhi has worked with prominent organizations like Coca Cola, Hindustan Unilever Limited, and HDFC Bank, contributing significantly to circular economy initiatives. He has received prestigious awards such as the Talented Conservator Award from The George Washington University and the Most Excellent Order of the Member of British Empire (MBE) from the UK Government. Sodhi is widely recognized for his published works and has been honored with appointments to various national and international committees, including the Waste to Wealth Mission and the UN Global Plastics Team. In 2022, he was appointed as Professor of Practice by UGC-supported CV RAMAN UNIVERSITY, Khandwa, Madhya Pradesh, in acknowledgment of his extensive knowledge and experience.

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BUILDING A SUSTAINABLE FUTURE THROUGH CIRCULAR ECONOMY

CIRCULAR FUTURE

ABSTRACT

INTRODUCTION

It is possible to make the linear economy's basic tenet—taking resources, producing goods, and discarding them—more sustainable. This strategy, however, has waste, exhausts natural resources, and exacerbates climate change. Conversely, the circular economy is an economic theory that prioritizes minimizing waste and improving resource use. This article tries to explore the circular economy's definition, significance, and potential to create a sustainable future. We will specifically examine the tenets of the circular economy, the benefits it provides, and the difficulties it encounters. Additionally, we will investigate instances of circular solutions being implemented in various industries. The circular economy has garnered significant attention in recent years as a means of building a sustainable future.

What is Circular Economy?

Eliminating waste, repurposing goods and materials, and recycling materials are the three pillars of the circular economy. Establishing the first principle of waste reduction demands that goods be created that use fewer resources, are more robust, and are simple to repair and recycle. Incorporating recycled or biodegradable materials and developing readily recyclable products can significantly decrease waste generation.

The second tenet, product reuse, involves creating products that can be taken apart and used again and devising business models that facilitate product reuse, such as leasing and rental services. This approach reduces the quantity of waste produced and the resources needed to manufacture new products. The third tenet, material recycling, concentrate on recycling materials once they end their lifespan. Achieving this goal requires designing straightforward products and establishing a recycling infrastructure that can process a wide range of materials. The ultimate objective is to transform waste into a valuable resource that can be reused. These principles aim to establish an economy that is restorative and regenerative, divergent from the linear and wasteful model. The circular economy also prioritizes creating products that have a longer lifespan, can be easily repaired, and are recycled or reused, reducing waste and pollution (known as the "design out waste and pollution" principle).

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Furthermore, the circular economy seeks to extend the utilization of products and materials using repair, refurbishment, and recycling, which diminishes the need for new resources (the "keep products and materials in use" principle). Lastly, the circular economy advocates for a sustainable economy that aligns with nature and revitalizes biological systems such as soil, water, and biodiversity (the "regenerate natural systems" principle).

Benefits of the Circular Economy

The circular economy presents several advantages, which include: Environmental benefits: The circular economy reduces waste and pollution, preserves resources, and aids in addressing climate change. Economic benefits: The circular economy can generate new business prospects, enhance resource efficiency, and decrease costs. Social benefits: The circular economy can create job opportunities, improve public health, and promote social justice. Challenges of the Circular Economy Despite the numerous benefits of the circular economy, it has its difficulties. Lack of awareness: Many individuals need to be aware of the circular economy or its principles, which can hinder its adoption. Resistance to change: Shifting to a circular economy necessitates.

significant alterations in manufacturing and consuming goods and services, which can be difficult. Limited infrastructure: The circular economy necessitates infrastructure to facilitate practices such as recycling and refurbishment. In many places, this infrastructure needs to be improved.

Why is Circular Economy Important?

The circular economy is imperative for several reasons. Firstly, it can aid in reducing our environmental impact. By diminishing waste and increasing resource efficiency, we can decrease our carbon footprint, safeguard natural resources, and protect ecosystems, ensuring the environment's preservation for future generations.

Secondly, a circular economy can generate economic opportunities. By developing products that are easy to disassemble and reuse, we can create novel business models that facilitate product reuse and recycling, stimulating economic growth and creating new job prospects.

Thirdly, a circular economy can assist us in addressing resource scarcity. As natural resources become more scarce, discovering ways to reuse and recycle materials will become increasingly vital.

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The circular economy can enable us to achieve this by optimizing the value we obtain from our resources and reducing the necessity for new resources.

Circular solutions are being implemented in all industries to encourage sustainability. Examples of some of these initiatives are shown below: the fashion sector. The wasteful practices and damaging impact on the environment of the fashion industry are well-known. However, certain companies are trying to implement circular solutions, such as using recycled materials, creating easily repairable clothing, and establishing closed-loop systems for product recycling and reuse. Here are a few instances of circular fashion industry solutions:

The fashion industry has utilized circular solutions to deal with its wasteful habits and environmental impact. These are some of the examples of these solutions:

1. Rental and second-hand clothing marketplaces: Rent the Runway, ThredUp, and The RealReal enable renting and used clothing, lowering the need for new clothing creation and waste.
2. Upcycling and repurposing: Businesses like Patagonia and Levi's have launched upcycling initiatives to turn waste materials into fresh, high-quality items.
3. Recycled and sustainable materials: To reduce the environmental impact of clothing production, companies like Nike, Adidas, and Stella McCartney use recycled materials in their products.
4. Closed-loop production: To minimize waste and the environmental impact of the clothing industry, businesses like H&M and Levi's have started closed-loop production programs.
5. On-demand production: Businesses like Unmade are launching on-demand production efforts to reduce waste while enhancing sustainability by only manufacturing things as needed.

To promote sustainability, the food industry is also embracing circular solutions by distributing surplus food to charity, producing animal feed out of leftovers, and using sustainable farming methods to encourage biodiversity and soil regeneration, for example, decreasing the quantity of food squandered.

Here are some examples of circular solutions in the food industry:

1. Reducing food waste: Programmes to reduce food waste entail diverting edible food that would otherwise go to waste to food banks, composting, or recycling. Some organizations, including City Harvest and the Food Recovery Network, have started initiatives to gather and give leftover food to those in need.
2. Composting: Composting turns food waste into nutrient-rich material that may be spread on the ground as a fertilizer. The Compost Company's food waste composting programs enable people and businesses to dispose of food waste in an environmentally responsible manner.
3. Regenerative agriculture: Regenerative agriculture is an agricultural strategy that emphasizes growing biodiversity, enhancing soil health, and lowering the usage of synthetic pesticides and fertilizers. Additionally, it may entail applying sustainable farming techniques like crop rotation, cover crops, and minimal tillage.

4. Programmes to reduce packaging is designed to utilize less packaging and more environmentally friendly materials. To cut down on waste, businesses like Loop are developing reusable packaging for food products.
5. Reducing the quantity of energy and water used in food production is a goal of energy and resource efficiency programs. For instance, vertical farming methods have been created to grow food in urban locations using less water and energy.

Electronics sector: The electronics sector is implementing circular solutions, such as designing simple products to upgrade or repair and developing closed-loop recycling systems.

The electronics sector offers the following instances of circular solutions:

1. Extended producer responsibility (EPR): EPR is a legal framework that calls on producers to manage the end-of-life of their products. This includes putting procedures for gathering, recycling, and reusing electronic equipment in place.
2. Repair and refurbishment: Repair and refurbishment programs seek to increase their lifespan by repairing and modernizing electronic devices. People can fix their devices using tools and resources from businesses like iFixit and The Restart Project. In contrast, companies like Apple and Dell provide product repair services.
3. Closed-loop production: In a closed-loop system, materials are recycled and reused after a product's life cycle. Closed-loop production initiatives have been started by businesses like Dell and HP to repurpose materials from their previous products to create new ones.
4. Recycling and recovery: Recycling and recovery programs recover valuable materials from outdated devices and repurpose them for use in manufacturing. To collect, process, and recycle electronic waste, ERI and RecycleForce provide recycling and recovery services.
5. Design for disassembly and recyclability: This practice entails creating simple items to disassemble so that the individual parts can be recycled or reused. Companies that support the reuse and recycling of electronic gadgets include Fairphone and Apple. Their products are designed with modular components that are simple to fix or replace.

HOW CAN WE BUILD A SUSTAINABLE FUTURE THROUGH CIRCULAR ECONOMY PRACTICES?

We must put various tactics into practice if we want to create a sustainable future through circular economy practices:

Design for circular economy

One of the most critical ways to carry out circular economy principles and create a sustainable future is to design simple goods to disassemble and reuse. Designing goods that consume fewer resources, are more robust, and are simpler to repair and recycle can help achieve this. For instance, using recyclable or biodegradable materials in manufacturing and developing simple items to recycle helps reduce waste generation

Implement a closed-loop supply chain.

A further essential phase in implementing circular economy practices for establishing a sustainable future is the actualization of closed-loop supply chains. As a result, waste decreases, and materials are reused as much as feasible. A furniture maker could implement a closed-loop supply chain by replacing worn-out furniture, renovating it, and reselling it as a demonstration.

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Invest in recycling infrastructure.
We must invest in recycling infrastructure for a sustainable future through the circular economy. This involves creating markets for recycled materials and developing systems for collecting, sorting, and categorizing resources. Governments and corporations can collaborate to invest in recycling infrastructure and incentivize consumers to recycle by launching awareness campaigns and offering rewards.

Encourage product reuse
Developing a circular economy and adopting laws that support sustainability have recently seen substantial progress in India. To address issues with resource shortages and waste management, the Indian government has acknowledged the significance of moving towards a circular economy.

Promote collaboration and innovation.
Building a sustainable future through circular economy practices requires collaboration and innovation. Governments, businesses, and consumers need to work together to solve the complex problems we face. This can involve creating partnerships between companies and governments or corporations and other industries. It can also include investing in research and development to develop new products and materials that are easier to recycle and reuse.

Circular Economy Policies in India
India is making enormous strides toward creating a circular economy and implementing sustainable development-promoting policies. The transition to a circular economy is essential for resolving issues with resource shortages and waste management, claimed according to the Indian government.

National Resource Efficiency Policy
To encourage adopting sustainable practices, promote the effective use of natural resources, and reduce waste generation, the Indian government released the National Resource Efficiency Policy (NREP) in 2017. All economic sectors, including manufacturing, construction, agriculture, and services, will likely increase resource efficiency due to the policy.

The NREP has set ambitious targets to enhance resource efficiency in essential industries, including a reduction of 50% in the intensity of construction and demolition waste generation and a decrease of 30% in the power of water consumption in industrial processes. The strategy further supports the circular economy principles, such as product redesign, reuse, repair, and recycling, to lessen waste generation while enhancing resource efficiency.

Increased producer accountability
The Indian government also implemented new waste management rules to encourage resource preservation and lower rubbish output. The 2016 Solid Waste Management Rules promote waste segregation at the source, safe trash disposal, and waste recycling. The regulations require that all entities, including enterprises, organizations, and homes, generate rubbish that is divided into three categories: wet, dry, and hazardous
.
The rules also require municipal governments to establish garbage-processing facilities, such as composting farms and recycling facilities, for waste's ethical handling and disposal. The regulations encourage the concept of "waste-to-energy," which entails producing energy from garbage by incinerating or gasifying waste.

Rules for Waste Management

The Indian government has also implemented new waste management policies to encourage resource conservation and reduce garbage generation. The 2016 Solid Waste Management Rules promote waste segregation at the source, safe trash disposal, and waste recycling. According to the rules, all entities, including enterprises, organizations, and homes, must generate rubbish that is divided into three categories: moist, dry, and hazardous
.
The regulations also call for the setting up by local governments of waste-processing facilities, including composting farms and recycling facilities, for the environmentally responsible treatment and disposal of garbage. The rules support the idea of "waste-to-energy," which involves generating energy from waste-utilizing processes such as gasification and incineration.

Plastic Waste Management Rules

India is one of the largest consumers of plastic in the world, and the quantity of garbage made of plastic produced there presents an essential threat to the environment. The Plastic Waste Management Rules, 2016, which the Indian government took place to address this issue, aims to reduce plastic consumption and promote recycling of plastic garbage.

Manufacturers of plastic goods are compelled by the laws to use recycled plastic in their products at a minimal level. In addition, the rules forbid the production and distribution of several plastic goods, including non-biodegradable plastic bags and containers with less than 200 ml capacity. Additionally, based on the regulations, local governments must set up facilities for collecting, sorting, and recycling plastic waste.

Conclusion

India has made significant achievements in promoting the actualization of circular economy principles and implementing sustainability policies in practice. To establish a circular economy and encourage resource efficiency, we must implement the National Resource Efficiency Policy, Extended Producer Responsibility, waste management rules, and plastic waste management rules.

By reducing the amount of waste and maximizing the utilization of resources, the circular economy offers a possible way to create a more sustainable future. Industries may lessen their environmental operation, offer fresh revenue streams, and promote societal equality by adopting circular solutions. The circular economy has to conquer various challenges, notably a need for more awareness and adequate infrastructure. The circular economy will grow increasingly important as we proceed towards a more sustainable future to create a world that's regenerative and restorative rather than linear and wasteful.

In conclusion, building a circular economy is essential for reducing resource scarcity, protecting the environment, and creating economic opportunities. We may make a circular economy that maximizes the use of our resources and decreases waste by designing products, carrying out closed-loop supply chains, establishing recycling infrastructure, encouraging product reuse, and encouraging collaboration and innovation. Businesses, governments, and consumers must collaborate collaboratively, but the advantages are worth it. Future generations will benefit from a sustainable future that we can create, and our planet can be protected for an extended period.

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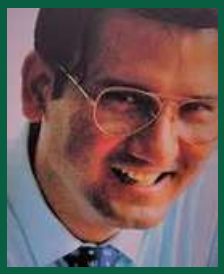

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Repair Cafés : A Sustainable Solution for Reducing Electronic Waste and Promoting Circular Economy

REPAIR CAFÉS

Repair Cafés : A Sustainable Solution for Reducing Electronic Waste and Promoting Circular Economy

ABSTRACT

This article presents a study conducted in Goa, India, to investigate consumer attitudes towards repairability of electronic devices and feasibility of setting up a repair cafe. The study utilized a mixed-methods approach, including an online consumer survey, interviews with repair shop owners, and discussions with officials from bodies involved in e-waste management. The findings revealed that screen replacement and battery issues were the most common repair problems faced by consumers, with over 50% of all users preferring repairs over replacement. However, higher repair costs often drove consumers towards purchasing new devices. Local repair shops were the preferred choice for repairs, and there was a lack of awareness about repair cafes and their benefits. The interviews with repair shop owners highlighted challenges such as the high price range for repairs in urban areas and limited contributions from suppliers towards recycling and repairing. Officials from e-waste management bodies expressed concerns about the declining e-waste collection, untraced e-waste, and illegal disposal. Overall, the findings underscore the need for improved awareness about repairability and sustainable e-waste management practices, as well as the potential benefits of repair cafes as a business opportunity for repairmen. The article concludes with recommendations for promoting repairability, enhancing e-waste collection and tracking mechanisms, and fostering collaboration between stakeholders for effective e-waste management in Goa.

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1.Introduction

The electronics industry is a complex and dynamic sector that relies on a diverse range of materials, including metals like Copper, Tin, Silver, Gold, Nickel, Aluminium, and Lithium. Additionally, the manufacturing of electronic devices, particularly smartphones, requires a variety of rare earth elements such as Lanthanum and Gadolinium among others. With emerging technologies and increasing demand for smartphones, the consequent demand for these rare earth elements is poised to increase.

The impact of smartphone manufacturing on the environment is often overlooked. People outside the industry are unaware of the vast quantities of minerals and elements required for the proper functioning of smartphones. Extracting rare earth elements from their ores is a very energy intensive process. Furthermore, the disposal of electronic waste, including smartphones, is a significant environmental concern. Many electronic devices end up in landfills, where they release toxic substances into the soil and water, posing risks to human health and the environment. The low rate of rare earth element recycling exacerbates this issue, as valuable resources are wasted instead of being recovered and reused. Despite this, less than 1% of rare earth elements are currently being recycled.

Addressing the environmental impact of smartphone manufacturing requires a multi-faceted approach. This includes improving the recycling and recovery of rare earth elements, reducing the use of harmful chemicals in electronic devices, and promoting responsible mining practices. It also requires raising awareness among consumers about the environmental impact of smartphones and the importance of repair, reuse, recycling and responsible disposal. Repair cafes are an emerging innovative solution to tackle the problem of e-waste.

Repair cafes are community spaces where people can bring their broken or malfunctioning electronics, appliances, and other items to be repaired by skilled volunteers. These cafes provide a solution to the environmental impact of the electronics industry by extending the lifespan of electronic devices, reducing the need for new device production, and promoting repair and reuse over replacement. These cafes can help reduce e-waste and prevent harmful chemicals from being released into the environment by providing free or low-cost repair services and educating consumers.

The study presented in this paper investigates the awareness about repair cafes among consumers and the feasibility of setting up repair cafés in the state of Goa, India. In the next section, the objectives of the study are presented. In section 3, the research methodology is described, followed by results, discussion and conclusions in sections 4, 5 and 6, respectively.

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2. Objectives of the study

The study aims to collect data on the types of repairs being carried out in Goa, in order to understand the process of managing e-waste in the region. It also seeks to gain insights into the needs of consumers when it comes to repairing their electronic devices and understand the problems faced by the unorganised sector in the repair industry. Additionally, the study aims to identify the barriers to establishing a Repair cafe in Goa and create awareness among people about the concept of repair cafes as a sustainable solution for reducing e-waste and promoting repair culture.

3. Research methodology

To gain a comprehensive understanding of the awareness levels and perspectives towards repair cafes and disposal of smartphones, three distinct sets of respondents were chosen: consumers, repair shop owners, and officials from bodies involved in e-waste management. The data from the consumers were collected through structured online surveys while semi-structured personal interviews were conducted with the other respondent groups.

3.1 Online consumer survey

The online consumer survey collected information regarding the demographic profiles of the respondents such as gender, age, and education level. Some questions intended to gain insights into their attitudes towards repairability and electronic device repair. These questions checked the level of usage of electronic devices by the consumers, the repair issues faced by them with mobile phones, their preferences for mobile phone repair in case of breakage, frequency of repairs, average spending on device repairs, preferred locations for mobile phone repairs, frequency of minor and major repairs, and average usage period of mobile phones. The survey also sought information on the consumer's consideration of repairability while purchasing new electronic devices. Further, the survey tested the awareness among the consumers regarding the concept of Repair Café and their willingness to visit a repair cafe if found.

3.2 Personal interviews with repair shop owners

To gain insights into the reusability and repairability of electronic devices, surveys were conducted through semi-structured personal interviews with repair shop owners and their employees in select towns and villages of Goa. The chosen locations for the interviews were Panjim, Porvorim, Mapusa, Sanquelim, and Ponda for specific reasons. Panjim, being the capital of Goa, has the highest concentration of electronics repair shops and formal service centers. Porvorim is an affluent residential hub with major consumer electronics retailers. Mapusa, known for its agricultural market, attracts people from nearby villages, hence having a few repair shops. Sanquelim, a village in North Goa, has a handful of repair shops. Ponda, located centrally in Goa, is a small town with a few repair shops. These chosen locations provide a diverse representation of the repair ecosystem in Goa, covering urban and rural areas, formal and informal repair sectors, and different market dynamics. Both the formal and informal sectors were included in the surveys, ensuring a comprehensive representation of the repair industry in Goa.

These interviews covered various aspects related to repair services and electronic waste.

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Initially, information about the respondents' educational background was collected. These questions were followed by questions about the number and type of repair items they receive daily, the challenges faced by customers and repairers, competition in the market, and the availability of original repair parts. The interviews also explored the respondents' attitudes towards repairing, refurbishing, and recycling, as well as the role of formal service centers and repair cafes. The interviews further investigated the different aspects of smartphone repair market such as cost of repairs, durability of items after repair, and disposal of electronic waste. Additionally, the respondents were asked about initiatives taken by companies and the municipality or state pollution control board for electronic waste disposal.

3.3 Personal interviews with officials from bodies involved in e-waste management

To understand the perspective of those involved in e-waste management, officials from the Goa State Pollution Control Board (GSPCB) and from Group Tenplus, an e-waste dismantler, were interviewed. These semi-structured personal interviews were not limited to the area of repair cafes but focused on the topic of electronic waste (e-waste) management in Goa. The interview questions sought to gather information about the procedures and budget for e-waste management, regulatory bodies or legal regulations in place, procurement of e-waste, number of e-waste collection centers, procurement costs, regions of Goa that produce the most e-waste, and the extent of disposal, recycling, and repair of e-waste. The interviews also explored respondents' view of the attitudes of repair centers and consumers towards e-waste management, campaigns or workshops conducted by these bodies related to e-waste management.

Future plans for tackling e-waste in Goa as well as the respondents' perspectives on the establishment of repair cafes in Goa were discussed.

The research methodology utilized in this study provided a comprehensive understanding of the awareness levels and perspectives towards repair cafes and disposal of smartphones among different stakeholder groups in Goa.

4. Findings of the study

4.1 Findings of the consumer survey

A total of 62 respondents participated in the online consumer survey. Figures 4.1 and 4.2 show the age and education profiles of the respondents.

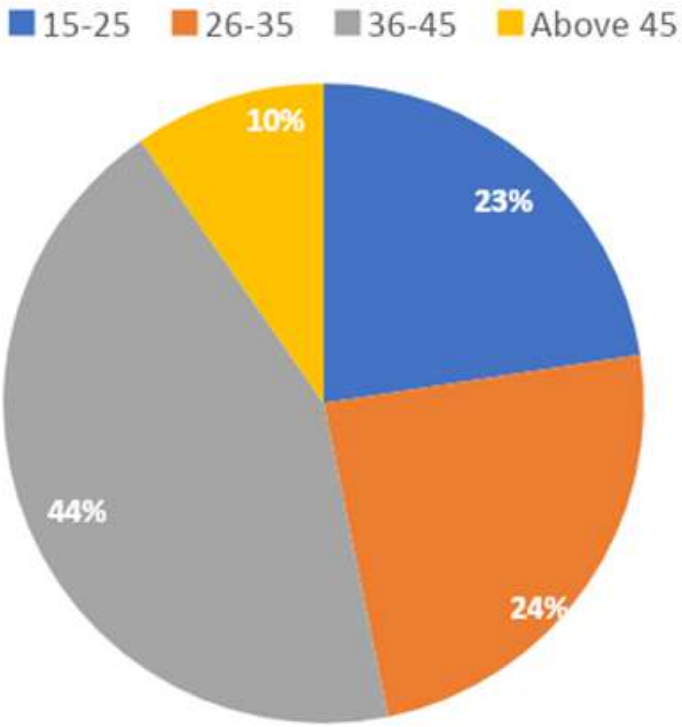

Figure 4.1. Age profile of the respondents

As can be observed from figures 4.1 and 4.2, the respondents age and educational background profiles are diverse. The major findings of the survey are given below:

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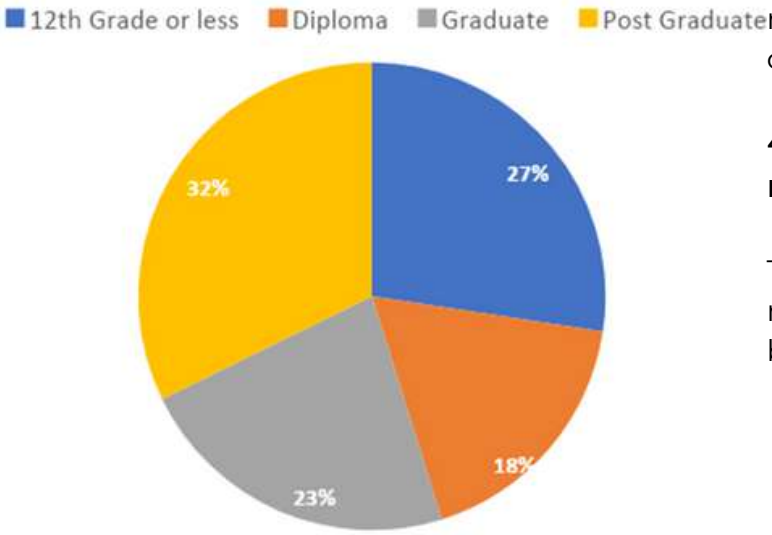

Figure 4.2. Educational background profile of the respondents

- According to the survey, the most common repair issues reported by consumers were related to screen replacement and battery problems with nearly 50% of the respondents facing them.
- One heartening finding was that over 50% of consumers preferred repairing their devices. Further, a significant percentage (25%) opted for replacement with exchange, with the remaining considering purchasing new devices without exchange.
- Majority of consumers were willing to spend between Rs. 500-2000 on repairing their devices, with higher costs driving them towards buying new devices instead.
- More than half of the consumers chose local repair shops for repairs, while the rest opted for authorized centers.
- Although repairability was a factor considered while purchasing electronic devices, most consumers did not tend to repair their old and damaged devices.
- There was a lack of knowledge and awareness about the benefits of repairability and its impact on sustainability among consumers. Also, there was a lack of awareness about repair cafes and their functioning among consumers.

4.2 Findings of the interviews with the repair shop owners

The interviews with the repair shop owners reveal several key points which are given below.

- Rural repair shop owners and workers showed more willingness to participate in the survey compared to their urban counterparts, likely due to the heavy competition in urban areas.
- The price range for repairs was found to be higher in urban areas as compared to rural areas.
- Suppliers had limited contributions towards recycling and repairing, with dealers retaining functional electronic parts and selling the remaining parts to repair shops.
- Majority of the repair shops focused on minor repairs such as battery and screen replacements, with only a few offering repairs for major issues like motherboard replacements.
- Of an average of 8 to 10 repairs per day, majority of issues handled by the repairmen were minor in nature.
- Major repairs were found to cost approximately 70-80% of the phone's original value.
- Repair shop owners did not provide any specific suggestions to customers regarding products that could not be repaired, leaving the decision to customers whether to keep the product or opt for recycling and e-waste disposal.
- Many of the phone repair shops had designated e-waste boxes or collectors for e-waste disposal. E-waste collection frequency was once a week in shops with e-waste boxes. E-waste collectors bought phones at a rate of Rs. 25-30 per phone or purchased spare parts in bulk at Rs. 30-60 per kg.

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- Branded/Multi-brand retail outlets did not offer repairs beyond the warranty period. Only one such outlet was found to be encouraging consumers to bring back non-functioning devices regardless of where they were sold, while others only accepted devices sold through their own outlets for disposal or recycling.
- Very few of the repairmen (approximately 20%) had any formal technical education with majority of them trained to repair electronic items from local Industrial Training Institutes (ITI). Majority of repairmen had received informal training from those experienced in the field. This informal training was imparted by friends and family in the region who either owned a repair shop or had some experience working in repair shops.
- Majority of repairmen were not aware of repair cafes and perceived the concept of repair café as a threat to their livelihood. However, some repairmen saw it as an opportunity for business development.

4.3 Findings of interviews with officials from bodies involved in e-waste management

Interviews with the officials from GSPCB revealed that e-waste management forms only a small part of their overall focus areas which also include hazardous waste, biomedical waste, municipal solid waste, batteries waste and plastic waste. GSPCB handles e-waste through authorized collection and storage agents. GSPCB also undertakes educational campaigns to spread awareness about waste management among the general public. When questioned about their perspective on the utility and feasibility of repair cafes in Goa, the respondents opined that it was a good initiative. However, they also cautioned that sustenance of such an initiative would be highly dependent on the volume of business generated.

The interview with the officials from Tenplus revealed several concerning trends in e-waste management. The respondents shared that there has been a decline in the amount of e-waste collected over the years, indicating potential inadequacies in the current collection methods. The amount of e-waste collected and managed by formal dismantlers and waste management bodies is disproportionately low compared to the actual amount of e-waste generated in Goa. This too indicated potential gaps in the e-waste management process. The respondents also shared an interesting insight that the design of latest smartphones has made repair difficult, leading to a decline in the repair business and resulting in more devices being discarded after use, contributing to the e-waste problem. Further, they also shared that over half of the e-waste generated is untraced post-disposal. They also raised concerns about illegal disposal and lack of proper tracking mechanisms. Over time, due to reduced e-waste collection, some dismantlers have resorted to collecting plastic waste to sustain their business, highlighting potential challenges in the economic viability of e-waste management. Overall, these findings emphasize the need for improved e-waste collection, tracking, and management processes, as well as promoting repairability and sustainable design of electronic devices.

5. Discussion

Based on the findings from the consumer survey, interviews with repair shop owners, and officials from bodies involved in e-waste management, it can be inferred that there is a potential utility and feasibility of setting up repair cafes as a sustainable solution for e-waste management.

The consumer survey revealed that over 50% of consumers preferred repairing their devices, indicating a demand for repair services.

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However, consumers also faced challenges such as high repair costs and lack of awareness about the benefits of repairability, which could be addressed through repair cafes. Repair cafes can offer affordable repair services and raise awareness about the importance of repairing and extending the lifespan of electronic devices, thus reducing the likelihood of devices being discarded as e-waste.

Interviews with repair shop owners highlighted that many repair shops focus on minor repairs and lack formal technical education. Repair cafes can serve as a platform for skilled repair technicians to provide repair services for a wide range of electronic devices, including major repairs, and also offer training and education opportunities for aspiring repair technicians. This can contribute to the professionalization of the repair industry and create employment opportunities.

Interviews with officials from bodies involved in e-waste management revealed concerns about the decline in e-waste collection, illegal disposal, and lack of tracking mechanisms. Repair cafes can play a role in reducing e-waste by repairing and refurbishing electronic devices, thereby extending their lifespan and reducing the need for new devices. Repair cafes can also implement proper e-waste disposal and tracking mechanisms, ensuring that any e-waste generated during repairs is managed in an environmentally responsible manner.

Additionally, repair cafes can contribute to creating a circular economy by promoting repair, reuse, and recycling of electronic devices, and by reducing the reliance on extraction of raw materials for manufacturing new devices.

Repair cafes can also raise awareness among consumers, repair shop owners, and officials from bodies involved in e-waste management about the benefits of repairability, sustainability, and responsible e-waste management practices.

However, there may be challenges in setting up and sustaining repair cafes, such as finding suitable locations, securing funding, recruiting and training volunteers with the necessary skills and overcoming potential resistance from existing repair shops. It would be important to address these challenges through collaborative efforts among stakeholders, including consumers, repair shop owners, e-waste management bodies, and policymakers.

6. Limitations of the study

The empirical research findings presented in this report on e-waste management and repair cafes should be interpreted with careful consideration of several limitations. Firstly, the methodology of in-person semi-structured interviews used for qualitative research may introduce biases, as respondents' perceptions may be subject to confounding factors. Secondly, the sample population consisted of individuals with little or no formal education, which may impact the generalizability of the results to other populations with different educational backgrounds.

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Additionally, the study was geographically limited to shops concentrated in the northern part of Goa, which may not fully capture the diverse perspectives and practices related to repair cafes in other regions.

These limitations suggest that caution should be exercised in drawing broad conclusions from the findings of this study.

The results may not be applicable to other contexts or populations, and further research with larger and more diverse samples is needed to validate and expand upon these findings. Future studies could also consider using a combination of qualitative and quantitative methods to complement the limitations of this study and provide a more comprehensive understanding of the topic. Despite these limitations, the findings of this study contribute to the existing literature on e-waste management and repair cafes, highlighting the need for further research in this area to inform policy and practice related to sustainable e-waste management initiatives.

7. Conclusions

The findings from the surveys and interviews collectively highlight the need for increased awareness and education among consumers about the benefits of repairability, the challenges faced by repairmen in terms of technical training and changing business models, and the need for better e-waste collection methods and product design standards. Repair cafes could potentially address some of these challenges by promoting repairability, providing standardized repair services, and contributing to the circular economy by reducing e-waste generation.

However, there may be challenges in setting up and sustaining repair cafes, and collaborative efforts among stakeholders would be required to address these challenges successfully. Further research and planning would be necessary to ensure the successful establishment and operation of repair cafes, considering the specific context and challenges of the local area.

By promoting repairability, extending the lifespan of electronic devices, reducing e-waste, creating employment opportunities, and raising awareness about responsible e-waste management practices, repair cafes have the potential to contribute to sustainable e-waste management. Future research may extend this study to other parts of India by building upon the findings of this study albeit taking the limitations into account.

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Advancing Circular Economy in India: Sustainable Resource Efficiency and Policy Imperatives in Solar Photovoltaics and Telecommunication

TRAPPING THE SUN

ABSTRACT

In an era of escalating environmental concerns and the pursuit of sustainable development, the circular economy emerges as a transformative solution. This paper examines India's Solar Photovoltaics and Telecommunication sectors, assessing their potential for circular economy practices, resource efficiency, and waste management. While solar photovoltaics contribute to a greener energy mix, the mounting concern of PV waste persists. Similarly, the telecommunications industry faces a surge in electronic waste due to rapid advancements. Mitigating these challenges necessitates robust policies, technological innovation, and collaboration. The paper identifies key policy and technology barriers and offers tailored recommendations. Synergistic strategies like energy exchange, dual land usage, and smart grid integration are proposed. This insight is crucial for policymakers, industry, and researchers committed to a more sustainable future in India.

Keywords

Solar photovoltaic panels; Telecommunication; Circular economy; Waste management; Recycling; Resource efficiency

INTRODUCTION

Amid global sustainability goals, the shift to a circular economy emerges as a transformative force, replacing linear models with resource-efficient, waste-reducing practices. This research paper focuses on India’s Solar Photovoltaics (PV) and Telecommunications sector, underscoring their scope and potential to transform to a circular economy (CE), thereby ensuring sustainable resource efficiency and effective waste management.

Both sectors are vital for India's growth but also major contributors to e-waste; the country generates about 3.2 million metric tonnes annually, with limited proper recycling [1]. In 2022, India expanded e-waste guidelines to cover telecom equipment and PV waste [2] [3], but policy gaps persist and inadequate recycling infrastructure raises environmental concerns.

This paper aims to address the challenges and policy gaps in handling e-waste effectively and presents a roadmap for India. Additionally, it proposes a recycling framework for the solar PV sector. It seeks to answer the following questions:

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1. What is the scale of waste generated in the solar PV and telecommunication segments? Why is the adoption of circular economy imperative in these sectors?
2. What are the existing gaps that hinder the seamless transformation of circular economy principles in the solar PV and telecommunication sectors?
3. How can the existing policies and practices be strengthened to enable sustainable resource efficiency and effective waste management in these sectors? What are the potential policy solutions for effective resource efficiency and waste management?

MATERIALS AND METHODS

The methodology involves an extensive literature review and in-depth data analyses, aiming to generate evidence-based insights for policy enrichment. The paper is organized as follows:

1. Following the introduction section that sets the background to our paper, the next section examines the solar PV and telecommunication sectors' growth, assessing their e-waste composition, and pinpointing policy gaps and waste management challenges.
2. The results and potential policy solutions form a roadmap for enhancing the integration and deployment of circular economy practices in the solar PV and telecommunication sectors.
3. Furthermore, the paper highlights cross-sector challenges and opportunities, emphasizing potential synergies, mutual benefits, innovation, and collaborative efforts to achieve a greener and more sustainable future.

Solar Photovoltaics in India: Overview

The remarkable growth of solar photovoltaics (PV) in India, exceeding yearly targets, is a key facet of the nation's pursuit of 500 GW renewable energy capacity by 2030, with solar contributing over 292 GW [4]. This shift towards solar energy is crucial in diversifying India's energy mix and reducing reliance on fossil fuels. However, the expansion also arises the concern about the PV waste's environmental impact.

With nearly 64 GW of PV installations as of March 2023 [5], projected to generate 4 million tonnes of waste by 2050 [6], urgent attention to proper management is needed. While India has initiated policies and regulations for PV waste management, ambiguity persists in policy maturity and recycling measures. Establishing a robust recycling framework and regulatory bodies is essential to ensure environmentally responsible PV waste management.

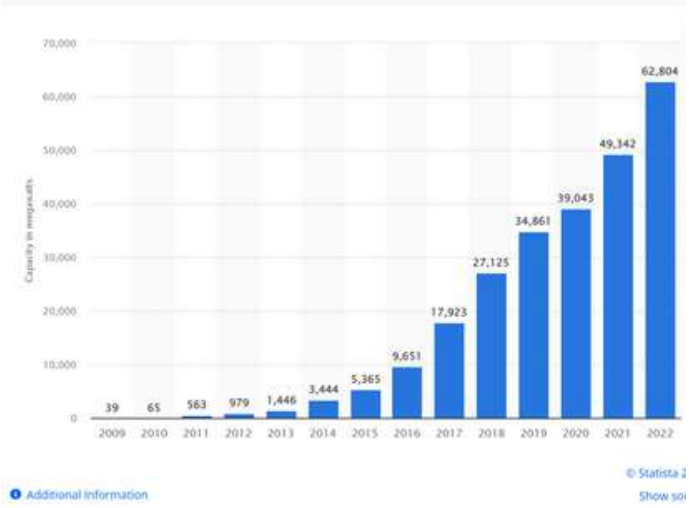

*Figure SEQ Figure * ARABIC 1 Growth of Solar Capacity over the years in India*
Source: Statista 2023

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In India, nearly 93% of PV modules are made of crystalline silicone (c-Si), while the remaining 7% consists of cadmium telluride (CdTe) thin film modules [7]. The figure below shows the composition of these modules [8].
As these PV panels approach their end-of-life (EOL), only approximately 20% of PV waste is effectively recovered, with the remaining waste often being informally treated [7]. Mishandling solar PV waste can lead to soil and water contamination, inefficient recycling emissions, and resource depletion. Tackling these challenges requires a comprehensive approach, prioritizing recycling management and circular economy principles for a greener future.

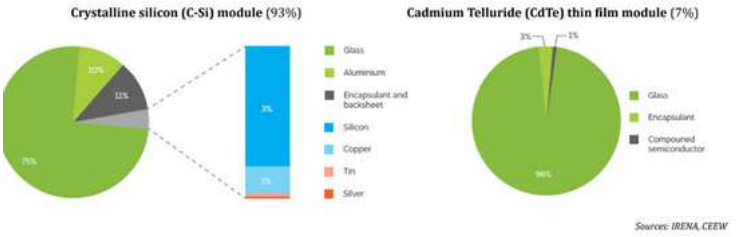

*Figure SEQ Figure * ARABIC 2 Composition of Solar PV panels*
Source: IRENA, CEEW

Recycling Framework

The proposed recycling framework [9] consists of the following three main components:

- 'Clusters' (addressed as Cs) are groups of PV plants that share common characteristics or are located near each other.
  The analysis of Cs serves as a valuable data exploration and mining tool, facilitating the division of a multivariate dataset into distinct and meaningful Cs or groups. In this study, groups or Cs of PV plants were identified on the basis of their proximity in terms of distance and the quantity of waste generated by each plant.
- 'Collection Centres' (addressed as CCs) are designated PV plants within each C that serve as collection points for EOL or failed panels from other PV plants within the C. These CCs store the panels temporarily before being transported for recycling. In this study, the CCs within each C were strategically located by considering the proximity to the PV plants and the overall transportation costs.
- 'Recycling Units' (addressed as RUs) are facilities established in an optimal industrial zone to recycle PV waste.

The stage-wise optimisation-modelling-driven recycling framework [9] is depicted in Figure 3.

Solar Power System For Telecommunications

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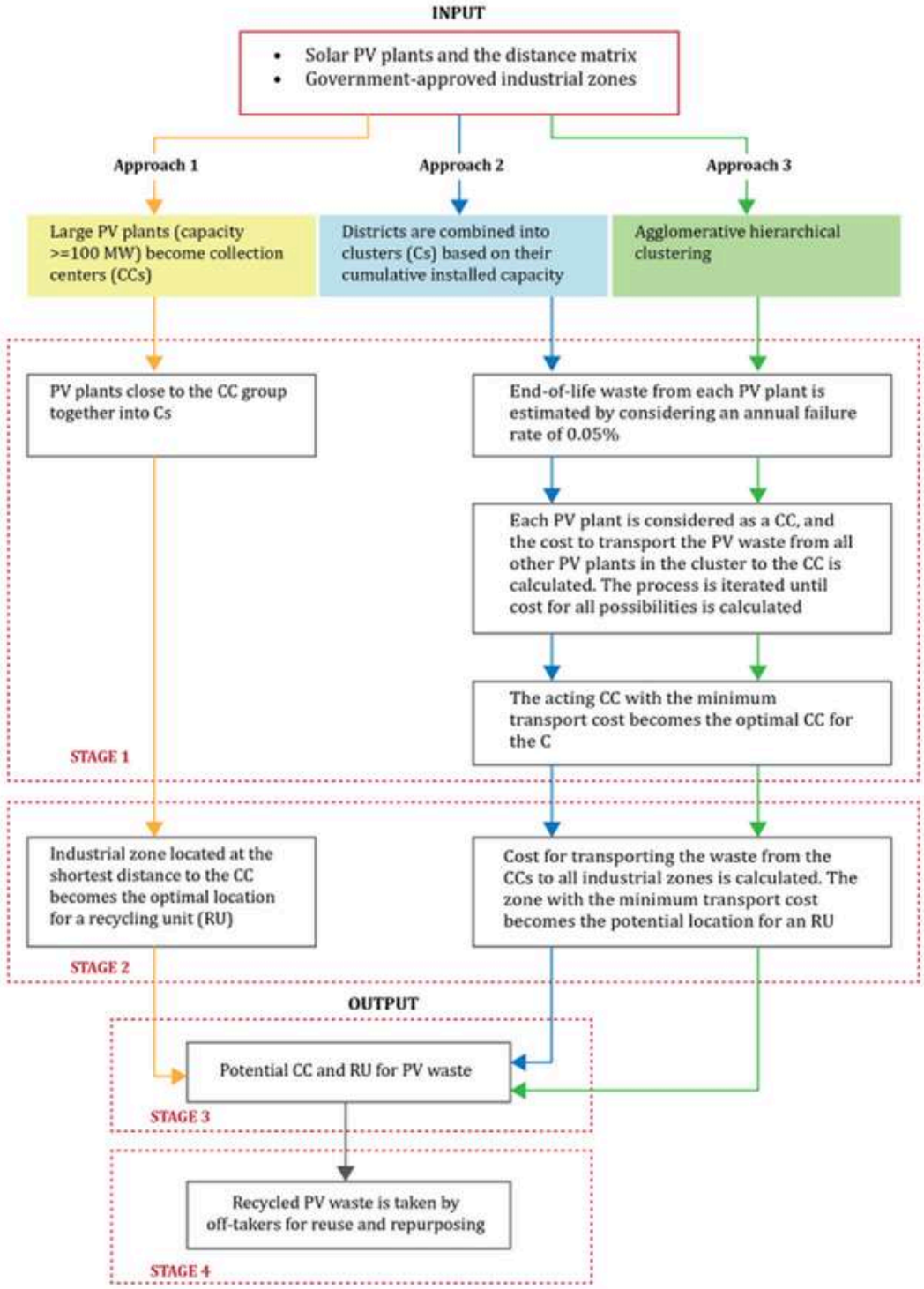

Figure-3

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Policy Gaps and Challenges in Managing Solar PV Waste

Managing solar PV waste in India encounters policy and technology obstacles, impairing efficient recycling of end-of-life modules. These gaps pose serious environmental risks, demanding immediate attention. The following table summarises these challenges.

Policy Barriers	Technology Barriers
Existence of greater informal sector involvement in waste handling	Lack of suitable technologies or tools to track PV waste generation.
Lack of clear segregation of PV waste from e-waste and absence of penalties	Outdated recycling technologies and inefficient recycling processes.
Absence of a national monitoring and reporting mechanism	Limited awareness regarding viable avenues for business growth within the solar PV waste management sector.
Inadequate infrastructure facilities for collection and recycling of waste	Absence of adequate R&D programs to advance domestic PV panel manufacturing and enhance recycling and repurposing of PV waste.
Inadequate awareness and information dissemination on waste handling practices and mechanisms.	
Lack of clearly defined recycling benchmarks and targets	

Table 1 Policy and technology barriers for solar PV waste management in India

Implementing clear regulations, investing in advanced recycling technologies, promoting information exchange, and fostering R&D will be pivotal in achieving circular economy principles and resource efficiency in the solar PV sector

Telecommunication Sector in India: Overview

The Indian telecom industry's rapid growth has positioned it as a dynamic global market, driven by widespread mobile penetration and expanding internet connectivity. This digital progress, however, is counterbalanced by a mounting challenge —escalating electronic waste (e-waste) due to technological advancement and consumer demand [1].

E-waste from devices like smartphones, network equipment, and accessories contains valuable materials like plastics, metals, semiconductors, batteries and, certain precious elements like rare earth metals, germanium, and gallium [10]. And a significant portion of this waste is informally managed, employing hazardous practices like burning and acid baths, causing pollution and health hazards [11].

A circular economy approach, focusing on reduced waste and enhanced resource efficiency, offers a sustainable solution for this sector's challenges. Addressing the e-waste issue demands collaborative efforts from manufacturers, policymakers, consumers, and waste management systems, with a clear understanding of policy gaps and integration hurdles.

Policy Gaps and Challenges in Achieving CE in the Telecommunication Sector

In the journey towards a circular economy in the telecommunication industry, policy and technology barriers pose significant challenges. The table below highlights these barriers.

A strong policy framework and regulatory body are essential for information dissemination, recycling infrastructure enhancement, and efficient waste management. With evolving technologies, increased R&D is crucial for innovation and recycling efficiency.

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Policy Barriers	Technology Barriers
Excessive involvement of the informal sector.	Lack of suitable technologies to track and manage telecom waste generation.
Lack of clear segregation between e-waste and telecom waste handling guidelines and regulations.	Outdated recycling technologies and ineffective processes.
Absence of a national monitoring and reporting agency to regulate waste quantity and recycling efforts.	Absence of profitable business opportunities for recycling and repurposing telecom waste.
Lack of suitable infrastructure for cost-effective collection and recycling of telecom waste.	Insufficient Research & Development (R&D) programs to support domestic manufacturing and recycling.
Inadequate information dissemination about recycling rates, Extended Producer Responsibility (EPR) guidelines, and sustainable practices.	

Table 2 Policy and technology barriers for telecom waste management in India

Suggestions for Enhancing Resource Efficiency in Telecommunication

- Provide Policy Incentives: Establish and apply robust policy incentives, encompassing tax advantages, grants, and subsidies, to foster the expansion of an eco-friendly and circular telecom ecosystem.
- Capacity Building and Awareness: Introduce awareness initiatives to educate consumers about responsible consumption and effective end-of-life handling.
- Promote R&D Collaborations: Catalyze research-business partnerships with funding and incentives to accelerate innovative recycling methods, reducing electronic waste and conserving resources.
- Start Pilot Interventions: Launch pilot projects throughout the telecom value chain to showcase circular business models, addressing unprofitable opportunities and fostering wider adoption.
- Promote Resource Efficiency Solutions: Promote resource-efficient technologies in telecom, including e-SIM, cloud storage, AI, IoT, and Blockchain, to minimise waste and enhance sustainability [12].
- Material Recycling and Product Improvement: Prioritize stable supply mechanisms, global resource development, recycling initiatives, and design improvements to counter rare metal scarcity [11].
- Create E-Waste Tracking Systems: Advocate for comprehensive electronic waste tracking systems across the lifecycle of electronic devices to ensure holistic management, addressing informal sector involvement and monitoring gaps.

Synergies: Collaboration and Resource Sharing between Sectors

This section explores collaborative opportunities between the solar PV and telecom sectors, unveiling innovative synergies. By leveraging sector strengths and fostering initiatives, these industries can advance toward a resilient and sustainable future.

- Energy Exchange: Integrating solar PV systems with telecom towers, particularly in off-grid or remote locations, offers mutual benefits. Excess solar energy generated can be fed into the grid or stored for powering nearby towers, fostering energy efficiency and lowering carbon footprints.

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Figure Potential collaboration between Solar PV and Telecommunication sectors
Source: authors' ideation

- Natural Resource Efficiency: Solar PV installations often demand substantial land, whereas telecom towers occupy underutilized spaces. Integrating solar panels on towers or using tower sites for solar installations [14] optimizes land use and reduces resource competition.
- Smart Grid Integration: Collaborating on smart grid technologies can optimize energy management. Telecom's data analytics and real-time monitoring expertise can enhance smart grid integration, boosting solar PV system efficiency and reliability.
- R&D, Innovation and Collaborations: Collaborative R&D can drive innovation in energy storage, batteries, and smart grids. Shared expertise accelerates technological progress and cultivates an innovation-driven culture.

Conclusion

The solar PV and telecommunication sectors in India have the potential to drive circular economy and sustainable resource practices. Therefore, addressing e-waste challenges and policy gaps is crucial for a greener future. Effective recycling, domestic manufacturing promotion, and collaborative R&D can lead to sustainable resource management. Moreover, synergies between sectors offer energy optimization and environmental conservation. Proactive policies and collaboration will advance circularity, guiding India toward a sustainable future. By embracing circular principles, these sectors can steer India toward a greener, environmentally conscious future.

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A REVIEW OF INDIAN POLICY FRAMEWORK FOR CIRCULAR ECONOMY IN BUILDING & CONSTRUCTION INDUSTRY

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A review of Indian policy framework for Circular Economy in Building & Construction Industry

ABSTRACT

The World Construction Industry is responsible for over 30% of the extraction of natural resources, as well as 25% of solid waste generated in the world. This is due to the linear economic model 'take, make, dispose', which is adopted by the construction sector; where materials are used to construct buildings and are disposed at the end of their life as they were made for one time use and don't retain potential for reuse. This was being done for several past decades, but now there has been a paradigm shift occurring in the industry at large, where companies are moving from linear model to circular economy model, by trying to create a closed loop, reducing waste generation and resources extraction for the Construction Industry. This paper aims to look at policies in the existing Indian policy framework for the Building & Construction Industry, which align with the Circular Economy Initiative. To achieve this, current laws and policies; and initiatives by the government of India towards the shift to CE were overviewed. This paper also integrates relevant information on laws and policies with a view to highlight their efficacy towards the transition to circular economy.
This paper also highlights the rising need for the transition to a circular economy.

Introduction

Between 1970 and 2015, India registered a six-fold increase from 1.18 billion to 7 billion tonnes in annual material consumption. India, by 2022 will be the most populous nation in the world, and by 2030, it's expected that the annual material consumption would double to 14.2 billion tonnes due to rise in population, rapid urbanisation, economic mobility, and the growth in resource consumption. While Europe recycles 70% of its consumption items, India recycles only 20%. India is also the third highest emitter of greenhouse gases, and accounts for 9.2% of total world emissions. Therefore, India's traditional take-make-waste linear economic approach will bring about severe ecological damage with unanticipated economic and social consequences. The construction industry has a significant impact on global resource consumption. The demand for resources is advancing due to the rapid urbanisation as the need for new housing and infrastructure increases globally. The long-established linear economy approach results in immense waste generation at all stages of a product life cycle right from resource extraction, manufacturing & processing, value addition, consumption to end of life stage. Subsequently, construction industry generates the largest volume of waste globally. 30-40 % of the waste generated globally is 'Construction & Demolition' (C&D) waste – of which 10% is created during the construction process and 90% is created during the demolition process (we.archive.org).

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Conventionally, India has been a frugal society and has practiced circularity as part of the everyday life but not into the construction sector. An integral approach is required for the expedition towards building a circular economy through an engaged participation of governments, industry and citizens. It needs a robust roadmap jointly owned and championed by the central, state, city and other local governments. This strong policy roadmap requires coordination between the various Government layers for the systematic metamorphosis of Indian economy involved in operationalising the roadmap for the transition from linear to circular model. Also, numerous other rules issued by the national government, such as the Plastic Waste Management Rules, E-waste Management Rules, Construction and Demolition Waste Management Rules, Metals Recycling Policy, etc., must be aligned with the national circular economy roadmap.

Methodology

This research discusses the concept of circular economy and its importance in the Building & Construction sector of India. The shift towards circular economy can be facilitated through the policy framework which are further narrowed down to the construction sector. There are several policies for the construction industry but the policies that addressed the circular economy either directly or indirectly are elaborated and studied further. All these policies were then assessed through the life cycle process of construction which involve: resource extraction,design,production/manufacturing, consumption/use, and end-of-life.

Circular Economy

The circular economy presents itself as an opportunity to take a holistic approach, to reduce, reuse, remanufacture, reprocess and recycle plastics (can this word be deleted?) throughout production, circulation and consumption. The main objectives of the circular economy are to close resource loops (limiting extraction of raw material), slowing and narrowing resource flows (through the waste hierarchy and the more efficient use of material and products) (OECD, 2019).

Although the principles of Circular Economy have been in circulation for long, its definition is subjected to vast ambiguity owing to its close association with sustainability and sustainable development (Corona et al., 2019), presence of similar concepts like green economy, (Kirchherr et al., 2017; www.unep.org) and a lack of assessment methodologies for the quantitative measurement of circular systems. However, despite the impediments, the concept has widely gained recognition within business models (www.ellenmacarthurfoundation.org) and policy frameworks (Murray et al., 2017). A comprehensive definition for a Circular Economy can be envisaged as a system, process or approach operating at the industry, eco-industrial park or regional level (Kirchherr et al., 2017) that emulates the natural systems. This emulation essentially arises in terms of regeneration through recycling (Geissdoerfer et al., 2017), closed loop material flows (Sauvé et al., 2016) as well as waste reduction and elimination thereby ensuring an advancement of human well-being and Sustainable Development (Murray et al., 2017). Morseletto (2020), further refined the concept of Circular Economy as an “economic model aimed at the efficient use of resources through waste minimization,

long-term value retention, reduction of primary resources, and closed loops of products, product parts, and materials within the boundaries of environmental protection and socioeconomic benefits".

Need for adopting circularity

With economic growth and urbanization taking place at an unprecedented pace in India, there is increased demand for natural resources, be it land, soil, water or mined materials. With the threat of serious scarcity of resources in the future and their impending depletion, it is imperative that we find more efficient ways to use them. Another menace due to rapid urbanization is the increase in waste generation volumes. Landfills, burning waste and other old age solutions only add to the existing problems. Therefore, there is an urgent need to adopt new age technologies and practices for sustainable resource utilization and waste management. Facilitating design for reuse, remanufacture and recycle through innovation would lead to development of disruptive technologies and practices, which then would contribute towards waste minimization.

India's material consumption in the past few decades exhibits a pattern typical of countries making a transition from an agrarian society to an industrial society, where the consumption of non-renewable materials increases, in particular minerals and metals required for building infrastructure and fossil fuels for energy supply (Dittrich, 2012). In India, extraction of primary raw materials increased by around 420% between 1970 and 2010. According to United Nations Environment (UNE), India consumed about five billion tonnes of materials in 2010 (Figure 2), out of which about 42% are renewable biomass and 38% are non-metal minerals (IRP, 2017).

Despite the need to take a systemic approach, it has been observed that policy initiatives have often focused on 'end of pipe' (waste management) and upstream (material used at the production stage) processes (Pamlin and Enarsson, 2019; Iacovidou, Hahladakis and Purnell, 2020). India's policy direction to formalise a circular economy is not too different. Recent endeavors including the planning of a National Resource Efficiency Policy (NREP) and National Resource Efficiency Authority, center around efficiency improvements in production and waste management, with modest insight into system-wide implementation and change.

The NREP and its ambition for India's circular economy is examined in detail in a later section (MoEFCC, 2019).

Circularity in buildings and construction in India

The housing and construction industry are the largest sources of employment in India, accounting for 60% of the working population. As a result, these two sectors consume vast

amount of raw materials. Due to rising population, housing, food and mobility will bear the brunt of most impact (World Bank 2017, IGEP 2013). Indian construction industry is expected to see a growth of 6.5% annually (Sustainability Outlook 2015) heading into the near future.

In addition to employment, urbanization of 60% of India's population will put severe stress on cities. Like other cities across the world, Indian cities are also expected to contribute to 75% of carbon emissions while using approximately 75% of natural resources (UNEP-SBCI, 2016) while at the same time cities in India are expected to contribute to 75% of GDP by 2030 (Ministry of Urban Development India, 2015).

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The construction sector in India has been seduced by the Prime Minister's Make in India (Make in India, 2018) program, set up in 2014 and this is anticipated to play a huge role in the next few decades. Make in India facilitates investment, fosters innovation, enhances skill development to build the best manufacturing infrastructure while protecting intellectual property.

Existing policy framework for circular economy

There are several policies and legislations guiding the construction sector of India, in spite of that only a few policies align with the notion of Circular Economy. On that account, only those current policies and legislations in India that seek to create change in terms of the transition towards circular economy, across various lifecycle stages are studied and mentioned below:

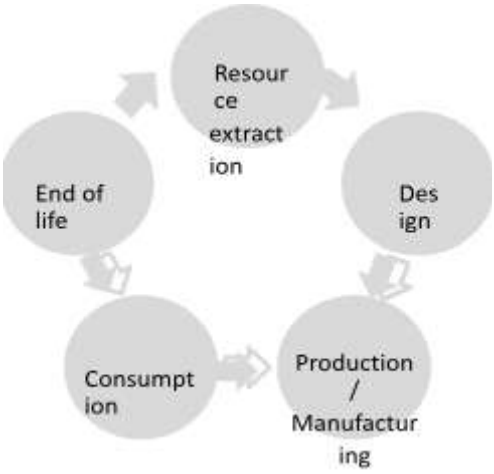

Figure 1: Various life cycle stages considered for the Construction sector.

Resource extraction:

1. National Mining Policy, 2008
2. National Steel Policy, 2017
3. National Mineral Policy, 2019

Design:

1. National Housing and Habitat Policy 2007
2. Ecomark issued by the Bureau of Indian Standards.

Production/ Manufacturing:

1. Make in India, 2014
2. National Manufacturing Policy, 2012

Consumption:

1. Task Force on Sustainable Public Procurement set up by Ministry of Finance in 2018.

End of Life:

Legislations protecting the environment, human health and ensuring sound management of waste streams, in part incorporating on Extended Producer Responsibility (EPR):

- Solid Waste Management Rules, 2016
- Construction and Demolition Waste Management and Handling Rules, 2016
- Steel Scrap Recycling Policy, 2019.

Resource extraction:

1.National Mining Policy, 2008

The National Mineral Policy (NMP), 2008 recognizes that the extraction of minerals closely impacts other natural resources like land, water, air and forest. NMP 2008 states that: Conservation of minerals shall be construed not in the restrictive sense of abstinence from consumption, or preservation for use in the distant future. Conservation is a positive concept leading to augmentation of reserve base through improvement in mining methods, beneficiation and utilisation of low-grade ore and rejects and recovery of associated minerals.

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All mining shall be undertaken within the parameters of a comprehensive Sustainable Development Framework which includes guiding principles for a miner to leave the mining area in a better ecological condition after mining. It aims for optimum utilization of the country's natural mineral resources.

2. National Steel Policy, 2017

Steel has several inherent advantages of durability, faster completion time, reduced environmental impact, and creation of a circular economy. Finalized by the Ministry of Steel and notified on 8th May 2017, the NSP laid down key imperatives to ensure that the Indian steel sector is prepared to service the growing requirements of modern India and to promote a healthy sustainable growth for the sector. Key features of the NSP 2017 include establishing self-sufficiency in steel production by providing policy support & guidance to private manufacturers and steel producers.

3. National Mineral Policy 2019

The National Mineral Policy, 1993, an important legal framework for the mines and mineral sector stipulates provisions for regulation of minerals, reviewed as the National Mineral Policy, 2008 for the first time incorporated the need for sustainable mining to preserve and augment the exhaustible mineral reserves and optimal utilization of natural resources. It established all mining to be undertaken within the comprehensive Sustainable Development Framework, which includes guiding principles for effective closure of mines, with appropriate reclamation/rehabilitation for maintaining the ecological condition. The National Mineral Policy approved in February 2019 incorporates the public trust doctrine, intergenerational equity principle, and ownership of natural resources as commons.It holds the State as the trustee on behalf of the people to ensure future generations receive the benefit of inheritance calling for stringent regulations to ensure environmentally sustainable mining practices incorporating social and economic considerations. The policy also promotes zero- waste mining through conservation and mineral development.

Design:

1.National Housing and Habitat Policy 2007

The National Housing and Habitat Policy, has been formulated to address the issues of sustainable development of housing infrastructure through strong public-private partnership. It also seeks to ensure that housing, along with supporting services, is treated as priority sector at par with infrastructure. This policy intends to promote sustainable development of habitat in the country with a view to ensuring equitable supply of land, shelter and services at affordable prices to all sections of society. This policy proposes to encourage the improvement of the environment in the nation.

2.Ecomark issued by Bureau of Indian Standards

Ecomark is a certification mark issued by the Bureau of Indian Standards (BIS) for products which are ecologically safe and adheres to the standards prescribed by the BIS. It was first issued in 1991 by a resolution. It is issued by the Ministry of Environment and Forests. It promotes products who have

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comparatively lower pollution, in terms of consumption, manufacture and disposal. Building materials made using industrial waste as one of the raw materials such as fly ash cement, slag cement etc. have gained popularity amongst producers and consumers in India as they have a quality code developed by Bureau of Indian Standards.

Production and Manufacturing:

1.Make in India, 2014:

The main motto of this program is to present India as a leading hub of manufacturing sector in the current global economy. The construction sector is considered as one of the leading areas of business. Make In India is a new national program designed to transform India into a global manufacturing hub. It contains a raft of proposals designed to urge companies - local and foreign - to invest in India and make the country a manufacturing powerhouse. This initiative led to increase in energy and water efficiency and pollution control technologies through Technology Acquisition and Development Fund (TADF). TADF is a new scheme to facilitate acquisition of Clean, Green & Energy Efficient Technologies, in form of Technology / Products. This fund will support, via subsidies, manufacturing of equipment / machines / devices for controlling pollution, reducing energy consumption and water conservation. The scheme will facilitate resource conservation activities in industries through the introduction of incentive/subsidy schemes for energy/ environmental/ water audits, construction of green buildings, implementation of waste treatment facilities and implementation of renewable energy projects through financial support under the TADF.

2.National Manufacturing Policy

The policy is based on the principle of industrial growth in partnership with the States. The policy promotes use of green technology by extending incentives and concessions. It supports conservation of energy and technological enhancement. Incentives and funding are provided to acquire new technology for controlling pollution, reducing energy consumption and water conservation for manufacturing products including building & construction material. The green technologies will help to minimize detrimental impact on environment and attract more investment in new and clean manufacturing industries.

<u>Consumption:</u>

1.Task Force on Sustainable Public Procurement set up by Ministry of Finance in 2018: They review international best practices in the area of Sustainable Public Procurement. Inventorise the current status of Sustainable Public Procurement in India across Government organizations. Prepares a draft Sustainable Procurement Action Plan. Sustainable Procurement in construction aims to create social and economic benefits for project stakeholders and minimize environmental damage, which is a process through which project stakeholders can meet design and development needs while realising value for money throughout the project lifecycle. This involves purchasing goods and services in a way that accounts for the social, economic, and environmental impact that the purchase will have on people and communities.

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End of Life:

1. Solid Waste Management Rules, 2016

The Solid Waste Management rules 2016 shifted the entire focus from collection and disposal of solid waste to segregation, waste minimization, setting up of holistic waste management systems and keeping landfill a last resort. Manufacturers and importers are increasingly encouraged or required to accept responsibility for their products after the point of sale, through so called “extended producer responsibility” or “product stewardship”. Solid waste management rules promotes circularity principles that can help India decouple its growth from consumption of primary resources and materials, thus ensuring efficient resource recovery from dry waste.

2.Construction and Demolition Waste Management and Handling Rules, 2016

A linear model of consumption is no longer sustainable as limited resources cannot meet our endless demand. The environmental benefits of avoiding waste far outweigh the environmental impacts of any other waste management options lower down on the waste hierarchy. The Construction and Demolition waste management rules promotes circular economy by material reuse either by direct use or by repair/refurbishment that ensures use of C&D Waste within the construction industry.

Regulatory framework for managing Construction and Demolition waste under the Construction and Demolition Waste Management and Handling Rules, 2016 are as follows:

- National Environmental Policy, (MoEF&CC, 2006).

`· CPWD Manual for Sustainable Habitat, (CPWD,2014).

- Green Building Norms, (CPWD,2012).

3.Steel Scrap Recycling Policy, 2019

The policy aims to achieve circular economy in the steel sector. It promotes a formal and scientific collection, dismantling and processing activities for end-of-life products that are sources of recyclable (ferrous, non-ferrous and other non-metallic) scraps which will lead to resource conservation and energy savings and setting up of an environmentally sound management system for handling ferrous scrap. It aims to produce high quality ferrous scrap for quality steel production thus minimizing the dependency on imports. It also intends to create a mechanism for treating waste streams and residues produced from dismantling and shredding facilities in compliance to Hazardous & Other Wastes (Management & Transboundary Movement) Rules, 2016 issued by MoEF & CC.

An analysis of all the above policies is done and is checked for the life cycle stages addressed by each policy.

Policy acknowledging circular economy in Building & Construction Industry in India:

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Conclusion

Keeping circularity in mind, the building and construction industry needs to move from short-term thinking to long-term thinking. It needs to consider design for deconstruction, be innovative both in terms of design and supply chain considerations, utilize new models of consumption and production which can therefore be facilitated with the help of policies. That being said, the Government of India needs to actively formulate policies and promote projects to drive the country towards circular economy.

Transition towards Circular Economy also requires a systematic and well-thought implementation roadmap– one that can only be designed and implemented through policy frameworks. The present analysis focused on assessing the role of policy in Circular Economy in context of the Building & Construction sector of India. Results revealed the need of better linkages between present practices and Circular Economy. It also lays out various policies that lead the path towards circular economy. Besides, policy regulations still suffer from inadequate implementation particularly at the processing and recycling stages. Framing of a Circular Economy policy for India would further accelerate the shift from Linear Economy.

Beyond the existing initiatives in India, the government can set guidelines for the transition and create the right enabling conditions by setting direction and showing commitment, creating and enabling regulatory frameworks and removing policy barriers, creating platforms for multi-stakeholder collaboration, supporting circular models through public procurement and infrastructure and embedding circular economy principles into education. Other organizations, including stakeholders & businesses, can play important supporting roles in the transition to a circular economy. In the short term, further engagement and research is needed to create and maintain mechanisms and identify knowledge gaps and build further to support policy initiatives.

Policies in India	Production, Manufacture and Processing	Use-Industry and Retail	End-of-life, Waste management, Disposal	Next Life, Recycling, Reprocessing
Draft National Resource Efficiency Policy			✓	✓
National Mining Policy	✓		✓	✓
National Steel Policy	✓		✓	✓
National Mineral Policy	✓		✓	✓
National Housing and Habitat Policy		✓		
Bureau of Indian Standards (BIS)	✓		✓	✓
Make in India	✓	✓		
National Manufacturing Policy	✓			
Sustainable Public Procurement		✓		
Solid Waste Management Rules			✓	✓
Plastic Waste Management Rules			✓	✓
C&D Waste Management and Handling Rules			✓	✓
Steel Scrap Recycling Policy			✓	✓

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Transitioning towards a Circular Economy – Opportunities & Challenges The Entrepreneurial Opportunity for India

OPPORTUNITIES & CHALLENGES

ABSTRACT

The Circular Economy – a buzzword in Business and Management circles today has been the foundation of Indian living – be it lifestyle or livelihood – enshrined in our scriptures, religious texts, beliefs and practices. It highlighted the fact that Humans, Nature and all other creations of God are interdependent and will always be. It was unfortunate that this simple logic is now being resurrected under the garb of a fresh paradigm that requires a focused thought process by the intellectual classes.

Indians were ingrained with the two critical concepts of the so-called Circular Economy, namely: Waste Elimination; Renewability;
Having grown -up on Grandma's tales about lifestyles in the native places where our families originally hail from, am sure, each one of us here, can recollect some anecdotal episode that highlights these concepts as a way of life.

Today, we are forced to look at the western concepts of Re-cycle & Re-purpose & Re-use to restore the imbalance generated from an insatiable over-consumption of industrially value-added goods and services, which have led to resource depletion and wastage – be it physical / natural as well as human resources, spiraling us to an unfathomable descent into chaos.
The silver lining for India comes from the traditional knowledge base, systematizing these age-old concepts like reverse logistics and fresh product innovations/design modifications, which created new and sustainable business models of entrepreneurship, coupled with our innate sense of savings – leading to competitiveness and reducing dependency on raw material inputs.

With each stakeholder – be it governments, businesses and consumers focusing targeted efforts at aligning themselves towards these concepts in their daily endeavors, the emergence of a new value chain, aimed at 'optimising' and not 'maximising' profitability, will begin to emerge and shape the decline of negative consequences of business and management.

Historical knowledge systems coupled with concurrent case studies succeeding as well as limiting the practical aspects of putting the Circular Economy in motion will be debated through this research paper presentation.

OPPORTUNITIES & CHALLENGES

PAPER PRESENTATION

Indians are almost genetically geared towards focusing efforts in everything that they do, towards the three basic necessities of life – Roti, Kapda aur Makaan (ie : Food, Clothing and Shelter.) Education is the mainstay of ensuring that these basics necessities are always fulfilled.

Food (Roti):

Dry roasted Bengal gram powder is not a novel item in Indian households. But when put through a long, yet unique process, it turns into highly nutritious and delicious sattu. Sattu powder was a regular ingredient in the daily diet of most Indians, yet today, not everyone knows of its high versatility, nutritious value, fillingness (satiety) and fascinating taste, yet being very affordable to the poorest of the poor. Commonly seen across many states such as West Bengal, Orissa, Bihar, Punjab , Delhi and Uttar Pradesh, sattu, which is usually consumed as coolant, can take up roles in many other dishes — parathas, porridge, shakes, bharta, cheela and more, it is reach in calcium and protein and can aid weight loss, improve bowel movements yet boost energy.

Spices have been the most integral part of Indian cuisine not just because they elevate the taste of any dish, but also for their health benefits, in specific food combinations. Known for anti - bacterial properties to slow down the breaking of food into digestible particles, they are known to cure and prevent a vast variety of illnesses and diseases.

Among these is the pippali, or long pepper, which in recent years has made a comeback to the Indian palate.

Historian K T Achaya has stated that pippali was among the earliest spices to ever be recorded in India, being exported from southern regions of the country more than around 4,000 years ago and used to add natural heat to food long before chillies gained popularity in the subcontinent.

“Sushruta describes seven types of cooked meats,” wrote Achaya, “[which] could either be spiced with long pepper (pippali), round pepper (maricha) and ginger, or sweetened with guda and ghee.” Pippali also found common usage in Awadhi cuisine, including kakori and galouti kebabs. It was also used extensively in Ayurvedic medicine.

While it belongs to the pepper family — Piperaceae — pippali looks very different from the round and small black pepper that we commonly use. It is a climbing perennial plant that bears long and slender spike-like fruits that are packed with several beneficial natural compounds.

A native of the Indo-Malaya region, it grows wild in the tropical rainforests of India, as well as in the North-eastern regions, West Bengal, Eastern Uttar Pradesh, Madhya Pradesh, Maharashtra, Kerala, Karnataka as well as Tamil Nadu.

Its uniqueness as an analgesic incorporates its rich content of alkaloids and beta sitosterol and possesses a long list of essential nutrients and compounds like glycosides, eugenols, terpenoids, resins, sugar, saturated fat, essential oil, and volatile oil, alongside several active components like piperine, piperlatine, piperlongumine and many more.

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Whilst many ancient scriptures and manuscripts mention its numerous health benefits, numerous modern-day studies continue to delve into demonstrating its variability prowess.
Helps in regulating blood sugar levels; Helps in curing digestive issues; Helps in curing respiratory issues; Aids weight loss; Antidepressant properties.

CLOTHING (Kapda):

With every possible thing looking at going the organic way it was only a matter of time that natural fibre fabrics such as Cotton, Jute, etc. too would initiate exploration of other plants that we Indians see, use and consume regularly; especially with the concept of 'KALPAVRUKSH' or Tree of Life which should not be restricted to just the Coconut Tree.

Enter the banana plant whose each part can be put to use and commercialising this idea, are the weavers of Anakaputhur - a suburb of Chennai that lies a little beyond the international airport on the banks of the Adyar, where around 15-years-ago, a group of third-generation weavers, predominantly women, decided to explore and innovate a new weave and saree fabric, out of banana fibre.

It all began with a member having read a version of the Ramayana in a Tamil magazine of Sita's abduction and her need for a change of clothes. She did not want to ask her abductor (Ravana) for anything and pleaded with Hanuman to get her 'vaazhai naaru' (banana fibre) and wove a sari out of it. If it could be done at a time when technology was no where close to what it is today then work began on finding the way to do this now, with two weavers, taking just two full days to complete the process of creating a fresh new saree.

SHELTER (Makaan):

Indian Architecture has never been just about design, style, fancy materials etc. it has always incorporated ingenuous concepts, natural raw materials and artistic skill-sets to create that personal space each of us calls home.

The 'KATH KUNI' homes of Himachal are constructed on horizontal beams using local bamboo, mud, stones and wood with a view to make them resistant to any natural calamity. Rajasthan's artistic 'HAVELIS' with their 'JHAROKHA' window-seats, intricately carved and shaped to incorporate natural weather whilst utilizing locally abundant terracotta bricks and sandstone – both of which store and release heat based upon the temperatures in the external environment. The 'WADAS' of Maharashtra were evolved to eliminate the need for huge, cumbersome fabric fans that required to be pulled- pushed by a dedicated handler to keep the large rooms cool and are a ventilation design of pure genius that is prevalent even today. Tamil Nadu's famous lime plaster on Burma Teak is known to be natural heat absorbers and natural cooling depending on external weather conditions.

Case Study I : Food Management as a sustainable venture

Jaimy Saji, a homemaker-turned-entrepreneur from Wayanad, Kerala, learned about this in a class she took conducted by the agricultural department in 2019. That's when she became aware of the health benefits of jackfruit seeds, which are available in plenty all over Kerala. She studied various methods to make use of the seeds of jackfruit, which otherwise goes into the garbage bin after having the fruit.

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One method she imbibed was to dry and powder the Jackfruit seeds to convert into payasam (sweet porridge, a South-Indian dessert). Having prepared this dessert and distributed it among her neighbours for tasting, the feedback received convinced her to making this dish during the off-season, the fruit is available in plenty, only during summers

However, since the wastage is huge, there is always an option to store them and use them throughout the year, leading her agripreneurship brainchild Holy Cross Industries, a venture to support jackfruit farmers by making value-added products using the fruit. Alongwith her husband, they initiated their custom-designed machines that could clean and powder the seeds.

Today, Holy Cross Industries uses the brand name 'Jack Fresh' to sell more than 10 varieties of products, such as dosa mix, idiyappam mix, steam cake mix, coffee powder and instant payasam mix. All of these products have jackfruit seeds as the main ingredient.

The seeds are filled with antioxidants, proteins, iron and Vitamin A and historically known for their capability of preventing anaemia, curing skin diseases and supporting healthy hair growth.

With statistical calculations that only 10 per cent of the fruit produced in the state is consumed, imagining the possibilities with the fruit directly as well as indirectly, are enormous, supplementing not just utilisation, but also enhancing health.

Another peculiar product from her product list is 'coffee powder' that does not have coffee beans as an ingredient, because, Jackfruit seeds, after processing, smell so similar to coffee, that has received rave reviews, with the product being manufactured in small quantities, yet expected to become the next bestselling item.

The jackfruit seeds go through two levels of cleaning and the plastic-like outer skin is removed, with the next layer, brown in colour, being good for the stomach in avoiding gastric problems. The next process is De-hydration, followed by Powdering, with other additives, in small quantities manually, adding to freshness as well as sustainability in manual labour employment.

Case Study II: Food Management as a sustainable venture

Cocoa beans, sugar, vanilla, milk—these three are common yet critical ingredients that one would find in one very essential sweet, all age groups crave and can never deny themselves - Chocolate!

Taking a traditional spin on this decadent confection, Hill Wild in Northeast India is not only revolutionising the way the world sees chocolate but is also helping build sustainable livelihoods for the community it comes from. Started in 2017 by Zeinorin Stephen Angkang and Leiyolan Vashum, Hill Wild aims to build an economically sustainable community through entrepreneurship in the North-east region of India.

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Having a friend who was a pastry chef and taught Zeinorin the art of chocolate making, who added something unique from the Ukhrul hills of Manipur – her heritage, into her creations.

Along with her pal and business partner Leiyolan Vashum, she launched a range of chocolates which incorporated locally sourced North-eastern ingredients such as pumpkin seeds, hodgsonia, plum wine and even the famous Naga King Chilli, to infuse the Hill Wind chocolates range. The company even creates rum raisins and whiskey truffles – all grown in a pristine environment and one can actually feel the terroirs in the chocolates, by providing employment to the local communities, for Sourcing, Manufacturing and Development of other products.

Case Study I : Clothing Management as a sustainable venture

An earthquake in 2015, and a cancelled flight were the start of a unique partnership between Zoya Wahi – a Digital Communications Consultant from Jaipur and Nitij Singh – a Public Policy Consultant from Haryana, both friends, in their early 30s.

Their efforts to help people affected by the disaster has translated into an eco-friendly fashion brand named ASLEE - focussed on sustainable living and lifestyle products made out of hemp, bamboo and the Himalayan nettle.

They had two motives while building the brand ASLEE :
To assist people in making planet-positive choices in their everyday lives;
To come up with a range of apparel that people could wear no matter the occasion;

Zoya opines that when people think of sustainable clothing, cotton is the first thing that comes to mind, though it's an over-utilised commodity, putting a burden on the farming community in tropical climates - taking away from its initial purpose of being sustainable.

That's how they worked to come up with a range of plant fibres that performed well and did not burden the farming community – hence, hemp, bamboo and nettle – each fabric variation, having unique properties, but one common feature – versatility. In the summer heat, they act as great sweat absorbers, whilst in the cold winters they can be used for layering. Apart from that are inherent characteristics of being anti-microbial, with a good protectant against UV radiation, thermo-sensitivity and sometimes even the added advantage of being fire-resistant.

Most of these textile fabrics come from plants that don't pollute the soil with harmful chemicals, whist also being totally bio-degradable.

These un-conventional materials, come with issues of production and sourcing because Hemp has only been legalised for cultivation in just a few states such as Uttarakhand, Madhya Pradesh and this does create issues in the supply chain. Next issue is Certification/s which poses a problem as there are negligible trusted certification authorities that can help test these fabrics. Thereafter, is the Regulatory Frameworks, pre-empted as well as people acceptance of the fabric.

OPPORTUNITIES & CHALLENGES

Lack of policies supporting production often makes operations tough, hence there should be a policy level push at the industrial level. Because Growth avenues are needed at a larger scale, should be incentivized, for quicker economies of scale.

Case Study II: Clothing Management as a sustainable venture

It is estimated that roughly 92 million tonnes of textile waste is generated per annum, which when evaluated simply, equals one truck full of clothes ending up in a landfill every second.
Anshika Yadav from Prayagraj, a graduate from NIFT, Bhubaneshwar decided to find a solution, one scrap cloth at a time, whilst still working at an export house, where huge amounts of fabric scraps were generated and disposed off, daily.

In January, 2021, she quit her job and founded the sustainable clothing brand 'Let's Save As', using discarded fabrics, from the neighborhood, boutiques, tailoring shops etc., to upcycle them into shirts, dresses, accessories and bags

As is well known, the going was tough initially, with people struggling to understand the concept of upcycling, Anshika has catered to over 200 customers till date and has upcycled over 500 kg of scrap fabric.

Case Study I: Shelter Management as a sustainable venture

Architecture, said to be the mother of all arts, can be perceived in different ways. Centre for Environmental Planning and Technology (CEPT) saw eight students – all friends saw Architecture, as a way to promote community development and sustainability.

It was the year 2017, whilst they were still in their final year of college, when Monik Shah, Aman Amin, Kishan Shah, Krishna Parikh, Vedanti Agarwal, Nishita Parmar, Prasik Chaudhary and Manuni Patel were on a field trip, visiting a village in Ahmedabad. Compartment S4, their sustainable architecture company was born out of the visit which had amazed them all, by the traditional rural architecture and the various methods used for construction, imbibed into a career goal.

Initial business development activity led them to the Ahmedabad Urban Development Authority (AUDA) for some projects and were asked to provide architectural services for a small number of toilets and lakes in villages between Ahmedabad and Gandhinagar. Within a span of five years, the team has carried out several remarkable projects, some of which are listed below:

Otla Par Gammat, December 2017

Their first project, under which an Anganwadi centre was built, in Badalpara Gram Panchayat of Gir district of Gujarat, using local resources and skills, with the roof made with clay axes. They used 3,000 kulhads from designs given to 4-5 potters of the village.

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Additionally, the walls were made from locally available limestone, whilst cement was used only on the joints. The heat in Gir reaches up to 45-50 degrees Celsius, but this construction technique helps the Anganwadi centre remain cold even during the summer, providing local employment and was completed within 12 days. Creating a play area made with household items like cans and tyres for children was part of the venture – all of this at a spend of just Rs 2.5 lakh (50% of regular costs).

Lakdi ki Kathi, May 2018

An earthquake-resistant structure built as an extension to the existing secondary school building in Ghuggukham village in Uttarakhand, the built space is completely cementless, using clay, stone and wood and it took just 17 days to build.

In keeping with space requirements of the students and teachers, incorporating water-proofing and water harvesting into the design, based on the problems faced by the village, their aim was to create a prototype for the village to adopt from.

Pink Toilet, 2019

To tackle open defecation on behalf of the Pauri district administration, the group utilised 2,000 bricks and 15 bags of cement, whilst adding thermal insulation too, using rat trap bonds - a type of brick masonry that can reduce the number of bricks. Adding to the set-up installed machines and breastfeeding rooms, spending just Rs 2 lakh for a 150 square foot, completely earthquake resistant toilet area, with a ventilator at a height of seven feet, so that natural light can come in.

Gau-ghar (Cattle Shed), 2020

A well-designed shelter housing 80-85 cows divided on the basis of milking cows, non-milking cows, pregnant cows, calves and bulls. The challenge was in incorporating efficient space management, circulation, drainage and ventilation systems, which are integral to cattle health and milk yield, whilst adding considerations such as the efficiency of flow of inlet food materials for the cows and removal of organic waste from cow feces and urine - a project located in the Surendranagar district of Saurashtra region of Gujarat.

The primary material used to make the shed is Bamboo, coupled with a structure placed on steel columns. Multiple steel joints are fabricated at the junctions for making the bamboo joints efficient and an exposed brick flooring that does not heat up and is not slippery, either. Jute cloth is used as a heat insulator below the tin sheets on the roof. The main walls have been made with local and cost efficient stone masonry, fortified with mud plaster techniques.

CS4's clients include Nainital Tourism Department, Surat Forest Department, ISKCON Group, Shankar Ice Cream, Midas Hospitality Group and the Water, Sanitation and Hygiene (WASH) program by UNICEF, making the venture successful and profitable, whilst rendering it a long life.

Case Study II : Shelter Management as a sustainable venture

A graduate of the JJ College of Architecture in Mumbai, Dean D'Cruz returned back to his home state of Goa almost 35 years ago and set up base,whilst working on over 350-

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projects across India–majority being residential houses and the rest - hotels – with almost a quarter of all these built in the most sustainable ways possible.

He wants house owners to utilise construction materials and human resources of the location where their homes are situated but also wants them to form a community of neighbors where resources are shared. These steps, he believes, will maintain the sustainability of the houses for years to follow.

He adds that ensuring a safe, empowering space to the local community and engaging with them long after the construction process is completed are two crucial factors to "sustain" the sustainability model.

In 2001, he co-founded Mozaic, an architectural firm advocating sustainable housing, constructed with wood, mud and other materials that are available in the proximity of the house's location. Back then, transporting material from one region to another was not feasible, and today, it is expensive.

Utilising local laterite that's cheaper than the usual bricks, the roof is made of Mangalore roof tiles arranged such that there are gaps in between two tiles and that allows for ventilation of air, considering the hot weather and humidity levels of most parts across coastal stretch of India.

Many designs of D'Cruz's make use of waste materials available nearby. In one instance, the team used timber from trees that had fallen near the site, which was used in the construction of a five- star hotel. In another instance, they got bike handles from a local garage and used them as a tap for a washbasin. In one homestay project, atop a hill, the stone excavated from the pool area, was used for the construction of the building, avoiding wood in the doors, windows by making them of light steel frames and rebated the stonework itself to create the seal.

Doors and windows in his designs are rarely brand new since D'Cruz believes in recycling materials for the gateways. Another brainchild of his efforts is to have huge windows with sliding glass doors and cane curtains, allowing for natural light to brighten and keep the premises well ventilated

His encouragement of community building with his projects is aimed at infusing the idea that homes need to respond and adapt to changing family structures and other such cultural changes over the years, plus reduce their footprint, having clusters of houses with shared resources rather than individual ones with repetitive infrastructure, fostering social interaction through collective bonding.

Sustainability is not limited to the infrastructure of a home or up-cycling fabrics and organic farming alone. Instead, it is a continuous effort to adopt small changes that make a lifestyle truly eco-friendly and nature interdependent.

The relationship between people and the environment in ancient India was one of harmony, coexistence, mutual care and concern – the two supporting and complementing each other in their own way. Some of the fundamental principles of ecology – the inter-relationship and inter-dependence of all life – are reflected in the ancient scriptural text, the Isopanishad.

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Handed down through the ages, this love and respect for nature pervaded community life across India and saw expressions from across the land. The legendary Tamil philosopher, Thiruvalluvar, talks of nature as man's fortress. If he destroys her, he remains without protection.

Though a circular economy may sound idealistic – if not like a fantasy – the truth is that the existing way of doing things is reaching the end of its utility. Sustainable development seeks disruptive transformations in the way our businesses and societies are organized. The circular economy model facilitates an opportunity for innovation and synchronization between our natural ecosystems, our businesses, our lifestyles and waste management. India has the legacy of historically working in consonance with nature – all that we now need to do is re-visit that legacy and modify-to-incorporate the principles from ancient knowledge repositories, into contemporary existence – just as some our case study heroes have ventured to do.

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Dr. Ms. Priya Madhukar Kenkare is Visiting Faculty at various Management Institutes across India and she brings with her over 37 years of experience such as Adjunct Faculty of Business & Management in a Global Context, International Comparative Perspectives, Core Management Concepts, E-Business, Human Resource Management with Russel Square International College and Business Study Skills & Methods, Business Communication, Management & Business in a Comparative Perspective, Advertising & Promotion Management with University of London's Royal Holloway College.

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ABOUT US

About International Council for Circular Economy

ICCE, the International Council for Circular Economy, stands as the premier and largest international network for professionals, corporates, and organizations engaged in advancing the Circular Economy. With a resolute mission, ICCE is dedicated to expediting the transition to a restorative and regenerative economic model that emphasizes circularity at its core. By harnessing expertise and strategic guidance, ICCE endeavors to cultivate a resilient and thriving local network that drives circularity from the grassroots level. Embracing a global perspective, ICCE seeks to redefine lives and spearhead transformative change on a global scale, ushering in a new era of circularity. Established in 2020, ICCE has made significant strides in propelling the Circular Economy movement in India. As a thought leader on the global stage, ICCE has successfully placed the circular economy on the agendas of corporate entities, decision-makers across various sectors including business, government, and academia, the council is a thought leader with a global outlook in building regenerative and restorative systems.

We are a member of Ellen MacArthur Community and have partnered with European Environmental Bureau, REVOLVE Circular, PREVENT Waste Alliance, ISO, BIS, OCCE, Close the Loop along with other major global organizations working towards boosting circularity·

About Indian Plastic Institute (IPI)

Indian Plastics Institute is a technical professional Body registered in April 1985 under the societies Registration Act 1860 and subsequently under the public trust act 1950. IPI was formally inaugurated on 6th May 1985 after taking over the Plastic and Rubber Institute, London (PRI) Indian Section (Plastics) as of 30th April 1985, which established in June 1963 as an Overseas Section of Plastic Institute, London. Today, IPI is a strong Professional Body of Industrialists, Plastic Technologists, Academicians, Economists and Students, spread over 14 Chapters across India and 2 Overseas Association partnerships with Sri Lanka & Nepal. We are engaged in Education, Training, Manpower Development and Dissemination of Knowledge on the latest technological developments in the world wide Plastics Industry. The contribution of IPI within the context of the Indian Plastics Industry is quite unique. Organizing Technical programme throughout the Country, including Conferences, Seminars, Lectures and Workshops, in addition to its Educational Programme and Activities are no meager achievement.IPI play a vital and complementary role to universities and other educational institutes in drafting course curricula, providing “Visiting Faculty” facilities through its members and arranging industrial training for students. In keeping with this IPI is represented on the Governing Council of Central Institute of Plastics Engineering & Technology (CIPET). IPI also represented in Bureau of Indian Standards(BIS) for promotion of standardization and testing and quality control procedures.

CONTACT US

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