WASTE TO WEALTH

EXPLORING THE POTENTIAL OF CIRCULAR ECONOMY

Project Outcomes:

1. **Waste to Wealth:** Exploring the Potential of Circular Economy
2. **Unlocking Value Through Circular Economy Practices**
3. **Circular Possibilities:** Future of Resource Management

Technical Session:

One technical session was conducted by **Dr. Gurpreet Singh Saggu**
Sustainability Manager, Office of Infrastructure Development,
Chitkara University, Punjab

Venue:

LH 502, Rockefeller Block, Chitkara Business School, Chitkara University, Punjab

Participants:

Students of **BA (Honours) Economics with Data Science**
Batches **2022, 2023, and 2024**

Organized by:

FACULTY OF ECONOMICS,
Chitkara Business School
Under the aegis of
CHITKARA UNIVERSITY CENTRE FOR RURAL MANAGEMENT (CUCRM)
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)
In association with the
CENTRE OF EXCELLENCE FOR SUSTAINABILITY,
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)

Project Outcome 1:

Waste to Wealth:

Exploring the Potential of Circular Economy

Course:

BA (Honours) Economics with Data Science
Batch: 2023

Prepared by:

- **Prabhleen Kaur** (2320993509)
- **Pratyush B. Dogra** (2320993513)
- **Reshveen Kour** (2320993514)
- **Jasleen Punia** (2320993534)
- **Jaspinder Kaur** (2320993535)
- **Rachel Masih** (2320993550)

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WASTE TO WEALTH

EXPLORING THE POTENTIAL OF CIRCULAR ECONOMY

9th september,2024 to 20th september,2024

SUBMITTED BY

Prabhleen Kaur (2320993509)
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In association with the
Centre of excellence for sustainability,
Chitkara university, Punjab (NAAC A+)

MESSAGE FROM THE CHANCELLOR, CHITKARA UNIVERSITY

I am delighted to see the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability, leading the way with the live project "Waste to Wealth: Exploring the Potential of the Circular Economy."

At Chitkara University, we are deeply committed to fostering innovation, sustainability, and real-world learning experiences for our students. This project exemplifies how education and practical engagement can come together to address one of the most critical challenges of our time—waste management.

By exploring the potential of the circular economy, students learn how waste materials can be transformed into valuable resources and contribute to a more significant global movement toward environmental sustainability. The hands-on site visits and practical applications will undoubtedly empower our students to be future leaders in sustainable development.

I believe such initiatives help shape the minds of young individuals and prepare them to tackle complex problems with innovative solutions. I am proud of the efforts and enthusiasm shown by our students, and I am confident that this project will inspire them to make meaningful contributions toward a greener, more sustainable world. I wish all the participants the best and look forward to seeing the outcomes of this important project.

Dr. Ashok K. Chitkara
Hon'ble Chancellor,
Chitkara University

MESSAGE FROM THE PRO CHANCELLOR, CHITKARA UNIVERSITY

I am genuinely pleased to witness the launch of the live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At Chitkara University, we believe in creating future leaders who are academically strong and conscious of the world around them. This project reflects our commitment to promoting sustainability and encouraging students to think beyond the classroom. Exploring how waste can be transformed into wealth and valuable resources is a commendable step towards understanding the circular economy and its crucial role in shaping a sustainable future.

The hands-on experience through site visits and practical applications will inspire our students to embrace sustainability as a core principle in their academic and professional journeys. Projects like these, help bridge the gap between theoretical knowledge and practical execution, essential in today's rapidly evolving world.

I am confident that this project will leave a lasting impact on our students and motivate them to take bold steps in contributing to global sustainability efforts. My heartfelt congratulations to all participants for their enthusiasm and dedication.

Warm regards,
Dr. Madhu Chitkara
Hon'ble Pro-Chancellor,
Chitkara University

MESSAGE FROM THE VICE CHANCELLOR, CHITKARA UNIVERSITY

I am proud to see the "Waste to Wealth: Exploring the Potential of the Circular Economy" project being successfully launched by the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability.

At Chitkara University, we emphasize the importance of innovative learning that extends beyond the classroom, fostering a mindset of sustainability and responsibility in our students. This live project beautifully aligns with our vision of nurturing leaders who can contribute to a sustainable and circular economy by transforming waste into valuable resources.

Through site visits and practical involvement, this project provides a unique opportunity for students to witness firsthand how waste management practices can be applied in real-world scenarios. It encourages them to explore how recycled materials can be repurposed, highlighting such initiatives' economic and environmental benefits.

I commend the students for their active participation and dedication, and I am confident that this experience will instill a strong sense of responsibility toward sustainability in their future careers. Such initiatives are a testament to our commitment to shaping responsible global citizens.

Warm regards,
Prof. Sandhir Sharma
Vice Chancellor, Chitkara University, Punjab

MESSAGE FROM THE DEAN, FACULTY OF ECONOMICS CHITKARA UNIVERSITY

I am immensely proud to witness the successful initiation of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At the Chitkara University Centre for Rural Management (CUCRM), we are committed to addressing pressing environmental challenges and promoting sustainable development, particularly in rural areas. This project is a testament to our efforts to integrate innovative, circular economy practices with real-world applications, offering our students a hands-on experience transforming waste into valuable resources.

This initiative highlights the need for sustainable development in urban and rural contexts. The insights gained will empower students to apply these lessons to broader societal challenges, mainly where waste management and sustainability are crucial. I commend the students for their enthusiasm and dedication and extend my heartfelt appreciation to everyone involved in this project.
I look forward to the positive outcomes of this meaningful initiative.

Warmest congratulations once again!
Sincerely,
Prof. Dhiresh Kulshrestha
Dean, Faculty of Economics, Chitkara Business School and
Chitkara University Centre for Rural Management (CUCRM)
Chitkara University, Punjab

MESSAGE FROM DIRECTOR, OFFICE OF ADMINISTRATION AND CENTRE OF EXCELLENCE FOR SUSTAINABILITY, CHITKARA UNIVERSITY

I am delighted to see the successful launch of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," an initiative led by the Faculty of Economics in collaboration with the Centre of Excellence for Sustainability at Chitkara University.

The Centre of Excellence for Sustainability is dedicated to advancing the principles of environmental stewardship, sustainable development, and green innovation. This project embodies our core mission by providing students an invaluable opportunity to engage with the practical aspects of waste management and resource recycling within a circular economy framework. Through real-world exposure, the students learn about waste-to-wealth practices and actively contribute to the broader sustainability goals we champion at the center.

As part of this initiative, students are immersing themselves in on-ground activities, from visiting liquid and solid waste management sites to understanding organic waste recycling methods. These experiences help them appreciate sustainability's critical role in today's world and empower them to apply these principles professionally and personally in their future endeavors. I commend the students and faculty for their enthusiasm and dedication to this project.
Sincere regards,

Sqn. Ldr. Dr. Reena Angel
Director, Office of Administration and
Director, Centre of Excellence for Sustainability
Chitkara University, Punjab

ACKNOWLEDGEMENT

We want to express our deepest gratitude to everyone who has contributed to the success of this live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability, Chitkara University, Punjab

First and foremost, we are profoundly grateful to Dr. Ashok K. Chitkara, Hon'ble Chancellor, and Dr. Madhu Chitkara, Hon'ble Pro-Chancellor, Chitkara University, for their visionary leadership and continuous support in fostering an environment of innovation, sustainability, and learning.

We thank Prof. Sandhir Sharma, Vice-Chancellor, Chitkara University, Punjab, for his guidance and unwavering encouragement throughout this initiative. His commitment to experiential learning and sustainability has been instrumental in shaping this project.

Our sincere appreciation goes to Sqn. Ldr. Dr Reena Angel, Director, Office of Administration, and Director of the Centre of Excellence for Sustainability, for her valuable insights and support in aligning the project with the broader goals of sustainability and circular economy principles.

We would also like to express our gratitude to Prof. Dhiresh Kulshrestha, Dean, Faculty of Economics, Chitkara Business School, and Director of the Chitkara University Centre for Rural Management (CUCRM), for his strategic direction and mentorship, which have been vital in guiding our students through this hands-on project

.A special thanks to the project coordinators, faculty members, and staff of Chitkara Business School, whose tireless efforts and commitment to student learning have made this project a remarkable success.

Lastly, we immensely thank the students for their enthusiasm, dedication, and active participation. Their hard work and keen interest in exploring sustainable solutions through the circular economy have driven this project's success.
Thank you all for your invaluable contributions!

CERTIFICATE

This is to certify that the following students from **B.A. (Honours) Economics with Data Science (Batch 2023)** have completed the live project titled **"Waste to Wealth: Exploring the Potential of the Circular Economy,"** held from **9th September 2024 to 20th September 2024**, organized by the **Faculty of Economics, Chitkara Business School**, in collaboration with the **Centre of Excellence for Sustainability** at **Chitkara University, Punjab**.

Participants:

1. Prabhleen Kour (Roll No: 2320993509)
2. Pratyush B. Dogra (Roll No: 2320993513)
3. Reshveen Kour (Roll No: 2320993514)
4. Jasleen Punia (Roll No: 2320993534)
5. Jaspinder Kaur (Roll No: 2320993535)
6. Rachel Masih (Roll No: 2320993550)

During this project, the students demonstrated excellent understanding of the principles of the circular economy, actively participated in visits to various waste management sites, and contributed valuable insights to group discussions and project reports. Their involvement in recycling initiatives and practical exercises showcased a commendable ability to apply theoretical knowledge to real-world sustainability challenges.

As a supervisor, I am proud of their dedication, enthusiasm, and contributions to the success of this project. I am confident that the skills and knowledge gained through this live project experience will serve them well in their future academic and professional endeavors.

I wish them continued success in all their future undertakings.

Supervisor

Dr. Gurwinder Singh

Assistant Professor, Faculty of Economics

Chitkara Business School

Chitkara University, Punjab

ABBREVIATIONS

WtW:Waste to Wealth

CE: Circular Economy

CU: Chitkara University

CUCRM: Chitkara University Centre for Rural Management.

CPCB: Central Pollution Control Board

UNEP: United Nations Environment Program

SD: Sustainable Development

R's: Refuse, Reduce, Reuse, Repair, Recycle

UNDP: United Nations Development Programme

WM: Waste Management

WHO: World Health Organization

STP: Sewage Treatment Plant

KLD: Kilolitres per Day

MLD: Megalitres per Day

F2W: Food-to-Waste

LCA: Life Cycle Assessment

PH: Potential of Hydrogen

BOD: Biochemical Oxygen Demand

COD: Chemical Oxygen Demand

C2C: Cradle to Cradle

R2V: Reuse to Value

TSS: Total Suspended Solids

WTE :Waste-to-Energy

MBBR: Moving Bed Biofilm Reactor

ACF: Activated Carbon Filter

PSF: Pressure Sand Filter

BIS: Bureau of Indian Standards

SMM: Sustainable Materials Management

R&D: Research and Development

ZWF :Zero Waste Framework

EF: Ecological Footprint

GLOSSARY

Activated Carbon Filter (ACF): a type of filtration technology that uses activated carbon to remove Total Organic Carbon (TOC), odor, color, and chlorine from the fluid by adsorption.

Biochemical Oxygen Demand (BOD): is the amount of oxygen needed to break down organic matter in water.

Circular Economy (CE): an economic system based on the reuse and regeneration of materials or products, especially as a means of continuing production in a sustainable or environmentally friendly way.

Chemical Oxygen Demand (COD): is a water quality indicator that measures the amount of oxygen required to chemically oxidize organic and inorganic compounds in water.

Cradle to Cradle (C2C): is a regenerative industrial system that uses everything produced in a continuous cycle.

Ecological Footprint (EF): It measures the ecological assets that a given population or product requires to produce the natural resources it consumes.

Life Cycle Assessment (LCA): is a systematic analysis that evaluates the environmental impact of a product or service throughout its entire life cycle, from raw material extraction to production, use, and end-of-life management, with the goal of identifying opportunities to minimize waste and maximize resource reuse through design and circular practices.

Moving Bed Biofilm Reactor (MBBR): is an aerobic biological process in which the degradation of organic matter is carried out by aerobic bacteria inside a moving bed biofilm reactor.

Pressure Sand Filter (PSF): is a type of filter that removes suspended particles and turbidity from water.

Sustainable Development (SD): is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

Sustainable Materials Management (SMM): is a systematic approach to using and reusing materials more productively over their entire life cycles.

Total Suspended Solids (TSS): is a measurement of the amount of suspended particles in water that are not dissolved.

Waste Management (WM): is the process of managing waste from the time it's created to when it's disposed of.

Waste-to-Energy (WTE): is a process that converts waste into energy, such as electricity, heat, or transport fuels.

Zero Waste Framework (ZWF): is a strategic framework that helps develop and implement systematic waste management activities to achieve zero waste goals.

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EXECUTIVE SUMMARY

This report is titled “Waste to Wealth: Exploring the Potential of the Circular Economy” organized by Chitkara University:

Project Overview:

Objective: The project aims to educate students on the principles of the circular economy and sustainable waste management. It involves hands-on learning through site visits and practical applications, transforming waste into valuable resources.

Key Messages:

Leadership Support: The Chancellor, Pro-Chancellor, Vice Chancellor, and Dean of Chitkara University emphasize the importance of sustainability and innovation in education. They commend the project for bridging theoretical knowledge with practical execution.

Student Involvement: Students actively participated in visits to waste management sites, engaged in recycling initiatives, and contributed to group discussions and project reports. Their involvement is seen as crucial for fostering future leaders in sustainability.

Institutional Commitment:

Sustainability Initiatives: Chitkara University is dedicated to environmental stewardship, with programs focusing on recycling, vermicomposting, and sewage treatment. The university aims to inspire students to contribute to a sustainable future through innovative projects and research.

Global and Local Context:

Waste Management Challenges: The report highlights the global issue of waste accumulation and the need for effective waste management strategies. It also addresses the specific challenges faced by India and Punjab, emphasizing the importance of converting waste into wealth.

Conclusion:

Impact and Future Goals: The project underscores the potential of the circular economy to address environmental and economic challenges. It calls for coordinated efforts at local and global levels to shift towards sustainable practices, highlighting the long-term benefits of such an approach.

CHITKARA UNIVERSITY, PUNJAB

Chitkara University is a private university established in 2002. Chitkara University is ranked 54th in the Management Category by NIRF 2024. Chitkara University is a globally recognized organization that encourages academic excellence through interdisciplinary applied research and expands realms of knowledge through innovation. With its philosophical core commitment towards excellence in education, Chitkara Educational Trust established Chitkara Institute of Engineering Technology in 2002; Chitkara International School, Chandigarh in 2004; Chitkara University, Himachal Pradesh under Himachal Pradesh State Legislature in 2008; and Chitkara University, Punjab in 2010; which was established under the Punjab State Legislature.

Today, Chitkara has 12 schools in Engineering, Management, Architecture, Nursing, Healthcare, Pharmacy, Media, Arts & Design, Education, Hospitality, Applied Sciences, and Applied Engineering. Comprising more than 13,000 students and 900 faculty members, Chitkara University is one of the best universities in North India that the government also recognizes with the right to confer degrees as per Sections 2(f) and 22(1) of the UGC Act, 1956.

Chitkara University Punjab Campus has modern infrastructure and world-class facilities that enhance the learning experience. The campus features well-equipped laboratories, libraries, auditoriums, sports complexes, and student activity centres. These facilities create an environment conducive to both academic pursuits and extracurricular activities.

Research and innovation are integral to Chitkara University's ethos. The university encourages faculty and students to engage in research projects and pursue innovation-driven initiatives. With numerous research centers and labs, the campus provides a conducive environment for groundbreaking research and fosters a spirit of curiosity and exploration.

Chitkara University Punjab Campus has forged strategic partnerships with renowned universities and institutions. These collaborations enable students to participate in exchange programs, research projects, and international conferences, enriching their global perspective and cultural exposure.

CHITKARA BUSINESS SCHOOL

Chitkara University B-school was established in 2008 on the campus of Chitkara University. College programs enable students to find the route to success at the intersection of theory and practice, discover and implement innovative solutions to real-world problems. You gain cutting-edge business knowledge and intensive practical business experience, which gives you an invaluable competitive edge. College is ranked among the top B-schools in India. The college has faculty, including people from the core academics with vast experience in academics and industry.

The university boasts a highly qualified and experienced faculty comprising professors, researchers, and industry experts. They are dedicated to imparting knowledge, guiding students, and conducting cutting-edge research in their respective fields. The faculty's commitment to excellence in teaching and research helps students develop a strong foundation for their future endeavors.

The university places significant emphasis on industry-academia collaboration, providing students ample opportunities to engage with leading companies through internships, workshops, seminars, and guest lectures. Such interactions bridge the gap between theoretical knowledge and practical application, preparing students to meet real-world challenges.

Moreover, Chitkara University has an excellent placement record, with top-notch companies visiting the campus to recruit talented graduates. The dedicated placement cell works closely with students to help them secure placements in reputed organizations, giving them a head start in their careers. Life at Chitkara University Punjab Campus is vibrant and dynamic, with various student clubs and societies catering to diverse interests, from arts and sports to entrepreneurship and social causes. Chitkara University Punjab Campus stands tall as a beacon of academic excellence, shaping the leaders of tomorrow.

FACULTY OF ECONOMICS

The B.A. (Hons.) Economics with Data Science program at Chitkara Business School boasts a faculty of renowned scholars and industry experts passionate about empowering students with the tools to unlock the power of data in economic analysis.

Faculty hold advanced degrees in Economics, Econometrics, Data Science, and related fields, ensuring a solid foundation in economic principles and quantitative methods. Faculty members possess expertise in various data analysis tools and techniques, including statistical software like SPSS, AMOS, STATA, Eviews, etc., equipping them to guide students in practical data manipulation and analysis. We actively publish copyrights, patents, and research papers in top academic journals, ensuring students are exposed to the latest advancements in economics and data science. Faculty members are dedicated to guiding students individually, providing support and guidance throughout their academic journey.

Graduates have Successfully secured placement positions at top companies across various sectors, including finance, consulting, government agencies, and research institutions. Strong partnerships with renowned organizations provide students with internship opportunities and practical exposure to cutting-edge data science applications in economics. Beyond expertise and achievements, the faculty of economics at Chitkara Business School fosters a unique learning environment.

In conclusion, the Faculty of Economics at Chitkara Business School is a team of highly qualified and dedicated individuals committed to helping students excel in Economics with Data Science. Their expertise, achievements, and commitment to student success make them invaluable assets to this unique and innovative program.

CHITKARA UNIVERSITY CENTRE FOR RURAL MANAGEMENT [CUCRM]

CUCRM is managed by a General Body of Chitkara Educational Trust and Cooperatives, Developmental Organisations, Governmental Agencies (National Dairy Development Board, National Cooperative Union of India, Ministry of Agriculture, and other influential public bodies), NGOs, Industry Partners and Centre members. The general body meets twice yearly to review the centre's performance on the plans. The Board Members meet every quarter to oversee the functioning of the CUCRM more frequently. The director oversees the day-to-day functioning of CUCRM. The director is assisted by other faculty members, researchers, and other supporting staff who work as coordinators and oversee the functioning of CUCRM's activities. You can visit the CUCRM webpage at:- https://www.chitkara.edu.in/cucrm/

CENTRE OF EXCELLENCE FOR SUSTAINABILITY

The Centre of Excellence for Sustainability was formed under Office Order in Jan 2024. Our team of eight passionate environmentalists joined hands and got our brains and mind ticking about how we could contribute to our roles. Numerous initiatives were already being undertaken by the various schools/ colleges and departments of the campus. Still, there was so much yet to be done (there would always be room for improvement and more activities!). We designed a route to connect with all teams and move ahead, one step at a time, but together. Offline and online meetings and discussions suggest how to take the next step. We would follow four principles - "What gets measured gets managed" & "Unless you know what assets you have, you cannot decide what to procure further". For both of these, data is a must, and so is data analysis. The second two principles are to "maximize students' participation in all activities" and to spread awareness as much as possible. This way, we provide more chances to create leaders who appreciate the responsibility of "leaving no one behind". We also needed to know what was done for the second principle, so we required data!! Hence, we decided to prioritize data and started with data collection. The results were overwhelming.

We had more than 2900 events in the various SDGs and were highly involved in research papers, collaborations, patents, etc., which were also related to sustainability. For specific departments, we suggested digitalising data; for most others, we suggested zooming into goals and achieving milestones. This way, we could analyze the performance and progress, too. Our first step was digitalising demands for plantation drives and green gifts in coordination with the Department of Horticulture and the Chalkpad Team. Further, we coordinated with all schools/colleges and departments for various sustainability-related activities. This newsletter will give you glimpses of the activities undertaken in collaboration with the Centre of Excellence for Sustainability from Jan 2024 to June 2024. We created a webpage, too - https://sustainable.chitkara.edu.in

INTRODUCTION

Waste management is a global issue that calls for creative solutions to turn waste material into useful resources. The idea of "waste to wealth" has garnered a lot of attention lately as a way to address the mounting issue of waste accumulation while fostering sustainability and generating income.

According to the World Bank (2022), global waste generation is projected to reach 3.4 billion tons per year by 2050, underscoring the urgent need for effective waste management strategies that can transform waste into valuable resources. Due to the rapid growth of urbanization, industrialization, and population, waste management has become a serious environmental concern on a global scale. The UNEP's Global Waste Management Outlook report sets a framework for understanding the critical role of waste management in achieving sustainable development goals and emphasizes the transformative potential of viewing waste as a resource for economic and environmental benefits.

On a national scale, managing its waste is a crucial challenge for India. The nation's garbage output has significantly increased as a result of its quick urbanization and economic growth. Only a small portion of India's 62 million tons of annual municipal solid waste generated is recycled or appropriately managed, according to the Central Pollution Control Board (CPCB, 2023) assessment. Inadequate infrastructure in many areas and ineffective waste management methods exacerbate this situation.

Coming to Punjab, a state in northern India known for its agricultural productivity, Punjab produces a lot of agricultural waste, especially from crop residues, and municipal solid waste as well. Due to its significant contribution to air pollution, stubble burning has been a problem for the state in recent years (Indian Council of Agricultural Research, 2020). However, efforts are beginning to emerge to convert agricultural waste into biodegradable products or energy, which is in line with the larger goal of converting waste into wealth [1]. Chitkara University, situated in Punjab, is an institution dedicated to cultivating an

environmentally conscious and sustainable campus. In order to address waste management, the university has put in place programs that emphasize recycling, vermicomposting, waste reduction, and the treatment of sewage waste through the establishment of sewage treatment plants (STPs). Chitkara University plays a vital role in the local and regional initiatives to turn waste into wealth through scholarly research, awareness campaigns, and creative projects (Chitkara University, 2022). The university works to educate and inspire the next generation of leaders and innovators to contribute to a more sustainable future in addition to integrating waste management practices on campus. Vermicomposting, waste reduction, and the treatment of sewage waste through the establishment of sewage treatment plants (STPs). Chitkara University is a key player in the local and regional initiatives to turn waste into wealth through scholarly research, awareness campaigns, and creative projects (Chitkara University, 2022). The university works to educate and inspire the next generation of leaders and innovators to contribute to a more sustainable future in addition to integrating waste management practices on campus.

Vision

To create a sustainable future where waste is transformed into valuable resources by adopting circular economy principles, fostering environmental stewardship, and contributing to a greener, more resilient society.

Mission

To engage students in hands-on, real-world applications of the circular economy by exploring innovative waste management practices, enhancing their understanding of sustainability, and empowering them to become advocates of resource efficiency and environmental responsibility in urban and rural contexts.

Objectives

Educate and Raise Awareness: To deepen students' knowledge of the circular economy and its importance in addressing environmental challenges by demonstrating how waste materials can be recycled and transformed into valuable products.

Hands-on Learning: To provide practical exposure to waste management processes, including liquid, solid, and organic waste treatment, through visits to specialized sites, allowing students to observe and engage with sustainable practices.

Foster Innovation and Problem-Solving: To encourage students to develop innovative solutions for transforming waste into wealth by applying circular economy principles and promoting creative thinking in sustainability initiatives.

Promote Sustainable Development: To highlight the relevance of sustainable waste management in urban and rural development, particularly through the Chitkara University Centre for Rural Management (CUCRM) activities.

Collaboration and Teamwork:
To cultivate teamwork by assigning group-based projects where students compile reports and offer recommendations based on their observations from waste management sites.

Contribute to Institutional Sustainability Goals: To align with Chitkara University's sustainability initiatives by involving students in projects that reflect the university's commitment to environmental stewardship and resource efficiency.

WASTE MANAGEMENT AT CHITKARA UNIVERSITY, PUNJAB

1 LIQUID WASTE MANAGEMENT

Chitkara University, Rajpura, has made significant strides in wastewater management with the installation of a Sewage Treatment Plant (STP) designed to handle up to 1.2 million liters per day. The STP is a critical component of the university's commitment to sustainable water management, aligning with global standards for environmental responsibility. The plant utilizes advanced Moving Bed Biofilm Reactor (MBBR) technology, a state-of-the-art process known for its efficiency and effectiveness in treating sewage.

Comprehensive Overview of the Sewage Treatment Process at Chitkara University, Punjab

1. Pre-Treatment: Initial Wastewater Conditioning

Fig 1.1 This screen filter removes bigger particles from the sewage like paper& plastics

Screening: The first step in the treatment process involves the removal of large debris from the incoming sewage. Screens filter out items such as plastics, rags, paper, and other non-biodegradable materials that could damage equipment and disrupt subsequent processes.

Grit Removal: After screening, the wastewater enters a grit chamber where heavier inorganic particles like sand, gravel, and small stones settle to the bottom. This step is crucial as it prevents abrasion and mechanical wear on pumps and other treatment equipment.

2. Primary Treatment: Settling and Separation

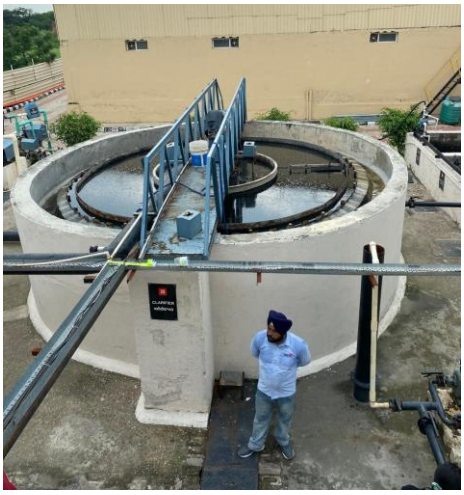

Fig 1.2

Fig 1.3

Coagulation tank and clarifier at Chitkara University's STP

Primary Clarification: In this phase, wastewater is directed into primary clarifiers or sedimentation tanks. Here, suspended solids settle at the bottom as sludge, while oils, grease, and lighter materials float to the surface and are skimmed off. This process removes about 50-70% of suspended solids and reduces the Biochemical Oxygen Demand (BOD) significantly, setting the stage for more effective biological treatment.

3. Secondary Treatment: MBBR Biological Treatment System

Fig 1.4

Fig 1.5

Fig 1.6

Students at the MBBR biological treatment plant

MBBR Technology: The core of the treatment process, MBBR (Moving Bed Biofilm Reactor) technology, utilizes thousands of small plastic carriers that float in the water. These carriers provide an extensive surface area for the growth of biofilm (microorganisms) that feed on organic pollutants.

Biofilm Formation: The plastic carriers are engineered to maximize surface area for biofilm development. These biofilms host a community of bacteria that degrade organic material in the wastewater through biochemical reactions.

Aeration Tanks: The aeration process is critical to the MBBR system. Fine bubble diffusers supply oxygen to the tank, promoting aerobic conditions that enhance the breakdown of complex organic compounds into simpler, less harmful substances like water and carbon dioxide.

Biological Degradation: As sewage flows through the MBBR tank, the bacteria on the biofilm consume the organic pollutants, drastically reducing the Chemical Oxygen - Demand (COD) and BOD levels of the water.

4. Secondary Clarification: Solid-Liquid Separation

Fig 1.7 showing our group members (Reshveen, Pratyush, Jasleen, Jaspinder) near the clarifier at STP

Secondary Clarifiers: The biologically treated water then enters secondary clarifiers, where the biofilm carriers are separated from the treated water. The settled biomass, a mix of dead microorganisms and residual sludge is collected at the bottom of the clarifiers.

Sludge Recycling and Disposal: A portion of the sludge is recycled back into the MBBR tanks to maintain microbial activity while excess sludge is directed to sludge treatment facilities for further processing and safe disposal.

5. Tertiary Treatment: Advanced Polishing and Disinfection

Fig 1.8

Fig 1.9

The pressure sand filter and activated carbon filter

Filtration: After biological treatment, the water undergoes additional filtration processes to remove any remaining suspended solids. Sand filters or other media are typically used to polish the water, enhancing clarity and removing finer particles.

Disinfection: The final step in ensuring the treated water is safe involves disinfection. Chlorination or other advanced disinfection methods are used to eliminate any residual pathogens, ensuring that the water meets stringent safety standards for non-potable reuse.

6. Sludge Management: Handling and Reuse of By-product

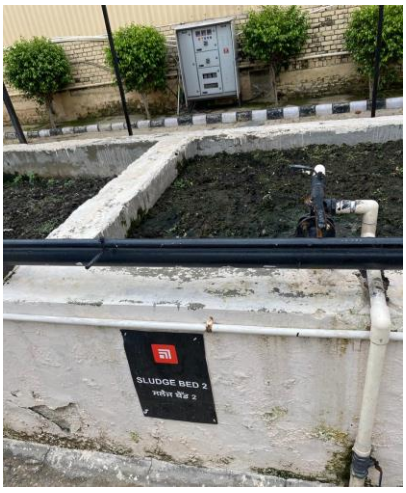

Fig 1.10

Fig 1.11

(1.10 & 1.11) Sludge is a semi solid, wet thick mixture which is a by - product of liquid waste treatment process and sludge beds help in dewatering the sludge to dry it and use it as an agricultural spread.

Sludge Thickening and Dewatering:
The excess sludge from the treatment process is thickened and dewatered to reduce its volume. This material, rich in organic content, can be further processed for use as a soil conditioner or safely disposed of according to environmental guidelines.

7. Water Reuse and Environmental Integration

Fig 1.12 exhibits the treated water which is used for irrigation and toilets. It is not fit for drinking

Reusing Treated Water: The treated water is utilized across the campus for non-potable applications such as irrigation, landscaping, and toilet flushing. This strategy significantly reduces the university's dependency on fresh water sources, contributing to water conservation efforts.

Rainwater Harvesting Integration: Complementing the STP, Chitkara University has established 18 rainwater harvesting pits on campus. These pits capture rainwater, recharge groundwater levels, and reduce the overall water footprint of the institution

8. Innovation and Future Prospects: Enhancing STP Efficiency

- **Nano Bubble Technology**: The university is exploring the integration of nano bubble aeration, which involves introducing ultra-fine bubbles into the wastewater. These bubbles significantly enhance oxygen transfer rates, improving the efficiency of the biological treatment process.
- **Monitoring and Research**: Daily monitoring of water quality is conducted by the Water Science Lab at Chitkara University, ensuring that the treatment process meets environmental standards. Continuous research and development efforts are geared towards optimizing the treatment process and exploring ways to make the treated water suitable for even higher standards, such as drinking purposes in the future.

Governance and Community Outreach

Management and Oversight: The entire waste management initiative is governed by Dr. Madhu Chitkara, Pro Vice Chancellor, and a team of experts including engineers, professors, and consultants. This team is responsible for the continuous improvement of the treatment process and extending support to local communities.

Community Involvement: Beyond the campus, the university's experts engage with local communities to help establish similar waste management systems, spreading awareness about efficient water use and the benefits of wastewater treatment

ORGANIC WASTE MANAGEMENT

2

As part of our research for the "Waste to Wealth: Exploring the Potential of Circular Economy" project, our team took a guided tour of the organic waste management facilities on campus on 12th of September, 2024. It was a fascinating experience to see how theory translates into practice and how our university is pioneering sustainable waste management.

1. Segregation at Source

Our visit began at one of the university's cafeterias, where we observed the process of waste segregation. We noticed several color-coded bins strategically placed around the dining area. The bright green bins, clearly marked for organic waste, caught our attention. Food scraps like peels, leftover meals, and biodegradable plates were disposed of here, while plastic and non-biodegradable waste went into separate bins.

We spoke with a staff member who explained how the system works. They mentioned that a big part of the success here is educating everyone on campus about what goes into each bin. Our team realized how crucial this step is—without proper segregation, the entire system would break down. It was satisfying to know that our campus community is actively participating in this sustainability initiative.

2. Collection and Transportation

From there, we followed the journey of the organic waste, visiting the areas where it's collected and transported. We saw dedicated collection staff making their rounds with specially designed carts for organic waste. These carts are eco-friendly, designed to prevent spillage and contamination. The team member accompanying us pointed out that the carts are collected at regular intervals from high-waste areas like hostels and mess halls to ensure that the waste doesn't rot or attract pests

The waste is then moved to the composting site and the biodigester units, which was our next stop.

3. Composting Facility at Chitkara University, Punjab

Fig 2.1

Fig 2.2

Fig 2.3

(2.1,2.2& 2.3) These images incorporate our curiosity during the visit at the organic waste composter. Gurpreet Sir let us know the whole process.

At the composting site, we were amazed by the large, neatly arranged piles of composting material. These were rows of organic waste being turned over to speed up the decomposition process. This method, we were told, is called windrow composting. The waste is regularly turned over to allow air to circulate and help microorganisms break it down faster. As we stood there, we could already see that the material was well on its way to becoming rich, dark compost.

One of the workers explained how critical it is to maintain the right balance of moisture and air. We learned that if the piles are too dry or too wet, the composting process slows down. It was interesting to see how such attention to detail makes a big difference in the efficiency of waste management.

4. Vermicomposting Area in Chitkara University, Punjab

Fig 2.4 The vermicomposting unit at Chitkara University's organic waste composter

The highlight of this visit was the vermicomposting section. We were introduced to hundreds of little workers: earthworms! Special species, like Eisenia fetida, were at work digesting the organic waste. It was fascinating to watch the worms burrow through the material, speeding up the process of breaking it down into compost.

One of us asked about the advantages of vermicomposting, and the person in charge explained that the compost produced by these worms is richer in nutrients compared to regular compost. The end result, called vermicast, is highly beneficial for the campus's gardens and green spaces.

5. Biodigester Unit at Chitkara University, Punjab

Fig 2.5

Fig 2.6

Our class at the visit and the biodigester unit

Next, we visited the biodigester facility, an area where things got even more interesting. We had only read about these systems in textbooks, but here we saw one in action. Organic waste, especially food waste, is fed into these biodigesters, where it undergoes anaerobic digestion—a process where microorganisms break down the waste without oxygen.

6. Campus Gardens and Compost Use

To see the final product of all this hard work, we were taken to one of the university's gardens, where the compost and slurry are used. The lush greenery we observed was no coincidence. The compost created from organic waste enriches the soil, ensuring that the plants and trees on campus thrive without the need for chemical fertilizers.

One of our team members pointed out how this circular process—where waste from the cafeteria and gardens is transformed into compost and used right back on the same grounds—was a perfect example of a closed-loop system. It was clear that the university's sustainability efforts were paying off, with a thriving green campus as proof.

7. Awareness Initiatives and Student Involvement

Throughout the visit, it became clear that the success of this waste management system depended on active participation from everyone on campus. As we passed by several buildings, we noticed banners and posters urging students to segregate waste properly. We were also told about workshops held to educate both staff and students on sustainable practices. We even discussed the possibility of organizing similar campaigns ourselves, considering the positive impact we had just witnessed.

8. Waste Reduction at the Source

Before concluding our visit, we stopped by one of the kitchens. Here, we learned about how the university is working to reduce waste even before it gets to the bins. Practices like portion control, where students are encouraged to take only what they can eat, and food donation programs, where surplus food is donated, are in place to minimize wastage.

Our team couldn't help but think about how this ties into the larger concept of a circular economy—waste isn't just something to be thrown away; it's a resource that, when managed properly, can create value.

By the end of our tour, we left with a deeper understanding of how Chitkara University manages its organic waste sustainably. Seeing the process in action—from segregation to composting and biogas production—helped us appreciate the real-world impact of the circular economy. It also reinforced the importance of everyone playing their part in waste management, whether it's through awareness or hands-on involvement. This experience will certainly shape
the recommendations we make in our report.

3 SOLID WASTE MANAGEMENT

Fig 3.1 Finished paper products at the paper recycling plant, Chitkara University. These items include paper bags, diaries, durable files for the faculty. envelopes etc.

The term "Solid Waste Management" (SWM) describes the procedures involved in gathering, moving, handling, and getting rid of solid trash. It's an essential component of environmental preservation and public health.

The following are SWM's main goals:

Public Health:

Lowering the amount of pathogens in waste products to stop the spread of disease. Reducing the possibility of mishaps and injuries brought on by poor waste management.

Protection of the Environment:

Preserving natural resources by encouraging recycling and cutting back on trash production. Preserving natural resources by encouraging recycling and cutting back on trash production.

Resource Conservation:

Lowering the need for raw materials by recycling garbage to recover precious materials. Utilizing recycled materials in production processes to save energy.

Financial Gains:

Making money from waste management practices like composting and recycling

.

SWM that is effective uses a variety of tactics, such as:

Trash Reduction:

Reducing trash production by recycling, reusing, and reducing sources.

Rubbish Collection:

Gathering rubbish from homes, companies, and public spaces in an efficient manner.

Waste processing includes sorting, recycling, composting, and other techniques to recover valuable materials while lowering waste production. Waste processing includes sorting, recycling, composting, and other techniques to recover valuable materials while lowering waste production.

Waste Disposal:

Getting rid of the leftover waste in a responsible and safe manner by using landfills or other suitable techniques.

Communities may improve public health, preserve the environment, and live better overall by putting excellent SWM principles into practice.

PURPOSE OF THE VISIT:

On September 19, 2024, we visited the solid waste management site Paper Recycling Unit at Chitkara University, Punjab with the intention of gaining practical knowledge about the procedures involved in turning waste into wealth. The visit's specific objectives were to learn more about the difficulties in managing solid waste and to investigate the handling, recycling, sorting, and disposal of paper waste. Our study of sustainable waste management techniques focuses on recycling's ability to lessen its negative effects on the environment, conserve resources, and possibly even convert waste into useful materials.

Fig 3.2 Manual paper cutter at CU's paper recycling plant.

OBSERVATIONS:

When we arrived at the location, we saw that a sizable amount of the solid waste being processed was made up of paper waste. The facility's focus on effective paper recycling was demonstrated by the methodical procedures used for disposal, recycling, and sorting. We discovered that one of the most frequently recycled materials is paper, and that maintaining the quality of recycled products requires careful sorting. Observing how the faculty addressed the issue of contamination in paper waste was one of the visit's main highlights. For the paper to be recycled successfully, contaminants like plastics, food residue, and other materials must be eliminated.

Furthermore, since different processing methods are needed for different grades of paper, such as cardboard, newspaper, and office paper, it was stressed how important it is to keep them separate. Additionally, we noticed that recycling paper contributes to a decrease in energy use, deforestation, and landfill usage. The facility converts waste into new resources as part of a circular economy by processing used paper products.

Fig 3.3 showing paper waste

PROCEDURES OBSERVED:

Paper waste is recycled through a number of important steps:-

1. Collection and Sorting:

Paper waste is brought into the facility from a variety of sources, such as university, homes. Sorting the paper according to its type and quality is the first step. Workers were manually sorting paper from other waste materials, like metal and plastic. More precise sorting was also accomplished with sophisticated machinery, particularly for separating various paper grades and getting rid of impurities.

2. Shredded and Pulped Paper:

Fig 3.4

Fig 3.5

Hydra Pulper used to break down paper into slurry

Following sorting, the paper is fed through a machine that shreds it into tiny fragments. After that, water is added to these pieces and added to a machine called Hydra Pulper to create a pulp. The pulping process is essential for separating the paper's fibers and getting rid of any leftover impurities. At this point, any glue, ink, or other additives have been dissolved, preparing the paper for the following processing step.

3. De-inking:

When recycling paper, especially printed paper, de-inking is crucial. We saw how the ink and dyes were taken out of the paper pulp using both chemical and mechanical processes. The facility makes sure that the recycled paper is free of residues and can be used again to make clean products like cardboard or newspapers by employing flotation or washing techniques.

4. Papermaking:

Fig 3.6

Fig 3.7

Uni vat: A machine that molds paper into sheets

The refined pulp is spread on a flat wire screen to form new paper sheets and machine used is uni vat.

5. Pressing and Drying:

Fig 3.8

Fig 3.9

Manual screw press: Used to remove excess water from sheets
Calandaring machine: It uses pressure and rollers to ensure that papers are smooth and uniform in thickness

Next, the sheet is dried and pressed using a machine called Manual Screw Press which helps to remove excess water. Calandaring machine is used to make the sheets thin and usable.

6. Final Products:

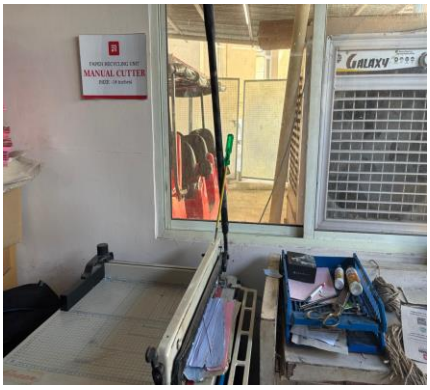

Fig 3.10

Fig 3.11

Fig 3.12

Shows manual cutter (used to cut the final recycled paper into reusable forms) along with final products like file covers and diaries

The final product i.e. the recycled paper is cut manually using a Manual Cutter. In Chitkara University, they are used to make file covers, diaries, notebooks. Newsprint, office paper, and cardboard are just a few of the products that are frequently made from recycled paper. We discovered that books and magazines can also be made from excellent recycled paper. The recycling facility lessens the need for the production of virgin paper, protecting natural resources and lessening the paper industry's environmental impact.

Fig 3.13 Our group holding the recycled paper outside the paper recycling plant

FINDINGS FROM SITE VISITS

LIQUID WASTE MANAGEMENT SITE

Efficient Liquid Waste Treatment

Chitkara University has a well-functioning *sewage treatment plant (STP)* on campus, which treats wastewater generated from hostels, kitchens, laboratories, and washrooms. The treated water is then reused for non-potable purposes, such as landscape irrigation and cleaning.

This closed-loop system helps in reducing the demand for fresh water while also ensuring that wastewater is managed in an environmentally friendly way.

Reuse of Treated Water

Treated water from the STP is used for *irrigation* in gardens and green areas across the campus, reducing the strain on freshwater resources. This water, although not potable, is safe for use in maintaining the lush green spaces that characterize the campus.

Using treated water for landscaping helps the university significantly reduce its overall water consumption, contributing to a sustainable water management strategy.

Minimizing Pollution and Environmental Impact

The STP adheres to environmental regulations, ensuring that harmful pollutants and pathogens are removed before water is discharged. This minimizes the risk of environmental contamination and protects local ecosystems.

Any sludge generated from the STP is also treated and safely disposed of, potentially being repurposed as soil conditioners, reducing overall waste.

Rainwater Harvesting

In addition to liquid waste management, the university employs *rainwater harvesting systems*, capturing runoff during the rainy season and storing it for later use. This initiative helps replenish groundwater levels and reduce dependency on external water sources.

The integration of rainwater harvesting with treated water reuse creates a resilient and sustainable water management infrastructure on campus.

Educational Opportunities for Students

Both the organic and liquid waste management systems serve as educational platforms for students, especially those studying sustainability, environmental science, or engineering. These systems provide hands-on learning experiences, encouraging student involvement in research and innovation related to waste management.

CHALLENGES AND SOLUTIONS

Inconsistent Wastewater Quality

Challenge: The quality of wastewater generated from different sources (kitchens, hostels, laboratories) can vary significantly. Laboratory wastewater might contain chemicals, while kitchen wastewater could have high levels of organic matter and grease. This variability requires specialized treatment methods.

Solution: Implement source-specific pretreatment units before wastewater enters the main sewage treatment plant (STP). For instance, installing *grease traps* in kitchen wastewater lines and *neutralization tanks* for chemical waste can help standardize the wastewater before treatment.

Maintenance of Sewage Treatment Plant (STP)

Challenge: STPs require regular maintenance to ensure they operate efficiently. Neglecting maintenance can lead to breakdowns, poor treatment quality, and non-compliance with environmental standards.

Solution: Establish a *regular maintenance schedule* for the STP, including routine inspections, equipment calibration, and timely replacement of parts. Additionally, ensure that skilled operators are available to manage the plant's daily operations, supported by training and capacity-building programs.

Sludge Management

Challenge: The STP generates *sludge* as a by-product, which needs to be safely treated and disposed of. If not managed properly, sludge can pose environmental hazards, including odor issues, groundwater contamination, and health risks.

Solution: Invest in *sludge dewatering systems* to reduce the moisture content of sludge, making it easier to handle and dispose of. Explore options to use the treated sludge as a *soil conditioner* or for *co-composting* with organic waste, thereby converting it into a valuable resource.

High Energy Consumption

Challenge: The STP and other liquid waste management processes can be energy-intensive, which raises operational costs and may lead to carbon emissions, reducing the sustainability of the system.

Solution: Optimize the STP by installing *energy-efficient pumps* and aeration systems. Explore the use of *renewable energy sources*, such as solar panels, to offset energy consumption. Additionally, implement process automation to reduce manual energy usage and improve overall efficiency.

Public Awareness and Participation

Challenge: Effective liquid waste management requires the cooperation of all stakeholders, including students, staff, and faculty. If wastewater is improperly disposed of (e.g., chemicals or grease poured down drains), it can overload the STP and degrade treatment performance.

Solution: Increase *awareness programs* for the campus community to educate them on proper waste disposal practices. Signage in kitchens, hostels, and labs should clearly indicate what materials should not go down the drain. Conduct workshops or training for staff in laboratories and kitchens to emphasize the importance of correct waste disposal methods.

Water Reuse and Acceptance

Challenge: While treated water from the STP is reused for irrigation and cleaning purposes, there may be reluctance from staff or gardeners to use it due to concerns about water quality.

Solution: Certify the quality of treated water through regular testing and ensure it meets safety standards for non-potable reuse. Provide transparent data about the quality of treated water to alleviate concerns. Demonstrating the safe use of this water in campus gardens can also build trust and encourage wider acceptance of water reuse.

Capacity and Demand Imbalance

Challenge: As the campus grows, the STP might struggle to handle the increasing volumes of wastewater. A capacity imbalance could lead to system overloads, inefficiency, and untreated wastewater being discharged into the environment.

Solution: Conduct *capacity assessments* regularly to predict future wastewater loads. Upgrade the STP's capacity as needed to accommodate campus expansion. Consider adding *modular treatment units* that can be scaled up as demand increases, avoiding the need for full system overhauls.

ORGANIC WASTE MANAGEMENT SITE

Effective Segregation at Source

Organic waste, primarily generated from canteens, hostels, and gardens, is effectively segregated from non-organic waste through a well-implemented system of color-coded bins. Awareness campaigns and proper signage play a crucial role in educating the campus community, ensuring minimal contamination between organic and non-organic waste streams.

Sustainable Composting Practices

The university employs both *windrow composting* and *vermicomposting* methods. Windrow composting transforms large quantities of organic waste into nutrient-rich compost, while vermicomposting accelerates the breakdown process through the action of earthworms, producing high-quality compost.

The final compost product is used on campus gardens and green spaces, reducing reliance on chemical fertilizers and closing the loop on organic waste recycling.

Biodigester for Organic Waste Processing

The university has installed a *biodigester* to process organic waste via anaerobic digestion. This system generates biogas, which is used to supplement energy needs on campus, particularly in cooking applications.

The by-product of this process, a nutrient-rich slurry, is used as a liquid fertilizer in gardens, ensuring a zero-waste approach and converting waste into energy and valuable agricultural inputs.

Closed-loop Circular System

The use of compost and slurry on campus gardens ensures that waste generated within the university is recycled back into the ecosystem, promoting sustainability and soil health.

This integrated system showcases a model of *circular economy* where waste is viewed as a resource, reducing both the environmental impact and operational costs of waste disposal.

Waste Minimization at Source

Initiatives such as portion control in dining areas and food donation programs help reduce the amount of organic waste generated at the source. This proactive approach aligns with waste minimization strategies critical to a successful organic waste management system.

CHALLENGES AND SOLUTIONS

Challenge: Inefficient Segregation at Source

Despite having designated bins, improper segregation of recyclable, organic, and non-recyclable waste is common. This contamination reduces the effectiveness of waste processing.

Solution: Implement stricter waste segregation protocols with color-coded bins in all areas. Enhance signage and education on what belongs in each bin. Introduce automated sensor-based bins to assist in proper disposal. Regular training workshops can reinforce the importance of proper segregation among students and staff.

Challenge: Lack of Awareness and Behavioral Change

Many students and staff are not fully engaged with the waste management systems in place, leading to inconsistent waste segregation and disposal practices.

*Solution***:** Launch awareness campaigns and incentive programs to encourage proper waste disposal. Offer rewards or points for those who segregate waste correctly. Include waste management lessons in the curriculum and hold competitions to engage the campus community actively.

Challenge: Limited Capacity of Composting and Recycling Units.

The current composting and recycling systems are not always able to handle the increased waste load, especially during large events or peak periods like examinations.

*Solution***:** Expand the composting and recycling facilities to increase their capacity. Set up additional windrow composting areas and invest in recycling equipment that can process larger volumes of waste. Improve infrastructure to manage solid waste effectively.

Challenge: Waste Generation in Hostels and Residential Areas

Hostels generate significant volumes of both organic and non-recyclable waste. Insufficient waste segregation in these areas leads to an overwhelming amount of mixed waste, complicating processing.

Solution: Implement segregation stations in hostels with clear instructions on disposing of organic, recyclable, and non-recyclable waste. Encourage student responsibility through awareness programs and competitions to maintain cleanliness and waste segregation in residential spaces.

Challenge: Lack of Advanced Waste Processing Technology

The university lacks sophisticated waste-to-energy technologies, such as pyrolysis or advanced plastic recycling, which could more efficiently handle certain waste streams.

Solution: Invest in advanced waste-to-energy solutions, such as pyrolysis plants or waste-to-energy incinerators, which convert non-recyclable waste into fuel or electricity. Partner with external waste management companies to handle materials that the campus cannot process.

Challenge: Overuse of Single-Use Plastics
Despite efforts to reduce plastic waste, single-use plastics are still a significant part of the campus's solid waste, particularly in dining areas and takeaway services.
Solution: Ban single-use plastics on campus and encourage vendors to switch to biodegradable or reusable alternatives. Promote the use of reusable containers for food and drinks, offering discounts or incentives for students who bring their own containers.

Challenge: Monitoring and Collection Issues
Waste collection and disposal schedules sometimes lead to overflowing bins, particularly in high-waste areas like dining halls and hostels.
Solution: Use smart bins equipped with sensors to track waste levels in real-time, ensuring timely collection and reducing overflow. Implement a waste monitoring system to optimize collection schedules and track data to improve efficiency.

SOLID WASTE MANAGEMENT SITE

Introduction:

During our visit at the Paper Recycling Unit at our university, we observed that solid waste management presents major global challenges, particularly with regard to paper waste. Paper waste is a persistent issue due to its sheer volume and the complexity of its sorting, recycling, and disposal, even with advancements in recycling technologies. This chapter, which focuses on recycling, sorting, and disposal methods, examines the difficulties in managing paper waste and offers possible solutions.

Challenges:

As we watched the procedures, we also learned about some of the problems the faculty had with recycling paper waste.

Issues with Handling High Volume of Paper Waste:

The volume of paper waste generated on a daily basis is one of the main issues with paper waste management. Paper products are widely used in homes, workplaces, schools, and other settings, which generates a significant amount of waste. The increased demand for paper goods strains recycling infrastructure, frequently resulting in processing delays and overflow at collection locations

Contamination:

When non-recyclable materials are mixed in with paper waste, it can seriously impede the recycling process. The facility stressed how crucial it is to inform the public about appropriate waste segregation at the point of origin. Paper waste loses quality for recycling when it is contaminated with food, liquids, or other non-recyclable materials. Paper that has been contaminated is either thrown in landfills or needs to go through extra steps in the recycling process, which raises expenses and decreases productivity. In mixed-waste collection systems, where paper is collected with other waste, this contamination problem is particularly prevalent.

Variable Market Demand:

The facility's operations are impacted by fluctuations in the demand for recycled paper. They lessen this by partnering with businesses that frequently use recycled paper and by varying the types of products they produce.

Processing Costs:

In certain cases, the expenses associated with handling paper waste surpass the monetary gains from recycling. Nonetheless, these expenses are somewhat offset by government subsidies, the environmental advantages of fewer landfills, and energy savings.

Complex Sorting Procedures:

To recycle paper effectively, it must be sorted properly to separate high-quality paper (e.g. office paper, and newspapers) as opposed to inferior paper (e.g. cardboard, and various papers). But automated systems are expensive to set up and maintain, and manual sorting takes a lot of time and labor. Because some types of paper are less recyclable than others, the variety of paper types—such as glossy paper or paper with coatings—makes sorting procedures even more difficult.

Water and Energy Use in Recycling:

Paper recycling, while environmentally beneficial in theory, still requires a large amount of water and energy. The process of making recycled paper includes pulping the material, eliminating the ink, and transforming it into fresh sheets. The energy and water used in these procedures can sometimes outweigh the environmental advantages of recycling. These steps also demand a significant amount of resources.

Limited Infrastructure and Awareness:

In many communities, especially in developing nations, there is a deficiency of infrastructure that is required to manage paper waste effectively. Inefficiencies are caused by a lack of recycling facilities, poor collection methods, and low public understanding of the value of recycling. Furthermore, recycling facilities find it more difficult to process waste effectively when customers combine paper waste with non-recyclable materials.

Solutions:

The growing volume of paper waste poses significant environmental and operational challenges in waste management systems worldwide. From contamination issues to the complexities of sorting and recycling, managing paper waste efficiently is crucial for reducing landfill use and conserving resources. As paper continues to be a major component of municipal waste, finding sustainable solutions is essential. Addressing these challenges requires innovative approaches, improved infrastructure, and collective efforts from governments, businesses, and communities. The need for practical and scalable solutions to manage, recycle, and reduce paper waste has never been more urgent to achieve a circular economy and promote environmental sustainability.

During our visits, we came across all these issues and tried to come up with various solutions that would help us solve such major problems.
The solutions are listed below.

1. **Raising Public Awareness and Education:** Educating the public about the value of recycling and the correct disposal of paper waste is one of the main strategies for enhancing paper waste management. Public awareness campaigns can teach people about the kinds of paper that can be recycled, the importance of keeping paper separate from other materials, and the harm that improper disposal can do to the environment. Establishing a recycling culture and educating the public are important roles that schools, offices, and local governments can play.

2. **Enhanced Sorting Technologies:** Investment in advanced sorting technologies can significantly improve the efficiency of paper recycling processes. Automated systems that use sensors and artificial intelligence can identify different types of paper, separate recyclable materials from contaminants, and streamline the recycling process. Such technologies not only reduce the need for manual labor but also ensure a higher purity of recyclable paper, leading to better-quality recycled products.

3. **Executing Source Separation Initiatives:** Promoting the separation of paper waste at the source (i.e. offices, stores, and other locations) can greatly lower contamination and raise recycling rates. It has been demonstrated that source separation initiatives, in which people sort waste materials into different categories, produce recyclables of a higher

caliber. Municipalities can put in place laws requiring source separation and offer rewards for taking part in them.

4. **Adopting Water and Energy-Efficient Recycling Techniques:** To address the issue of high water and energy consumption in recycling, new technologies that minimize resource use need to be developed and adopted. For instance, water-efficient de-inking processes and energy-saving recycling methods can reduce the environmental footprint of paper recycling. The integration of renewable energy sources, such as solar or wind power, in recycling facilities can also contribute to reducing overall energy consumption.

5. **Strengthening Waste Management:** Infrastructure To ensure effective recycling and disposal, paper waste management infrastructure must be improved. This entails expanding the number of recycling facilities, setting up easily accessible locations for the collection of paper waste, and outfitting these facilities with cutting-edge recycling machinery. Governments can be very helpful in promoting the development of infrastructure by enacting laws, offering financial incentives, and forming alliances with private recycling companies.

6. **Encouragement of Digital substitutes:** Encouraging the use of digital alternatives is one practical strategy to cut down on the amount of paper waste produced. The adoption of digital documentation, e-billing, and e-books by numerous businesses, educational institutions, and government agencies has already started to reduce the amount of paper used. The quantity of paper that enters the waste stream can be decreased by promoting these alternatives. Governments and organizations have the power to enact laws that encourage a paperless environment. Examples of these laws include rewards for businesses that cut back on paper use or encourage online transactions.

7. **Development of Biodegradable and Recyclable Paper Products:** Another solution lies in innovation within the paper manufacturing industry. Developing and promoting biodegradable or fully recyclable paper products can reduce the environmental impact of paper waste. For instance, some manufacturers are creating paper that can be recycled more easily, or designing products that break down more rapidly in landfills. Research into alternative raw materials for paper production, such as agricultural waste or bamboo, can also reduce the need for tree-based paper, decreasing both the waste and environmental degradation.

8. **Incentivizing Businesses to Reduce Paper Usage:** Many businesses still rely heavily on paper, often unnecessarily. Incentive programs can encourage companies to adopt paper-saving measures by offering financial rewards or tax credits for reducing their paper waste output. Businesses can also be encouraged to participate in "zero-waste" programs, where they commit to recycling all paper products or drastically reducing their reliance on paper. Additionally, corporations can be asked to submit annual reports detailing their waste management strategies, encouraging a shift toward greener practices.

9. **Encouraging Reuse of Paper:** Encouraging the reuse of paper before disposal or recycling is another effective strategy. Offices, schools, and households can adopt practices like printing on both sides of a sheet of paper, using scrap paper for notes, or reusing envelopes and packaging. Additionally, promoting the use of paper for arts and crafts or repurposing old paper for new uses can extend the life cycle of paper products, reducing the need for immediate recycling or disposal.

10. **Technological Innovations in Recycling:** Paper recycling can be made more sustainable and efficient with the help of technological innovations in recycling. One technique that makes recycling paper products easier and less harmful to the environment is enzymatic deinking, which uses enzymes to remove ink from paper fibers. Extending the range of materials that can be recycled, advancements in chemical recycling processes have the ability to extract high-quality paper fibers from even highly contaminated paper.

GLOBAL INSIGHTS

1. UNDP (United Nations Development Programme)

The UNDP is a major global advocate for sustainable development and waste management, closely linking waste management to environmental sustainability and the achievement of the Sustainable Development Goals (SDGs).

Key Takeaways:

Waste Management as a Driver of Sustainable Development:

The UNDP emphasizes waste management as essential to achieving SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production). Waste management is tied directly to reducing environmental pollution, improving public health, and promoting sustainable cities.

Circular Economy Promotion:

The UNDP promotes the transition from linear waste systems (produce, use, discard) to circular economies, where waste is seen as a resource to be reused, repurposed, or recycled.

Integration of Technology in Waste Management:

The UNDP encourages the adoption of innovative technologies, such as waste-to-energy systems, composting facilities, and recycling infrastructure that reduce the environmental impact of waste.

Community Involvement and Governance:

The organization highlights the importance of local community participation in waste management systems, as well as establishing clear waste governance frameworks that ensure accountability and efficiency in waste services.

2. UNICEF (United Nations Children's Fund)

UNICEF views waste management, especially sanitation waste, as critical to ensuring child health, safety, and overall well-being, focusing primarily on the implications of waste on public health.

Key Takeaways:

Waste Management for Public Health:

UNICEF stresses that inadequate waste management, especially of hazardous waste, can lead to disease outbreaks, particularly affecting vulnerable populations such as children. Exposure to unsafe water and poor sanitation linked to

unregulated waste disposal can increase child mortality.

Sanitation and Hygiene in Schools:

Effective waste management in schools is crucial to maintaining hygiene standards. Proper disposal of sanitation waste (such as menstrual hygiene products and other solid waste) is necessary to ensure children, particularly girls, stay in school and maintain dignity and health.

Waste Management Education:

UNICEF advocates for the education of children on sustainable waste management practices, integrating waste-related learning into school curricula to build environmentally conscious habits from a young age.

Emergency Waste Management:

During emergencies or natural disasters, UNICEF works to ensure that proper waste management is part of the emergency response to protect children from exposure to unsafe waste, which can lead to the spread of communicable diseases.

3. World Bank

The World Bank is a major global player in supporting countries' waste management systems through funding, policy advice, and capacity-building initiatives.

Key Takeaways:

Global Waste Generation Forecasts:

The World Bank's report, What a Waste 2.0, highlights that global wastegeneration is expected to increase by 70% by 2050 if current practices continue, making efficient waste management strategies critical for sustainable development, particularly in urban areas.

Waste and Climate Change:

According to the World Bank, solid waste management, particularly landfills, is a major contributor to greenhouse gas emissions (especially methane). The World Bank encourages a shift toward integrated waste management systems that minimize landfill use through recycling, composting, and waste-to-energy solutions.

Focus on Low-Income Countries:

Low- and middle-income countries, particularly in Asia and Sub-Saharan Africa, struggle with unregulated and open dumping practices.

The World Bank advocates for improving waste collection systems, expanding waste processing infrastructure, and focusing on capacity building in these regions to reduce environmental degradation.

Extended Producer Responsibility (EPR):

The World Bank promotes the principle of Extended Producer Responsibility, where manufacturers are held accountable for the disposal and recycling of their products. EPR has been adopted in many high-income countries and is gradually being introduced in middle- and low-income regions to reduce the burden on municipal waste systems.

Private Sector Involvement:

The World Bank recommends fostering public-private partnerships in waste management, where private companies take an active role in providing waste collection, processing, and recycling services, helping to bridge gaps in government capacity.

Global Best Practices and Initiatives:

1. 3Rs Approach (Reduce, Reuse, Recycle)

All institutions emphasize the adoption of the 3Rs principle as the cornerstone of sustainable waste management. Reducing waste generation at the source, reusing materials where possible, and recycling resources are key components to minimize the amount of waste entering landfills.

2. Waste-to-Energy Technologies

Both the UNDP and the World Bank strongly advocate for the adoption of waste-to-energy technologies, particularly in urban areas, where large volumes of waste can be converted into energy, thereby reducing landfill use and generating renewable energy.

3. Circular Economy Models

Global institutions recommend transitioning toward circular economies where waste is minimized and the lifecycle of products is extended through recycling and repurposing. This reduces the environmental footprint and promotes economic sustainability.

4. Integration of Data and Technology

Leveraging data analytics, IoT, and smart technologies in waste management can optimize waste collection routes, monitor landfill capacities, and ensure better resource allocation. This is an area of focus for global institutions, encouraging cities and regions to adopt smart waste management systems.

5. Inclusive Waste Management

Integrating informal waste workers into formal waste management systems has been a focus, particularly by organizations like the World Bank. Informal recyclers play a crucial role in waste segregation, especially in developing countries, and their inclusion in policy frameworks improves both efficiency and livelihoods.

Conclusion:

From a global perspective, waste management is increasingly recognized as a multi-faceted challenge with significant implications for public health, environmental sustainability, and economic development. Organizations like the UNDP, UNICEF, and the World Bank emphasize the need for integrated, circular, and inclusive waste management systems. The focus is on reducing waste at the source, expanding recycling and reuse initiatives, and leveraging technology for smarter waste handling, all while ensuring the active participation of local communities and governments. These insights can provide a solid foundation for developing your report's global context on waste management.

PRACTICAL APPLICATIONS
(LIVE PROJECT)

19th September, 2024 and 20th September, 2024 marked as the days of experiential learning, with teachers and students working together to repurpose waste materials into creative products. Dr. Gurpreet Singh Saggu demonstrated major projects on September 19th, which showed how to recycle and reuse campus waste in an approachable way to encourage environmental responsibility.

Dr. Gurpreet Singh Saggu told us to focus on constructing models using discarded materials such as paper, plastic bottles, metal scraps, and wood remnants. Our aim was to highlight how even seemingly insignificant waste can be re-engineered into valuable products through creativity and resourceful thinking.

Productive Models and Practical Use of Waste Materials on Campus

Recycled Paper Products:

Fig 1

Fig 2

Paper bags created from recycled paper

Paper waste collected from various sources on campus was processed into handmade paper. Our team actively engaged in creating notebooks, paper bags, and diaries from these recycled sheets, promoting a culture of waste reduction.

This model encourages students to participate in waste-to-wealth initiatives by showing the potential of waste materials and offering a workable example of how universities can adopt sustainable practices on a large scale.

Art Pieces from Recycled Paper and Metal Wires:

Fig 3

Fig 4

Illustrates art pieces created from recycled paper and scrap metal wires

We also used recycled paper and scrap metal wires to create innovative art pieces and models to show our ability of making the best out of waste.

Eco-friendly Plant Holders:

Old plastic bottles and tin cans were repurposed into decorative plant holders. These were not only functional but also aesthetically pleasing, showing how plastic waste can be transformed into long-lasting, practical items.

Application of Circular Economy Concepts in these Models

The circular economy framework was central to the models created during the "Waste to Wealth" event. By applying this concept, students emphasized sustainability, resource efficiency, and minimizing environmental impact.

Key Circular Economy Concepts Applied:

Designing for Durability: Instead of creating single-use products, the models were designed to be long-lasting and resilient. This approach aligns with circular economy principles, where products are built to have an extended lifecycle and can be repaired or repurposed when needed.

Waste Minimization: Students ensured that leftover waste from the projects was either reused in subsequent models or properly sorted for recycling. For example, small wooden offcuts from furniture production were repurposed into decorative items like keychains or coasters.

Resource Looping: Materials used in the projects were sourced from campus-generated waste, demonstrating a closed-loop system. This approach significantly reduced the need for new raw materials and provided an efficient way to reuse campus resources.

Long-term Benefits:

The models created by students and faculty during this event serve as functional, sustainable solutions for everyday campus life. They promote environmental consciousness and set an example for the broader university community. Through these initiatives, Chitkara University is taking meaningful steps toward reducing its waste footprint and fostering a culture of sustainability.

The "Waste to Wealth" event at Chitkara University Rajpura was a powerful demonstration of how waste materials can be re-envisioned into valuable resources. Led by Dr. Gurpreet Singh Saggu on 19th September 2024 and 20th September 2024, the productive models created showcased the creativity, resourcefulness, and interdisciplinary collaboration of the students. By integrating circular economy principles, the event not only provided practical solutions for waste management but also inspired participants to rethink the role of waste in a sustainable future.

POLICY RECOMMENDATIONS

1. Liquid Waste Management

Stricter Regulations on Industrial Effluents: Implement stringent laws for industries to treat liquid waste before discharging into water bodies. This should include regular monitoring and penalties for non-compliance.

Investment in Advanced Water Treatment Technologies: Encourage government and private sector collaboration to invest in cutting-edge treatment technologies, such as membrane filtration or bio-remediation, which are more efficient in purifying wastewater.

Public-Private Partnerships (PPP) for Wastewater Recycling: Create incentives for industries to recycle water and reduce overall water consumption through PPP models, leading to sustainable resource use.

Community-Level Greywater Recycling: Promote the use of greywater (from baths, sinks, etc.) for non-potable uses like irrigation, which can help reduce the pressure on freshwater resources.

2. Organic Waste Management:

Mandatory Organic Waste Segregation at Source: Implement policies that require households and commercial establishments to segregate organic waste at the source. This ensures a cleaner and more efficient composting process.

Subsidies for Composting Units: Provide financial support for community composting units and individual households to install small-scale composting solutions.

Promotion of Bioenergy Production: Develop policies that support the use of organic waste to generate bioenergy, which can serve as a renewable energy source and reduce dependence on fossil fuels.

Public Awareness Campaigns: Launch initiatives that educate citizens about the benefits of composting and how they can contribute to reducing organic waste in landfill.

Incentivize Organic Waste to Biofertilizer Programs: Support programs that convert organic waste into biofertilizers for agricultural use. This can reduce chemical fertilizer dependency and promote sustainable farming. Government subsidies

or tax incentives could encourage farmers to adopt biofertilizers.

Decentralized Organic Waste Management Systems: Encourage the creation of localized composting centers in urban and rural areas. Decentralized systems reduce transportation costs and emissions, while fostering community-driven composting initiatives, making waste management more efficient at the grassroots level.

3. Solid Waste Management (Paper Recycling):

Extended Producer Responsibility (EPR) for Paper Products: Introduce policies that make paper manufacturers responsible for the entire lifecycle of their products, encouraging them to use recycled materials and improve paper recycling processes.

Incentivize Recycling Through Tax Breaks: Provide tax incentives to businesses that actively use recycled paper and reduce their environmental impact..

Promotion of Circular Economy Initiatives: Implement policies that encourage businesses to adopt circular economy principles, such as designing products for reuse, repair, and recyclability. This will reduce the generation of solid waste and extend the lifecycle of materials like paper, plastics, and metals.

Investment in Recycling Infrastructure: Increase government funding for better recycling facilities and technologies that enhance the efficiency and output of the paper recycling process.

Public Education on Recycling: Encourage communities to recycle by promoting the environmental benefits of paper recycling, and introducing initiatives like "zero-waste" programs in schools, businesses, and government offices.

Mandatory Waste Audits for Large Generators: Require large commercial establishments, industries, and institutions to conduct regular waste audits. These audits will track the types and quantities of waste generated, promoting better waste management.

These recommendations can help enhance the waste-to-wealth approach, promoting sustainability and efficient waste management practices.

CONCLUSION

The project on the **Circular Economy – *Waste to Wealth*** has shed light on the critical importance of rethinking how we manage waste. Through comprehensive site visits to Liquid, Organic, and Solid Waste Management plants, it became clear that waste is not merely a byproduct of human activity but a potential resource that can be transformed into wealth. This project underscores the urgent need to embrace a circular economy model, where waste is minimized, materials are continuously reused, and the environmental impact of production and consumption is significantly reduced.

The lessons learned from each site visit reflect the diverse methods by which waste can be managed and repurposed. At the Liquid Waste Management plant, we observed the intricate processes involved in treating wastewater, removing harmful pollutants, and ultimately restoring the water to a state where it can be reused. This not only helps preserve vital water resources but also reduces the harmful effects of untreated wastewater on ecosystems and communities.

The Organic Waste Management visit provided an eye-opening look into how food waste and other organic materials can be efficiently composted, turning waste into nutrient-rich compost and bioenergy that support agriculture and reduce the need for chemical fertilizers. Finally, the Solid Waste Management plant demonstrated the potential of recycling materials like paper, which not only conserves natural resources but also reduces the environmental damage caused by excessive landfill use and deforestation.

The *Waste to Wealth* approach reveals that by employing innovative technologies and sustainable practices, we can harness waste as a valuable resource rather than seeing it as an inevitable burden. However, the success of these processes depends on the implementation of supportive policies, investments, and societal shifts in waste management practices. Governmental regulations play a pivotal role in ensuring that industries comply with environmentally friendly waste disposal techniques and invest in technologies that promote resource recovery. Public-Private Partnerships (PPPs) can facilitate investment in large-scale recycling, composting, and wastewater treatment projects, ensuring they are financially sustainable and scalable.

Moreover, effective waste management is not just a technical or governmental responsibility; it requires active participation from all segments of society. Citizens must be educated on the importance of waste segregation, recycling, and the environmental impact of their consumption patterns. Schools, businesses, and communities must work together to implement zero-waste programs that encourage individuals to contribute to the circular economy at a grassroots level. Public awareness campaigns, incentivized recycling programs, and educational initiatives are all essential in fostering a culture of environmental responsibility and sustainable living.

The economic opportunities arising from a circular economy are immense. The *Waste to Wealth* model fosters the creation of new industries, from recycling plants and composting centers to bioenergy production units, all of which create jobs, stimulate local economies, and reduce the overall environmental footprint of human activity. Furthermore, the reduction in the extraction and consumption of finite natural resources, as facilitated by circular practices, ensures that we are better positioned to meet the growing demands of a rapidly expanding global population.

However, the journey toward a fully realized circular economy is not without its challenges. It requires a coordinated effort at both local and global levels, with policymakers, industries, and individuals working in unison to shift away from the traditional "take-make-dispose" model to a regenerative one. The transition also demands significant upfront investments in infrastructure, technology, and education, but the long-term benefits of such an approach far outweigh the initial costs. This shift will reduce the strain on landfills, conserve natural resources, lower greenhouse gas emissions, and ultimately contribute to climate change mitigation.

In conclusion, the *Waste to Wealth* project has highlighted the vast potential of the circular economy to address the environmental and economic challenges of our time. By transforming waste into a valuable resource, we can foster a more sustainable, resource-efficient, and prosperous future. It is evident that waste is not the end of the line, but rather the beginning of a new cycle of opportunity and innovation. By embracing this model, we pave the way for a future where economic growth and environmental preservation are no longer seen as conflicting goals, but as complementary aspects of a more sustainable global economy. The road ahead may be challenging, but the promise of turning *waste into wealth* offers a hopeful vision for the future, where sustainability and prosperity go hand in hand for generations to com

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Project Outcome 2:

Unlocking Value Through Circular Economy Practices

Course:

BA (Honours) Economics with Data Science
Batch: 2023

Prepared by:

Misthi (2320993508)

Salyani (2320993515)

Danish (2320993523)

Gopal Kishan Anand (2320993533)

Devesh (2320993541)

Organized by:

FACULTY OF ECONOMICS,
Chitkara Business School
Under the aegis of
CHITKARA UNIVERSITY CENTRE FOR RURAL MANAGEMENT (CUCRM)
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)
In association with the
CENTRE OF EXCELLENCE FOR SUSTAINABILITY,
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)

CHITKARA UNIVERSITY

CHITKARA BUSINESS SCHOOL

CHITKARA UNIVERSITY Centre of Excellence for Sustainability

Detailed Project Report

UNLOCKING VALUE THROUGH CIRCULAR ECONOMY PRACTICES

9TH SEPTEMBER, 2024 TO 20TH SEPTEMBER, 2024

Submitted By

Name	***Roll No***
Misthi	2320993508
Salyani	2320993515
Danish	2320993523
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Organized by

Faculty of Economics, Chitkara Business School,

Under the aegis of

Chitkara University Centre For Rural Management (CUCRM)

Chitkara University, Punjab *(NAAC A+)*

in association with the Centre of Excellence for Sustainability,

Chitkara University, Punjab *(NAAC A+)*

Message from the Chancellor, Chitkara University

I am delighted to see the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability, leading the way with the live project "Waste to Wealth: Exploring the Potential of the Circular Economy."

At Chitkara University, we are deeply committed to fostering innovation, sustainability, and real-world learning experiences for our students. This project exemplifies how education and practical engagement can come together to address one of the most critical challenges of our time—waste management.

By exploring the potential of the circular economy, students learn how waste materials can be transformed into valuable resources and contribute to a more significant global movement toward environmental sustainability. The hands-on site visits and practical applications will undoubtedly empower our students to be future leaders in sustainable development.

I believe such initiatives help shape the minds of young individuals and prepare them to tackle complex problems with innovative solutions. I am proud of the efforts and enthusiasm shown by our students, and I am confident that this project will inspire them to make meaningful contributions toward a greener, more sustainable world.

I wish all the participants the best and look forward to seeing the outcomes of this important project.

Dr. Ashok K. Chitkara
Hon'ble Chancellor,
Chitkara University

Message from the ProChancellor, Chitkara University

I am genuinely pleased to witness the launch of the live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At Chitkara University, we believe in creating future leaders who are academically strong and conscious of the world around them. This project reflects our commitment to promoting sustainability and encouraging students to think beyond the classroom. Exploring how waste can be transformed into wealth and valuable resources is a commendable step toward understanding the circular economy and its crucial role in shaping a sustainable future.

The hands-on experience through site visits and practical applications will inspire our students to embrace sustainability as a core principle in their academic and professional journeys. Projects like these help bridge the gap between theoretical knowledge and practical execution, which is essential in today's rapidly evolving world.

I am confident that this project will leave a lasting impact on our students and motivate them to take bold steps to contribute to global sustainability efforts—my heartfelt congratulations to all participants for their enthusiasm and dedication.

Warm regards,

Dr Madhu Chitkara
Hon'ble Pro-Chancellor,
Chitkara University

Message from the ViceChancellor, Chitkara University, Punjab

I am proud to see the "Waste to Wealth: Exploring the Potential of the Circular Economy" project being successfully launched by the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability.

At Chitkara University, we emphasize the importance of innovative learning that extends beyond the classroom, fostering a mindset of sustainability and responsibility in our students. This live project beautifully aligns with our vision of nurturing leaders who can contribute to a sustainable and circular economy by transforming waste into valuable resources.

Through site visits and practical involvement, this project provides a unique opportunity for students to witness firsthand how waste management practices can be applied in real-world scenarios. It encourages them to explore how recycled materials can be repurposed, highlighting such initiatives' economic and environmental benefits.

I commend the students for their active participation and dedication, and I am confident that this experience will instil a strong sense of responsibility toward sustainability in their future careers. Such initiatives are a testament to our commitment to shaping responsible global citizens.

Warm regards,

Prof Sandhir Sharma
Vice-Chancellor, Chitkara University, Punjab

Message from the Dean, Faculty of Economics, Chitkara University, Punjab

I am immensely proud to witness the successful initiation of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At the Chitkara University Centre For Rural Management (CUCRM), we are committed to addressing pressing environmental challenges and promoting sustainable development, particularly in rural areas. This project is a testament to our efforts to integrate innovative, circular economy practices with real-world applications, offering our students a hands-on experience transforming waste into valuable resources.

This initiative highlights the need for sustainable development in urban and rural contexts. The insights gained will empower students to apply these lessons to broader societal challenges, mainly where waste management and sustainability are crucial. I commend the students for their enthusiasm and dedication and extend my heartfelt appreciation to everyone involved in this project.

I look forward to the positive outcomes of this meaningful initiative.

Warmest congratulations once again!

Sincerely,

Prof. Dhiresh Kulshrestha
Dean, Faculty of Economics, Chitkara Business School,
Chitkara University Centre For Rural Management (CUCRM)
Chitkara University, Punjab

Message from Director, Office of Administration and Centre of Excellence for Sustainability, Chitkara University, Punjab

I am delighted to see the successful launch of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," an initiative led by the Faculty of Economics in collaboration with the Centre of Excellence for Sustainability at Chitkara University.

The Centre of Excellence for Sustainability is dedicated to advancing the principles of environmental stewardship, sustainable development, and green innovation. This project embodies our core mission by providing students with an invaluable opportunity to engage with the practical aspects of waste management and resource recycling within a circular economy framework. Through real-world exposure, the students learn about waste-to-wealth practices and actively contribute to the broader sustainability goals we champion at the centre.

As part of this initiative, students are immersing themselves in on-ground activities, from visiting liquid and solid waste management sites to understanding organic waste recycling methods. These experiences help them appreciate sustainability's critical role in today's world and empower them to apply these principles professionally and personally in their future endeavours. I commend the students and faculty for their enthusiasm and dedication to this project.

Sincere regards,
Sqn. Ldr. Dr. Reena Angel
Director, Office of Administration and
Director, Centre of Excellence for Sustainability
Chitkara University, Punjab

Acknowledgment

We want to express our deepest gratitude to everyone who has contributed to the success of this live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability, Chitkara University, Punjab.

First and foremost, we are profoundly grateful to Dr. Ashok K. Chitkara, Hon'ble Chancellor, and Dr. Madhu Chitkara, Hon'ble ProChancellor, Chitkara University, for their visionary leadership and continuous support in fostering an environment of innovation, sustainability, and learning.

We thank Prof. Sandhir Sharma, Vice-Chancellor of Chitkara University, Punjab, for his guidance and unwavering encouragement throughout this initiative. His commitment to experiential learning and sustainability has been instrumental in shaping this project.

Our sincere appreciation goes to Sqn. Ldr. Dr Reena Angel, Director, Office of Administration, and Director of the Centre of Excellence for Sustainability, for her valuable insights and support in aligning the project with the broader goals of sustainability and circular economy principles.

We would also like to express our gratitude to Prof. Dhiresh Kulshrestha, Dean, Faculty of Economics, Chitkara Business School, and Director of the Chitkara University Centre For Rural Management (CUCRM) , for his strategic direction and mentorship, which have been vital in guiding our students through this hands-on project.

A special thanks to the project coordinators, faculty members, and staff of Chitkara Business School, whose tireless efforts and commitment to student learning have made this project a remarkable success.

Thank you all for your invaluable contributions!

Certificate

This is to certify that the following students from **B.A. (Honours) Economics with Data Science (Batch 2023)** have completed the live project titled **"Unlocking Value through Circular Economy Practices"** held from **9th September 2024 to 20th September 2024**, organized by the **Faculty of Economics, Chitkara Business School**, in collaboration with the **Centre of Excellence for Sustainability** at **Chitkara University, Punjab**.

Participants:

1. Mishti (Roll No: 2320993508)
2. Salyani (Roll No: 2320993515)
3. Danish (Roll No: 2320993523)
4. Gopal Kishan Anand (Roll No: 2320993533)
5. Devesh Gautam (Roll No: 2320993541)

During this project, the students demonstrated excellent understanding of the principles of the circular economy, actively participated in visits to various waste management sites, and contributed valuable insights to group discussions and project reports. Their involvement in recycling initiatives and practical exercises showcased a commendable ability to apply theoretical knowledge to real-world sustainability challenges.

As a supervisor, I am proud of their dedication, enthusiasm, and contributions to the success of this project. I am confident that the skills and knowledge gained through this live project experience will serve them well in their future academic and professional endeavors.

I wish them continued success in all their future undertakings.

Supervisor

Dr. Gurwinder Singh

Assistant Professor, Faculty of Economics

Chitkara Business School

Chitkara University, Punjab

Note: This certificate includes all the students on one page, acknowledging their contributions collectively.

Abbreviations

CAGR: Compound Annual Growth Rate

CUCRM: Centre for Rural Outreach and Sustainable Development

KLD: Kilo Liters per Day

MBBR: Moving Bed Biofilm Reactor

MLD: Mega Liters per Day

SDGs: Sustainable Development Goals

STP: Sewage Treatment Plant

UNDP: United Nations Development Programme

UNICEF: United Nations Children's Fund

USD: United States Dollar

Glossary

Black Water:	Wastewater containing human waste from toilets requires more intensive treatment before it can be safely released or reused.
Circular Economy:	An economic system aimed at eliminating waste and the continual use of resources by creating closed-loop systems where waste is reused and recycled.
Educational Workshops:	Programs designed to teach participants about sustainable practices often involve hands-on learning experiences related to waste management and environmental conservation.
Grey Water:	Wastewater generated from domestic activities such as laundry, dishwashing, and bathing can be reused for irrigation after proper treatment.
KLD (Kilo Liters per Day):	A unit of measurement for the water flow rate indicates how many thousand liters are processed or used daily.
MLD (Mega Liters per Day):	A unit of measurement for larger volumes of water indicates how many million liters are processed or used daily.
Moving Bed Biofilm Reactor (MBBR):	A type of biological wastewater treatment process that uses moving plastic media to support the growth of microorganisms that break down organic matter in wastewater.
Nutrient Recycling:	Returning nutrients from organic waste into the soil enhances soil fertility and reduces the need for chemical fertilizers.
Organic Waste:	Biodegradable waste that comes from plant or animal sources, such as food scraps, garden waste, and paper products.

Rainwater Harvesting: The collection and storage of rainwater for reuse before it reaches the ground is often used for irrigation and reducing freshwater demand.

Sewage Treatment Plant (STP): A facility designed to treat wastewater from residential and industrial sources to remove contaminants before releasing it back into the environment.

Sustainable Practices: Methods that promote environmental stewardship by minimizing resource use and reducing waste through recycling, composting, and efficient resource management.

Vermicomposting: A process that uses earthworms to convert organic waste into nutrient-rich compost, enhancing soil quality.

Waste Management: The collection, transportation, processing, recycling, and disposal of waste materials to minimize their impact on the environment and human health.

Table of Contents

Executive Summary

The escalating global waste crisis poses significant challenges to public health, environmental sustainability, and economic stability. Over 2 billion tonnes of waste are generated annually worldwide, projected to increase to 3.4 billion tonnes by 2050 without urgent intervention. The waste management market was valued at approximately USD 1,293.70 billion in 2022 and is expected to grow at a CAGR of 5.4%, reaching USD 1,966.19 billion by 2030. However, there is a stark disparity in waste management practices between high-income and developing nations, with the latter often lacking adequate infrastructure and resources.

In India, about 62 million tonnes of waste are produced yearly, with only 7580% collected and a mere 2228% treated. Punjab generates around 3,500 tonnes of municipal solid waste daily, predominantly managed through open dumping or landfilling, leading to severe environmental degradation and public health risks.

To combat these issues, a transition towards a circular economy is essential. This model emphasizes sustainable waste management by reducing waste generation, promoting recycling and reuse, and transforming waste into valuable resources. The United Nations Sustainable Development Goals (SDGs) advocate for improved waste management practices globally.

Chitkara University has implemented innovative waste management systems that exemplify these principles. Key initiatives include:

Liquid Waste Management: The university operates three sewage treatment plants (STPs) that utilize a multistage treatment process to recycle wastewater for horticulture and gardening purposes.

Organic Waste Management: A dedicated system collects organic waste for processing in a vermicompost plant, converting it into nutrient-rich compost used on campus.

Solid Waste Management: A paper recycling facility transforms waste paper into new products like diaries and gift wraps, fostering creativity and sustainability among students.

The university's approach addresses the immediate challenges of waste management and serves as an educational platform for students, enhancing their understanding of sustainability practices through hands-on learning experiences.

Key findings from site visits highlight the effectiveness of Chitkara University's integrated waste management strategies:

I. **Multistage Treatment Processes:** Efficient treatment methods for liquid waste ensure reuse and nutrient recycling.
II. **Educational Engagement:** Students actively monitor and manage these systems, reinforcing theoretical knowledge with practical application.
III. **Community Impact:** The initiatives promote environmental stewardship within the campus community and serve as a model for broader societal engagement in sustainability efforts.

In conclusion, transitioning to a circular economy through comprehensive waste management practices is critical for mitigating environmental impacts while fostering sustainable development. Collaborative efforts among stakeholders at local, regional, national, and international levels will be essential to achieve these goals effectively.

Chitkara University

Chitkara University is a private university established in 2002. Chitkara University is ranked 54th in the Management Category by NIRF 2024. Chitkara University is a globally recognized organization that encourages academic excellence through interdisciplinary applied research and expands realms of knowledge through innovation. With its philosophical core commitment towards excellence in education, Chitkara Educational Trust established Chitkara Institute of Engineering & Technology in 2002; Chitkara International School, Chandigarh in 2004; Chitkara University, Himachal Pradesh under Himachal Pradesh State Legislature in 2008; and Chitkara University, Punjab in 2010; which was established under the Punjab State Legislature.

Today, Chitkara has 12 schools in Engineering, Management, Architecture, Nursing, Healthcare, Pharmacy, Media, Arts & Design, Education, Hospitality, Applied Sciences, and Applied Engineering. Comprising more than 13,000 students and 900 faculty members, Chitkara University is one of the best universities in North India that the Government also recognizes with the right to confer degrees as per Sections 2(f) and 22(1) of the UGC Act, 1956.

Chitkara University Punjab Campus has modern infrastructure and world-class facilities that enhance the learning experience. The campus features well-equipped laboratories, libraries, auditoriums, sports complexes, and student activity centres. These facilities create an environment conducive to both academic pursuits and extracurricular activities.

Research and innovation are integral to Chitkara University's ethos. The university encourages faculty and students to engage in research projects and pursue innovation-driven initiatives. With numerous research centres and labs, the campus provides a conducive environment for groundbreaking research and fosters a spirit of curiosity and exploration.

Chitkara University Punjab Campus has forged strategic partnerships with renowned universities and institutions. These collaborations enable students to participate in exchange programs, research projects, and international conferences, enriching their global perspective and cultural exposure.

Chitkara Business School

Chitkara University School was established in 2008 on the campus of Chitkara University. College programs enable students to find the route to success at the intersection of theory and practice, and discover and implement innovative solutions to real-world problems. You gain cutting-edge business knowledge and intensive practical business experience, which gives you an invaluable competitive edge. College

is ranked among the top Schools in India. The college has faculty, including people from the core academics with vast experience in academics and industry.

The university boasts a highly qualified and experienced faculty comprising professors, researchers, and industry experts. They are dedicated to imparting knowledge, guiding students, and conducting cutting-edge research in their respective fields. The faculty's commitment to excellence in teaching and research helps students develop a strong foundation for their future endeavours.

The university significantly emphasizes industry-academia collaboration, providing students ample opportunities to engage with leading companies through internships, workshops, seminars, and guest lectures. Such interactions bridge the gap between theoretical knowledge and practical application, preparing students to meet real-world challenges.

Moreover, Chitkara University has an excellent placement record, with topnotch companies visiting the campus to recruit talented graduates. The dedicated placement cell works closely with students to help them secure placements in reputed organizations, giving them a head start in their careers. Life at Chitkara University Punjab Campus is vibrant and dynamic, with various student clubs and societies catering to diverse interests, from arts and sports to entrepreneurship and social causes. The campus organizes cultural events, fests, and competitions, fostering a spirit of companionship and creativity among students.

Chitkara University Punjab Campus stands tall as a beacon of academic excellence, shaping the leaders of tomorrow. With its rigorous academic programs, experienced faculty, world-class infrastructure, and industry connections, the university provides a nurturing environment for students to realize their full potential and embark on successful and fulfilling careers.

Faculty of Economics, Chitkara Business School

The B.A. (Hons.) Economics with Data Science program at Chitkara Business School boasts a faculty of renowned scholars and industry experts passionate about empowering students with the tools to unlock the power of data in economic analysis.

Faculty hold advanced degrees in Economics, Econometrics, Data Science, and related fields, ensuring a solid foundation in economic principles and quantitative methods. Faculty members possess expertise in various data analysis tools and techniques, including statistical software like SPSS, AMOS, STATA, Eviews, etc., equipping them to guide students in practical data manipulation and analysis. They bring real-world insights and case studies to the classroom, bridging the gap between theory and practice. We actively publish copyrights, patents, and research papers in top academic journals, ensuring students are exposed to the latest

advancements in economics and data science. Faculty members are dedicated to guiding students individually, providing support and guidance throughout their academic journey.

Graduates have Successfully secured placement positions at top companies across various sectors, including finance, consulting, government agencies, and research institutions. This is a testament to the program's effectiveness in preparing students for successful careers. Strong partnerships with renowned organizations provide students with internship opportunities and practical exposure to cutting-edge data science applications in economics. Beyond expertise and achievements, the faculty of economics at Chitkara Business School fosters a unique learning environment:

Collaborative learning: Group projects and interactive sessions encourage students to learn from each other and develop strong communication and teamwork skills.

Global outlook: The faculty incorporates international perspectives into the curriculum, preparing students to thrive in a globalized economy.

In conclusion, the Faculty of Economics at Chitkara Business School is a team of highly qualified and dedicated individuals committed to helping students excel in Economics with Data Science. Their expertise, achievements, and commitment to student success make them invaluable assets to this unique and innovative program.

Chitkara University Centre For Rural Management [CUCRM]

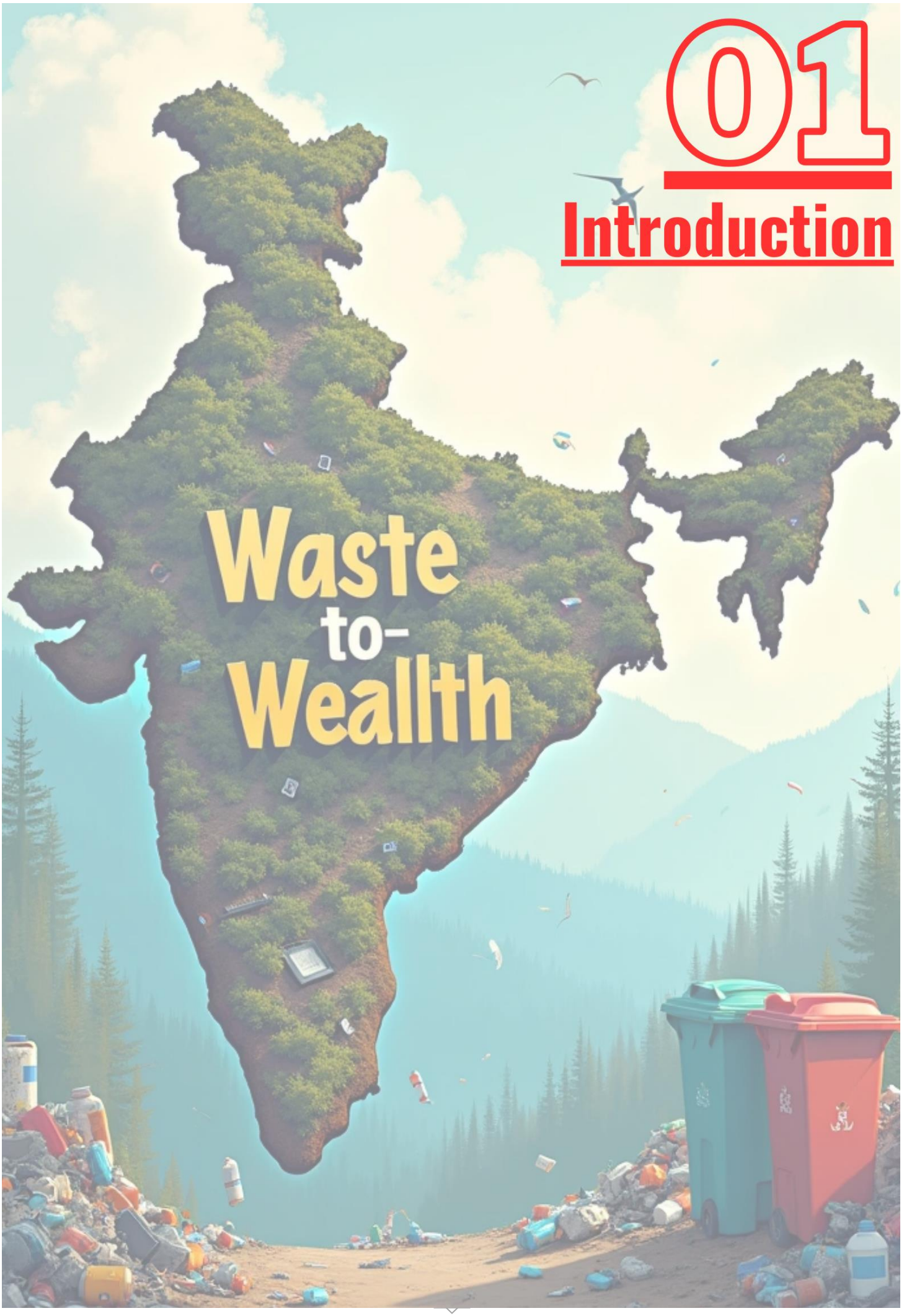
CUCRM is managed by a General Body of Chitkara Educational Trust and Cooperatives, Developmental Organisations, Governmental Agencies (National Dairy Development Board, National Cooperative Union of India, Ministry of Agriculture, and other influential public bodies), NGOs, Industry Partners and Centre members. The general body meets twice yearly to review the centre's performance on the plans. The Board Members meet every quarter to oversee the functioning of the CUCRM more frequently. The director oversees the day-to-day functioning of CUCRM. The director is assisted by other faculty members, researchers, and other supporting staff who work as coordinators and supervise CUCRM activities' functioning.
https://www.chitkara.edu.in/cucrm/

Centre of Excellence for Sustainability

The Centre of Excellence for Sustainability was formed under Office Order in Jan 2024. Our team of eight passionate environmentalists joined hands and got our brains and

mind ticking about how we could contribute to our roles. Numerous initiatives were already being undertaken by the various schools/ colleges and departments of the campus. Still, there was so much yet to be done (there would always be room for improvement and more activities!). We designed a route to connect with all teams and move ahead, one step at a time, but together. Offline and online meetings and discussions suggest how to take the next step. We would follow four principles: "What gets measured gets managed" & "Unless you know what assets you have, you cannot decide what to procure further". For both of these, data is a must, and so is data analysis. The second two principles are to "maximize students' participation in all activities" and to spread awareness as much as possible. This way, we provide more chances to create leaders who appreciate the responsibility of "leaving no one behind". We also needed to know what was done for the second principle, so we required data !! Hence, we decided to prioritize data and started with data collection. The results were overwhelming.

We had more than 2900 events in the various SDGs and were highly involved in research papers, collaborations, patents, etc., which were also related to sustainability. For specific departments, we suggested digitalizing data; for most others, we suggested zooming into goals and achieving milestones. This way, we could analyze the performance and progress, too. Our first step was digitalizing demands for plantation drives and green gifts in coordination with the Department of Horticulture and the Chalkpad Team. Further, we coordinated with all schools/colleges and departments for various sustainability-related activities. This newsletter will give you glimpses of the activities undertaken in collaboration with the Centre of Excellence for Sustainability from Jan 2024 to June 2024. We created a webpage, too https://sustainable.chitkara.edu.in


01
Introduction
Waste
to-
Wealth

Introduction

Our growing concern about the state of the environment has led us to be deeply alarmed by the escalating global waste crisis. The world currently generates over 2 billion tonnes of waste annually, which is projected to rise to 3.4 billion tonnes by 2050 if urgent action is not taken. This staggering amount of waste severely threatens public health, the environment, and the economy (World Bank, 2018). At the global level, the waste management market was valued at USD 1,293.70 billion in 2022 and is expected to grow at a CAGR of 5.4% from 2023 to 2030, reaching USD 1,966.19 billion by 2030 (Grand View Research, 2023). However, waste management practices vary widely across countries. While high-income nations have relatively advanced waste management systems, with over 90% of waste collected, many developing countries

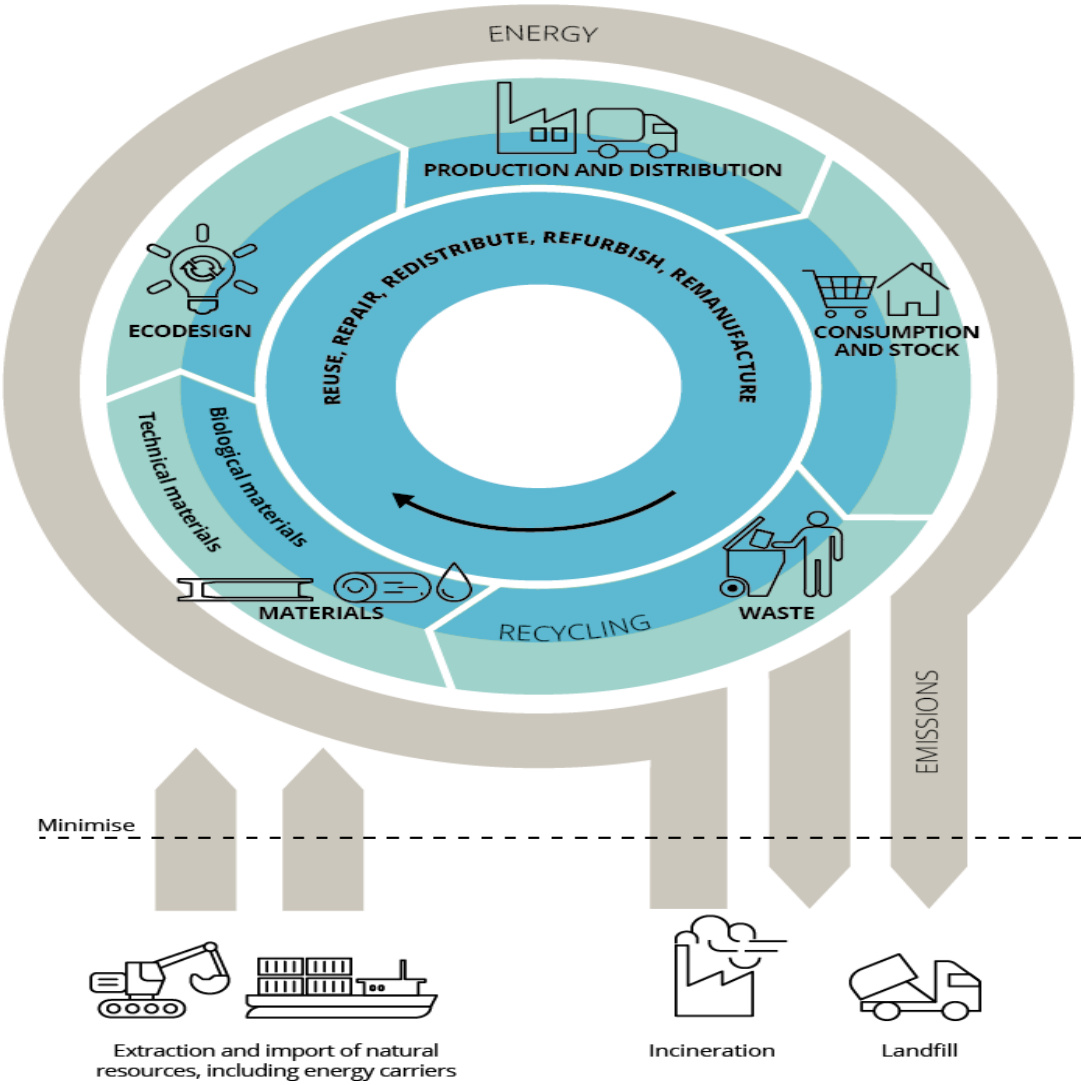


Fig.01 Circular Economy

struggle with inadequate infrastructure and resources (Kaza et al., 2018). Globally, improper waste management leads to soil, air, and water pollution, attracts disease vectors, and contributes to climate change, accounting for about 5% of global carbon emissions (Widmer et al., 2005).

India, the world's most populous country, generates around 62 million tonnes of waste annually, with only 7580% of municipal waste collected and 2228% treated (Ahmad, 2021). The lack of proper waste segregation, collection, and disposal systems has led to significant environmental and public health issues. Punjab, my home state, generates approximately 3,500 tonnes of municipal solid waste per day, with only a few functional waste processing facilities (Ahmad, 2021). Most waste is either openly dumped or sent to landfills, leading to soil and groundwater contamination, air pollution, and the spread of diseases (Ahmad, 2021).

To address these challenges, a comprehensive and integrated approach to waste management is required, one that embraces the principles of a circular economy. A circular economy promotes sustainable approaches to waste management by designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, 2017). By adopting a circular economy approach, we can create a closed-loop system for recycling and transforming waste into new products, reducing our environmental footprint, creating jobs, and supporting ecofriendly industries.

At the global level, the United Nations Sustainable Development Goals (SDGs) include proper waste management and a strategic vision for using waste as resources in a more circular economy (United Nations, 2015). In India, the Government has identified 11 end-of-life products/recyclable materials/wastes that pose considerable challenges and must be addressed holistically through a comprehensive circular economy framework (Ministry of Environment, Forest and Climate Change, 2021). At the state level, Punjab must strengthen its existing policies and regulations to integrate circular economy principles, promote innovations and research to accelerate circularity and attract higher investment in the waste management sector.

we believe transitioning to a circular economy is crucial for creating a sustainable future. By reducing waste generation, increasing recycling and reuse, and transforming waste into valuable resources, we can mitigate the environmental and economic costs of the current linear "take make waste" model. However, achieving a circular economy

requires concerted action among local, regional, national, and international stakeholders, including governments, businesses, civil society, and individuals.

- **Vision**
  - To create a sustainable future where waste is transformed into valuable resources by adopting circular economy principles, fostering environmental stewardship, and contributing to a greener, more resilient society.
- **Mission**
  - To engage students in handson, realworld applications of the circular economy by exploring innovative waste management practices, enhancing their understanding of sustainability, and empowering them to become advocates of resource efficiency and environmental responsibility in urban and rural contexts.
- **Objectives**
  - **Educate and Raise Awareness:**
    - To deepen students' knowledge of the circular economy and its importance in addressing environmental challenges by demonstrating how waste materials can be recycled and transformed into valuable products.
  - **Hands on Learning:**
    - To provide practical exposure to waste management processes, including liquid, solid, and organic waste treatment, through visits to specialized sites, allowing students to observe and engage with sustainable practices.
  - **Foster Innovation and Problem Solving:**
    - To encourage students to develop innovative solutions for transforming waste into wealth by applying circular economy principles and promoting creative thinking in sustainability initiatives.
  - **Promote Sustainable Development:**
    - To highlight the relevance of sustainable waste management in urban and rural development, particularly through the Chitkara University Centre For Rural Management (CUCRM) activities.

- **Collaboration and Teamwork:**
  - To cultivate teamwork by assigning group based projects where students compile reports and offer recommendations based on their observations from waste management sites.

- **Contribute to Institutional Sustainability Goals:**
  - To align with Chitkara University's sustainability initiatives by involving students in projects that reflect the university's commitment to environmental stewardship and resource efficiency.

02

Waste Management At Chitkara University, Punjab

2.1

Liquid Waste Management at Chitkara University, Punjab

2.1 Liquid Waste Management At Chitkara University, Punjab. (site visit on 10th September, 2024)

Fig.2: Liquid Waste Management at Chitkara University

Chitkara University has implemented a comprehensive liquid waste management system to treat and reuse wastewater generated on campus efficiently. The university operates three sewage treatment plants (STPs) with capacities of 250 KLD, 1 MLD, and 2 MLD (under construction) to handle the liquid waste from the campus and hostels.

The liquid waste management process at Chitkara University involves the following steps:

2.1.1. Physical Separation Stage

Fig.03: grit for physical separation

Organic and inorganic waste is separated from the Grey and black water using a bar screen with a 6 to 10-mm thickness connected to a collection tank.

2.1.2. (MBBR)

Air is supplied to the MBBR for bacterial growth and breakdown of organic matter.

The MBBR media acts as a growing surface for the bacteria, preventing them from settling at the bottom of the reactor.

Some inorganic waste may remain at this stage and is separated before proceeding to the next step.

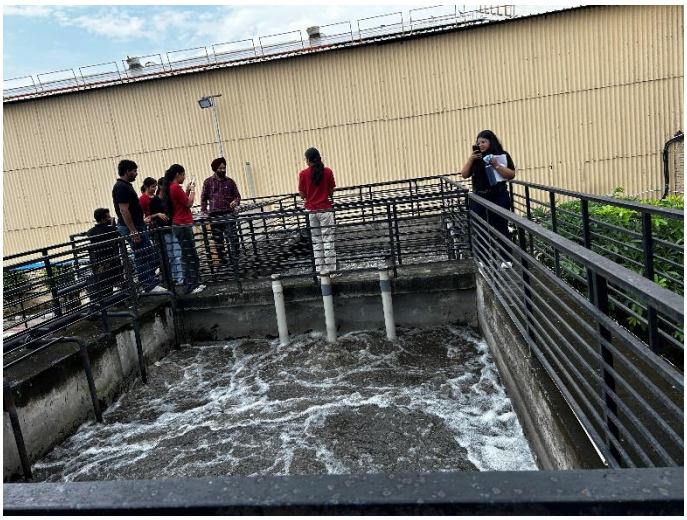


Fig.04: MBBR

2.1.3. Sludge Separation and Clarification

The water from the MBBR enters a sludge separation and clarification tank.

In this tank, small sludge particles coagulate and settle down with the help of gravity, aided by a flash mixer.

Chemicals like polyelectrolyte and alum may be used to speed up the coagulation and sedimentation process.

The clarified water is collected in tanks for further treatment, while the settled sludge is sent to sludge pits.

2.1.4. Sludge Treatment and Reuse

The sludge collected in the pits is further processed and converted into organic manure.

The manure is used for agricultural purposes, providing nutrients to the soil and reducing the need for chemical fertilizers.

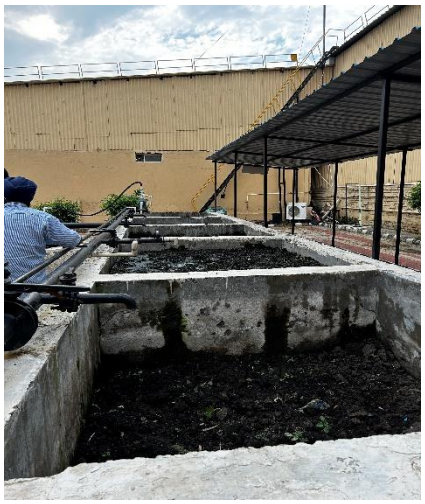


Fig.5: Sludge Bed

2.1.5. Treated Water Reuse

The treated water from the clarifier is stored in tanks.

This treated water is used for horticulture and gardening purposes within the university campus, reducing the demand for fresh water.

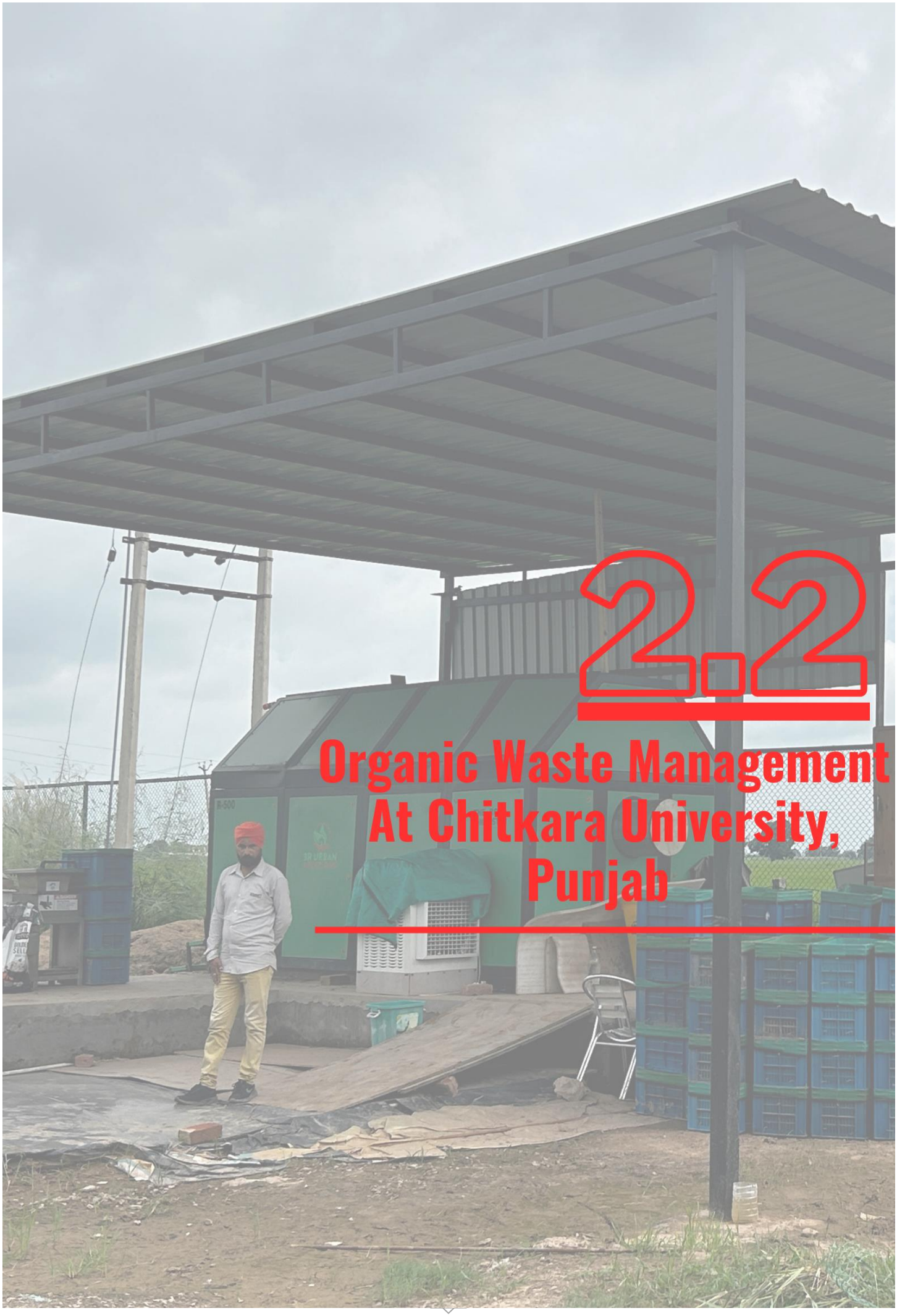
Fig.06: Acraion Tank

Chitkara University's liquid waste management system not only efficiently treats wastewater but also promotes sustainability by reusing treated water for gardening and converting sludge into organic manure for agriculture. This closed-loop system minimizes waste, conserves natural resources, and contributes to the university's environmental responsibility.

Key observations

- The STP utilizes a multistage process involving physical separation, biological treatment (MBBR), and sludge management to ensure that treated water is suitable for irrigation and other uses.
- Students learn about the operational aspects of the STP, including monitoring water quality through chemical analysis. This hands-on experience reinforces theoretical concepts learned in class and enhances their understanding of sustainable practices.

- The treated water from the STP is used for irrigation purposes within the university campus, reducing the demand for fresh water and promoting water conservation.



2.2

Organic Waste Management At Chitkara University, Punjab

2.2 Organic Waste Management Site & Yellow Farm Visit (12th September, 2024)

Organic Waste Management and Yellow Farm at Chitkara University

Chitkara University has implemented a comprehensive organic waste management system and an ecofriendly Yellow Point Farm to promote sustainability on campus. Here's a step-by-step overview of their initiatives:

2.2.1. Organic Waste Collection

Organic waste from the campus and hostels is collected separately using dedicated bins.

2.2.2. Vermicompost Plant

The collected organic waste is fed into a Vermicompost Plant, which utilizes earthworms to break down the waste.

Fig.07: Vermicompost Unit

The plant operates on a closed-loop system, converting organic waste into nutrient-rich vermicompost.

2.2.3. Vermicompost Production

The vermicompost produced in the plant is used as a natural fertilizer for the Yellow Point Farm and other green areas on campus.

It helps enrich the soil, improve soil structure, and provide essential nutrients for plant growth.

2.2.4. Yellow Point Farm

The Yellow Point Farm is an ecofriendly, sustainable farm within the Chitkara University campus.

It serves as an outdoor classroom, providing hands-on learning opportunities for agriculture, horticulture, and environmental sciences students.

Fig.08: Miyawaki Forest

2.2.5. Organic Farming Practices

The Yellow Point Farm employs organic farming techniques, avoiding synthetic fertilizers and pesticides.

It promotes using natural methods like vermicompost, green manure, and biological pest control.

2.2.6. Crop Cultivation

Using sustainable farming practices, the farm cultivates various crops, including vegetables, fruits, and herbs.

Students actively participate in farming activities, gaining practical experience in crop cultivation and management.

Fig.09: Organic Manure

2.2.7. Sustainable Water Management

The farm uses rainwater harvesting systems to collect and store water for irrigation.

This helps reduce the dependence on groundwater and promotes water conservation.

Fig.10: Collection of Recyclable Products

2.2.8. Educational Opportunities

The Yellow Point Farm is an outdoor classroom providing students with opportunities to learn about organic farming, sustainable agriculture, and environmental conservation.

Workshops, seminars, and hands-on activities are regularly conducted at the farm to enhance students' understanding of sustainable practices.

Chitkara University's organic waste management system and Yellow Point Farm demonstrate its commitment to sustainability and environmental responsibility. The university exemplifies how educational institutions can contribute to a greener future through innovative and eco-friendly initiatives by closing the loop between waste management and organic farming.

Key observations:

- The university operates a Vermicompost Plant that utilizes earthworms to break down organic waste, converting it into nutrient-rich compost used as a natural fertilizer for the Yellow Point Farm and other green areas on campus.
- The Yellow Point Farm employs organic farming techniques, avoiding synthetic fertilizers and pesticides. Students actively participate in farming activities, gaining practical experience in sustainable agriculture.
- These initiatives promote soil health, reduce waste, and give students a deeper understanding of environmental science and sustainable practices.
-

2.3

Solid Waste Management Site At Chitkara University, Punjab

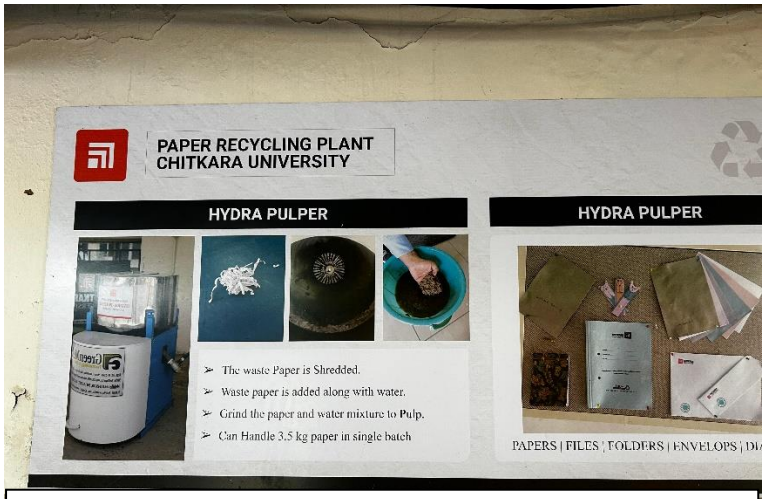


Fig.11: Paper Recycling Plant

2.3 Solid Waste Management Site (19th September 2024)

At Chitkara University, a dedicated paper recycling plant is part of the institution's commitment to sustainability and environmental stewardship. This facility plays a crucial role in transforming waste paper into new products, reducing landfill contributions, and promoting ecofriendly practices within the campus community.

Paper Recycling Process

Recycling begins with collecting waste paper from various sources around the university. Once collected, the paper is meticulously sorted and shredded into small pieces to facilitate further processing. This shredding is essential as it increases the paper's surface area, making it easier to convert into pulp. After shredding, the paper pieces are mixed with water and other additives to create a slurry. This slurry is then subjected to a settling process where impurities are removed, resulting in a clean pulp. The pulp is carefully spread onto a fine iron mesh or net, which acts as a base for forming new sheets of paper. Once the pulp is evenly distributed, it is transferred onto a cotton cloth, serving as another layer in the sheet formation process. This cloth supports the pulp and aids in moisture absorption during drying. Subsequently, the sheets are placed under a hydraulic press that applies significant pressure to remove excess water and compact the fibers, ensuring a uniform thickness. After pressing, the newly formed sheets are laid out in sunlight to dry naturally. This

Fig.12: Person Teaching Us Paper Recycling

step is vital as it enhances the paper's durability and prepares it for subsequent use. Once dried, the sheets are cut into standard sizes suitable for various applications.

End Products

The recycled paper produced at Chitkara University creates various items, including diaries, file covers, and gift wraps. These products serve functional purposes and symbolize the university's commitment to sustainability and creativity. For instance, students often use these recycled materials to craft gifts or educational resources, reinforcing the idea of innovatively reusing materials.

Fig.13: We Doing Paper Recycling

Key observations:

I. **Efficient waste management**:

The university's commitment to recycling waste paper demonstrates its dedication to efficient waste management practices. By diverting paper from landfills, the university reduces its environmental footprint and promotes a circular economy.

II. **Hands-on learning opportunities**:

The paper recycling plant is a valuable learning resource for students, providing practical experience in sustainable practices. Students can participate in workshops, tours, and Hands-on activities, enhancing their understanding of environmental conservation.

III. **Creativity and innovation**: T

he recycled paper products, such as diaries, file covers, and gift wraps, showcase the creativity and innovation of the university community. Students and faculty can explore new ways to utilize recycled materials, fostering a culture of sustainability and resourcefulness.

IV. **Reduced carbon footprint**:

By recycling paper onsite, the university minimizes the need for transportation and energy-intensive industrial processes associated with traditional paper production. This reduction in carbon emissions contributes to the university's overall sustainability efforts.

V. **Community engagement**:

The paper recycling initiative at Chitkara University serves as a model for other educational institutions and the local community. The university fosters a sense of collective responsibility toward environmental protection by sharing its practices and encouraging participation.

VI. **Continuous improvement**:

The university's commitment to sustainability is evident in its ongoing efforts to improve and expand its recycling program. Regular monitoring, evaluation, and adaptation of the process ensure that the program remains effective and efficient.

03

FINDINGS FROM SITE VISITS

3. Findings from Site Visits

3.1 Liquid Waste Management Site

I. Multistage Treatment Process:

a. Liquid waste management involves a multistage process, including physical separation, biological treatment using Moving Bed Biofilm Reactor (MBBR) technology, sludge separation, and clarification.

b. A bar screen separates Organic and inorganic waste from grey and black water.

II. Efficient Sludge Management:

a. The sludge collected during the treatment process is converted into organic manure, which is then utilized for agricultural purposes on campus, thus promoting nutrient recycling and reducing reliance on chemical fertilizers.

III. Treated Water Reuse:

a. The treated water is stored and used for horticulture and gardening within the university, significantly lowering the demand for fresh water.

IV. Educational Component:

a. Students actively monitor water quality through chemical analysis at the STP, enhancing their practical understanding of sustainable practices.

V. Environmental Responsibility:

a. The system treats wastewater and contributes to the university's sustainability goals by minimizing waste and conserving natural resources.

Problems that are faced At Liquid Waste Management Site and solutions to it:

I. Inadequate Infrastructure:

Problem:

Many regions lack adequate liquid waste treatment facilities, leading to improper disposal and environmental contamination.

Solution:

Governments and organizations should prioritize funding for developing wastewater treatment facilities and infrastructure improvements to ensure effective treatment and disposal.

II. Limited Financial Resources:

Problem:

Financial constraints hinder developing and maintaining liquid waste management systems, particularly in developing countries.

Solution:

Implementing decentralized wastewater treatment systems can facilitate local liquid waste processing, making it more manageable and reducing transportation costs.

III. Lack of Awareness:

Problem:

Insufficient public knowledge about the importance of proper liquid waste management contributes to poor practices and increased pollution risks.

Solution:

Increasing awareness through educational initiatives can promote responsible liquid waste management practices among communities, encouraging participation in sustainable practices.

IV. Regulatory Gaps:

Problem:

Weak enforcement of existing regulations leads to noncompliance by industries and households, resulting in untreated waste entering ecosystems.

Solution:

Developing comprehensive policies with strict enforcement mechanisms can ensure compliance from industries and households regarding liquid waste management practices.

V. Complex Composition of Liquid Waste:

Problem:

Liquid waste varies widely in composition, requiring specialized treatment methods for different types, such as industrial effluents or sewage, complicating management efforts.

Solution:

Utilizing advanced treatment technologies such as membrane filtration, constructed wetlands, and activated sludge systems can enhance the efficiency of wastewater treatment processes.

VI. Health Risks:

Problem:

Improper management of liquid waste can lead to serious health issues due to exposure to pathogens and toxic substances, especially in urban areas with inadequate sanitation systems.

Solution:

Involving local communities in planning and executing liquid waste management strategies ensures solutions are tailored to specific needs and conditions, fostering a sense of ownership and responsibility.

Research and Development:

Investing in research can lead to the development of new technologies that improve the effectiveness and efficiency of liquid waste management systems, particularly in resource-limited settings

3.2 Organic Waste Management Site & Yellow Farm Visit

I. Organic Waste Collection:

The university has established a dedicated system for collecting organic waste from campus and hostels, using specific bins to ensure proper segregation.

II. Vermicompost Plant:

The collected organic waste is processed in a Vermicompost Plant, which employs earthworms to decompose the waste efficiently. This closed-loop system transforms organic waste into nutrient-rich vermicompost.

III. Vermicompost Utilization:

The vermicompost produced is utilized as a natural fertilizer for the Yellow Point Farm and other green areas on campus, enhancing soil health and providing essential nutrients for plant growth.

IV. Yellow Point Farm:

This ecofriendly farm is an outdoor classroom, offering hands-on learning experiences in agriculture, horticulture, and environmental sciences. It promotes sustainable practices among students.

V. Organic Farming Techniques:

The farm adheres to organic farming principles, avoiding synthetic fertilizers and pesticides. It relies on natural methods such as vermicompost, green manure, and biological pest control.

VI. Crop Diversity:

Various crops, including vegetables, fruits, and herbs, are cultivated using sustainable practices. Students engage in farming activities, gaining practical experience in crop management.

VII. Sustainable Water Management:

Rainwater harvesting systems are implemented at the farm to collect and store water for irrigation, reducing reliance on groundwater and promoting conservation efforts.

VIII. Educational Workshops:

The Yellow Point Farm hosts workshops and seminars to educate students about organic farming and sustainable agriculture practices, reinforcing their understanding of environmental conservation.

Problems that are faced At Organic Waste Management Site & Yellow Farm Visit and Solutions to it:

I. **Limited Awareness and Participation**:

Problem:

Not all students and staff may fully know the organic waste management system or the benefits of participating in sustainable practices.

Solution:

Implement regular awareness campaigns through workshops, seminars, and social media to educate students and staff about the importance of organic waste management and encourage participation.

II. Inconsistent Waste Segregation:

Problem:

There may be improper waste segregation, leading to contamination of organic waste with nonorganic materials, which can hinder the vermicomposting process.'

Solution:

Conduct training sessions for students and staff on proper waste segregation techniques and provide clear signage on bins to minimize contamination.

III. **Resource Constraints**:

Problem:

The Vermicompost Plant and Yellow Point Farm operation may face limitations in terms of funding, workforce, or equipment, affecting their efficiency and output.

Solution:

Seek partnerships with local businesses, NGOs, or government bodies for funding and resources. Consider involving students in internships or volunteer programs to support farm operations.

IV. **Pest Management Challenges**:

Problem:

While organic farming techniques are employed, pests can still significantly threaten crop yields, potentially leading to losses.

Solution:

Adopt IPM strategies that combine biological control methods with cultural practices to manage pests effectively while minimizing reliance on chemical pesticides.

V. **Water Management Issues**:

Problem:

Although rainwater harvesting is implemented, inconsistent rainfall patterns may lead to water shortages for irrigation, especially during dry seasons.

Solution:

Explore alternative water sources such as groundwater recharge systems or partnerships with local water supply authorities to ensure a consistent water supply for irrigation.

VI. **Limited Crop Diversity and Yield**:

Problem:

Focusing on a limited variety of crops may not yield sufficient produce to meet the campus community's or local markets' needs.\

Solution:

Introduce crop rotation and diversify the types of crops grown in the Yellow Point Farm to improve soil health, increase resilience against pests, and enhance overall yield.

VII. **Another essential solution is Monitoring and Evaluation Systems**:

Establish a monitoring system to assess the effectiveness of organic waste management and farming practices. Use feedback for continuous improvement.

3.3 Solid Waste Management Site

I. Commitment to Sustainability:

Chitkara University operates a dedicated paper recycling plant, reflecting its commitment to sustainability and environmental stewardship by transforming waste paper into new products and reducing landfill contributions.

II. Efficient Recycling Process:

Recycling involves several steps: collection, sorting, shredding, pulping, pressing, and drying. This meticulous approach ensures the effective conversion of waste paper into usable products.

III. Educational Resource:

The paper recycling plant is a valuable educational tool for students, providing hands-on learning opportunities about sustainable practices and the recycling process through workshops and tours.

IV. Diverse End Products:

The recycled paper is utilized to create various products such as diaries, file covers, and gift wraps, promoting creativity and resourcefulness within the university community.

V. Reduction of Environmental Footprint:

By recycling paper onsite, the university minimizes transportation needs and energy consumption associated with traditional paper production, significantly reducing its carbon footprint.

VI. Community Engagement:

The initiative encourages participation from students and faculty, fostering a culture of sustainability and collective responsibility towards environmental protection within the campus community.

VII. Continuous Improvement:

The university emphasizes ongoing evaluation and adaptation of its recycling program to enhance efficiency and effectiveness, demonstrating a commitment to continuous improvement in sustainability efforts.

VIII. Promoting Circular Economy:

The recycling plant contributes to a circular economy by diverting waste from landfills and creating new products from recycled materials, aligning with broader sustainability goals.

Problems that are faced At Solid Waste Management Site & Yellow Farm Visit and solutions to it:

I. Inconsistent Paper Collection:

Problem:

Inconsistent or insufficient collection of waste paper from various sources on campus may lead to fluctuations in the supply of raw materials for the recycling plant.

Solution:

Conduct regular waste audits to identify sources of paper waste and optimize collection routes, ensuring a consistent supply of raw materials for the recycling plant.

II. Contamination of Paper Waste:

Problem:

Improper segregation of paper waste from other types of waste can lead to contamination, reducing the quality and usability of the recycled paper.

Solution:

Implement a robust waste segregation system with clear guidelines and dedicated bins for paper waste. Provide training to students and staff on proper waste segregation practices.

III. Limited Capacity of the Recycling Plant:

Problem:

The current capacity of the recycling plant may be insufficient to handle the growing volume of paper waste generated on campus, leading to potential bottlenecks in the recycling process.

Solution:

Consider expanding the capacity of the recycling plant to handle increased volumes of paper waste. This may involve investing in new equipment, streamlining processes, or exploring partnerships with external recycling facilities.

IV. Quality Control Challenges:

Problem:

Maintaining consistent quality standards in recycled paper products may be challenging, affecting their marketability and user acceptance.

Solution:

Establish a comprehensive quality control system to ensure consistent quality in the recycled paper products. This may include regular testing, implementing quality standards, and providing training to plant operators.

VIII. Lack of Awareness and Participation:

Problem:

Not all students and staff may fully know the paper recycling initiative's importance, leading to low participation rates and reduced program effectiveness.

Solution:

Launch awareness campaigns through workshops, social media, and campus events to educate students and staff about the paper recycling initiative and its importance. Encourage participation and provide incentives for active involvement.

VII. Limited Utilization of Recycled Products:

Problem:

The university community may not fully utilize recycled paper products, leading to excess inventory and reduced plant output demand.

Solution:

Explore opportunities to diversify the range of recycled paper products based on market demand and user preferences. This may involve creating new product lines or collaborating with student and faculty groups to develop innovative applications for recycled paper.

4. Global Insights on Waste Management

I. Integrated Solid Waste Management (ISWM):

ISWM emphasizes a holistic approach that combines various waste management strategies, including reduction, reuse, recycling, and safe disposal. This method considers local conditions and stakeholder engagement to create effective waste management systems.

II. Waste Minimization and Prevention:

Preventing waste generation at the source is crucial. This involves designing products that minimize waste during production and encouraging practices like going paperless in businesses and institutions.

III. Public Private Partnerships (PPP):

Collaborations between public entities and private companies can enhance waste management efficiency. For example, engaging private firms in collection and recycling can improve services and innovation in waste processing technologies.

IV. Community Engagement and Education:

Successful waste management initiatives often involve community participation. Educating the public about waste segregation, recycling benefits, and sustainable practices fosters a culture of responsibility towards waste management.

V. Use of Technology:

Implementing technology such as smart bins for waste segregation and tracking systems can optimize collection routes and improve recycling rates. Data analytics can also help understand waste generation patterns for better planning.

Case Studies Relating to India

I. Door-to-Door Collection in Trichy:

Trichy, India, has implemented a door-to-door collection system for solid waste, significantly improving the efficiency of waste management services. This initiative has led to better segregation at the source and increased recycling rates among residents.

II. Waste Characterization Studies:

Conducting waste characterization studies in cities like Naucalpan has helped understand the composition of municipal solid waste, allowing for targeted interventions in recycling and composting efforts tailored to local needs.

III. Community-Based Initiatives:

Various local NGOs in India have engaged communities in composting organic waste at home. These initiatives reduce the amount of waste sent to landfills and provide valuable compost for gardening, promoting sustainable agricultural practices.

IV. Implementation of Solid Waste Management Rules:

India's Solid Waste Management Rules (2016) mandate segregation at source and emphasize the role of local bodies in managing waste effectively. These regulations encourage cities to adopt best practices worldwide while tailoring them to local contexts.

V. Innovative Recycling Models:

Some cities are adopting innovative recycling models that include informal sector workers in formal waste management processes. This integration helps improve livelihoods while enhancing recycling rates and reducing landfill use.

5. Policy Recommendations

I. Adopt a Circular Economy Framework

Implement policies that encourage a circular economy approach, promoting the recycling and reuse of materials to minimize waste generation. This could include incentives for businesses adopting sustainable practices and penalties for those not complying with waste management regulations.

II. Strengthen Waste Segregation Policies

Mandate strict waste segregation at the source by implementing public awareness campaigns and providing separate bins for organic, inorganic, and hazardous waste. This can facilitate better recycling rates and reduce contamination in recyclable materials.

III. Enhance Infrastructure for Waste Management

Invest in developing robust waste management infrastructure, including more sewage treatment plants (STPs) and recycling facilities across urban and rural areas. This includes ensuring facilities are equipped with modern technologies like Moving Bed Biofilm Reactor (MBBR) systems for efficient wastewater treatment.

IV. Promote Decentralized Waste Management Systems

Encourage decentralized waste management solutions that allow local communities to manage their waste effectively. This could involve supporting smallscale composting facilities and vermicomposting initiatives to process organic waste at the community level.

V. Implement Financial Incentives for Sustainable Practices

Provide financial support and tax incentives for businesses and industries that invest in sustainable waste management technologies and practices. This could help alleviate the financial burden on smaller enterprises looking to adopt greener methods.

VI. Increase Research and Development Funding

Allocate funds for research into innovative waste management technologies and practices tailored to India's unique challenges. This research should focus on developing costeffective solutions for liquid and solid waste treatment in resourcelimited settings.

VII. Strengthen Regulatory Frameworks

Develop comprehensive regulations with strict enforcement mechanisms to ensure compliance with waste management practices across all sectors, including industries, municipalities, and households. Regular audits and penalties for noncompliance should be instituted.

VIII. Enhance Public Awareness and Education

Launch nationwide educational campaigns to raise awareness about the importance of sustainable waste management practices among citizens. Incorporating sustainability education into school curricula can foster a culture of environmental responsibility from a young age.

IX. Support Community Engagement Initiatives

Encourage local communities to participate in waste management initiatives through volunteer programs, workshops, and collaboration with educational institutions. Engaging communities can enhance ownership of local environmental issues.

X. Monitor and Evaluate Waste Management Programs

Establish a framework for regularly monitoring and evaluating the effectiveness of waste management policies and programs. This should include metrics for assessing progress towards sustainability goals, such as reduction in landfill use and increases in recycling rates.

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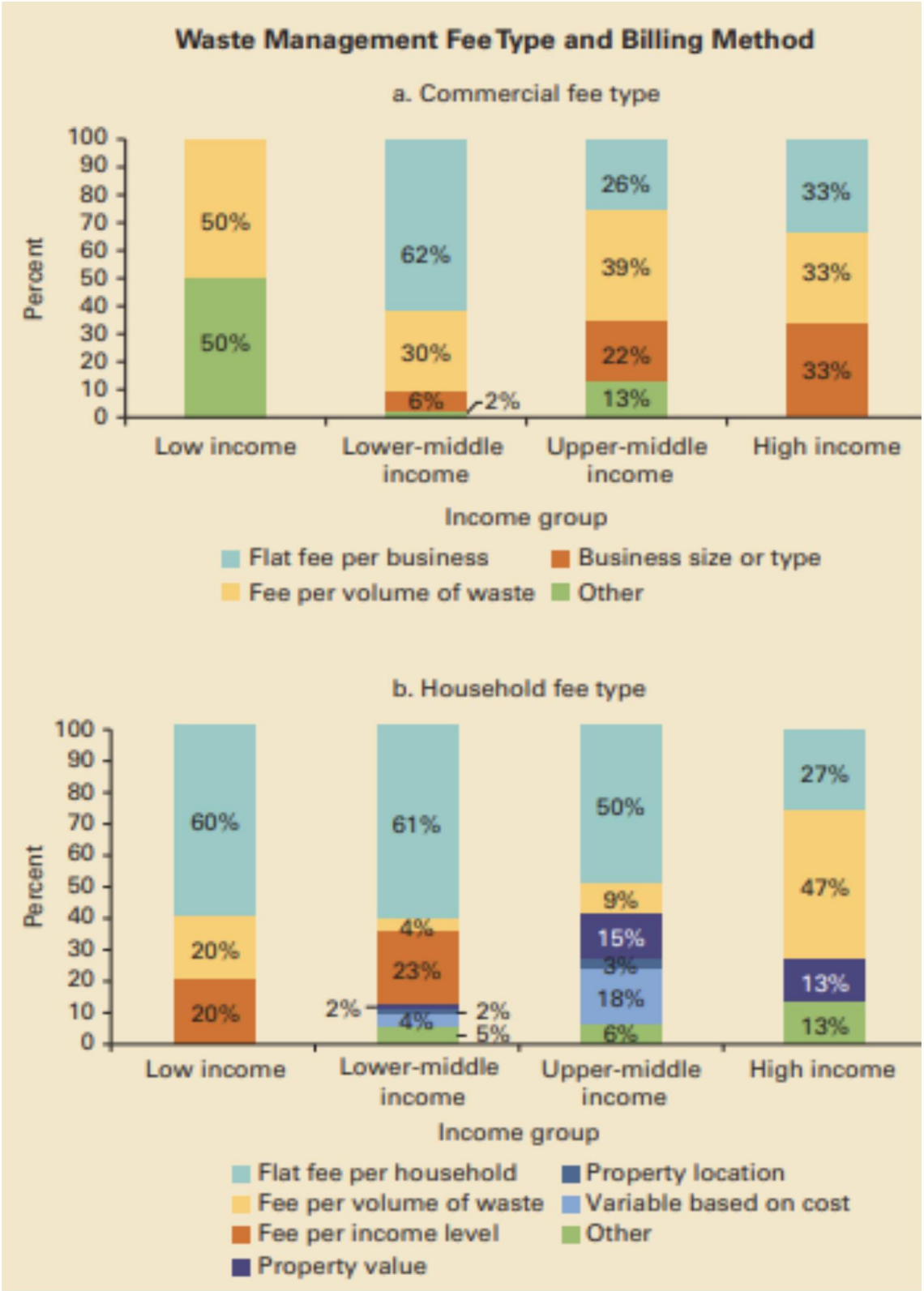
Appendices

Category	Current Value	Projected Value	Notes
Global Waste Generation	Over 2 billion tonnes	3.4 billion tonnes (2050)	Severe threats to public health and the environment
Waste Management Market Value	USD 1,293.70 billion (2022)	USD 1,966.19 billion (2030)	CAGR of 5.4% from 2023 to 2030
India Annual Waste Generation	62 million tonnes	N/A	Only 7580% collected; treated: 2228%
Punjab Daily Waste Generation	~3,500 tonnes	N/A	Limited processing facilities
Carbon Emissions from Waste	~5% of global emissions	N/A	Major environmental concern
Plastic Waste (2024)	220 million tonnes	N/A	One-third mismanaged

Source: World Bank, 2018



Source: World Bank, 2018

Organic waste management

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Project Outcome 3:

Circular Possibilities:

Future of Resource Management

Course:

BA (Honours) Economics with Data Science
Batch: 2023

Prepared by:

- **Jashanpreet Singh** (2320993505)
- **Lakshay** (2320993507)
- **Pranchal Narang** (2320993511)
- **Tanushree** (2320993546)
- **Himani Nagpal** (2320993551)
- **Lavanya** (2320993552)

Organized by:

FACULTY OF ECONOMICS,
Chitkara Business School
Under the aegis of
CHITKARA UNIVERSITY CENTRE FOR RURAL MANAGEMENT (CUCRM)
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)
In association with the
CENTRE OF EXCELLENCE FOR SUSTAINABILITY,
CHITKARA UNIVERSITY, PUNJAB (NAAC A+)

CHITKARA UNIVERSITY

CHITKARA UNIVERSITY Centre of Excellence for Sustainability

CHITKARA BUSINESS SCHOOL

Detailed Project Report

Circular Possibilities: Future of Resource Management

9th September, 2024 to 20th September, 2024

Submitted By:

Name	*Roll no.*
Jashanpreet Singh	*2320993505*
Lakshay	*2320993507*
Pranchal Narang	*2320993511*
Tanushree	*2320993546*
Himani Nagpal	*2320993551*
Lavanya	*2320993552*

Organised By:

Faculty of Economics, Chitkara Business School,

Under the aegis of :

Chitkara University Centre for Rural Management Development (CUCRM)

Chitkara University, Punjab (NAAC A+)

in association with the Centre of Excellence for Sustainability,

Chitkara University, Punjab (NAAC A+)

Message from the Chancellor, Chitkara University

I am delighted to see the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability, leading the way with the live project "Waste to Wealth: Exploring the Potential of the Circular Economy."

At Chitkara University, we are deeply committed to fostering innovation, sustainability, and real-world learning experiences for our students. This project exemplifies how education and practical engagement can come together to address one of the most critical challenges of our time—waste management.

By exploring the potential of the circular economy, students learn how waste materials can be transformed into valuable resources and contribute to a more significant global movement toward environmental sustainability. The hands-on site visits and practical applications will undoubtedly empower our students to be future leaders in sustainable development.

I believe such initiatives help shape the minds of young individuals and prepare them to tackle complex problems with innovative solutions. I am proud of the efforts and enthusiasm shown by our students, and I am confident that this project will inspire them to make meaningful contributions toward a greener, more sustainable world.

I wish all the participants the best and look forward to seeing the outcomes of this important project.

Dr. Ashok K. Chitkara
Hon'ble Chancellor,
Chitkara University

Message from the Pro-Chancellor, Chitkara University

I am genuinely pleased to witness the launch of the live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At Chitkara University, we believe in creating future leaders who are academically strong and conscious of the world around them. This project reflects our commitment to promoting sustainability and encouraging students to think beyond the classroom. Exploring how waste can be transformed into wealth and valuable resources is a commendable step towards understanding the circular economy and its crucial role in shaping a sustainable future.

The hands-on experience through site visits and practical applications will inspire our students to embrace sustainability as a core principle in their academic and professional journeys. Projects like these help bridge the gap between theoretical knowledge and practical execution, essential in today's rapidly evolving world.

I am confident that this project will leave a lasting impact on our students and motivate them to take bold steps in contributing to global sustainability efforts my heartfelt congratulations to all participants for their enthusiasm and dedication.

Warm regards,

Dr Madhu Chitkara
Hon'ble Pro-Chancellor,
Chitkara University,Punjab.

Message from the Vice-Chancellor, Chitkara University, Punjab

I am proud to see the "Waste to Wealth: Exploring the Potential of the Circular Economy" project being successfully launched by the Faculty of Economics, Chitkara Business School, in association with the Centre of Excellence for Sustainability.

At Chitkara University, we emphasize the importance of innovative learning that extends beyond the classroom, fostering a mindset of sustainability and responsibility in our students. This live project beautifully aligns with our vision of nurturing leaders who can contribute to a sustainable and circular economy by transforming waste into valuable resources.

Through site visits and practical involvement, this project provides a unique opportunity for students to witness
s firsthand how waste management practices can be applied in real-world scenarios. It encourages them to explore how recycled materials can be repurposed, highlighting such initiatives' economic and environmental benefits.

I commend the students for their active participation and dedication, and I am confident that this experience will instil a strong sense of responsibility toward sustainability in their future careers. Such initiatives are a testament to our commitment to shaping responsible global citizens.

Warm regards,

Prof Sandhir Sharma
Vice Chancellor, Chitkara University,Punjab.

Message from the Dean, Faculty of Economics, Chitkara University, Punjab

I am immensely proud to witness the successful initiation of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability.

At the Chitkara University Centre for Rural Management Development (CUCRM), we are committed to addressing pressing environmental challenges and promoting sustainable development, particularly in rural areas. This project is a testament to our efforts to integrate innovative, circular economy practices with real-world applications, offering our students a hands-on experience transforming waste into valuable resources.

This initiative highlights the need for sustainable development in urban and rural contexts. The insights gained will empower students to apply these lessons to broader societal challenges, mainly where waste management and sustainability are crucial. I commend the students for their enthusiasm and dedication and extend my heartfelt appreciation to everyone involved in this project.

I look forward to the positive outcomes of this meaningful initiative.

Warmest congratulations once again!

Sincerely,

Prof. Dhiresh Kulshrestha
Dean, Faculty of Economics, Chitkara Business School,
Chitkara University Centre for Rural Management Development (CUCRM),
Chitkara University, Punjab.

Message from Director, Office of Administration and Centre of Excellence for Sustainability, Chitkara University, Punjab

I am delighted to see the successful launch of the live project titled "Waste to Wealth: Exploring the Potential of the Circular Economy," an initiative led by the Faculty of Economics in collaboration with the Centre of Excellence for Sustainability at Chitkara University.

The Centre of Excellence for Sustainability is dedicated to advancing the principles of environmental stewardship, sustainable development, and green innovation. This project embodies our core mission by providing students an invaluable opportunity to engage with the practical aspects of waste management and resource recycling within a circular economy framework. Through real-world exposure, the students learn about waste-to-wealth practices and actively contribute to the broader sustainability goals we champion at the center.

As part of this initiative, students are immersing themselves in on-ground activities, from visiting liquid and solid waste management sites to understanding organic waste recycling methods. These experiences help them appreciate sustainability's critical role in today's world and empower them to apply these principles professionally and personally in their future endeavours. I commend the students and faculty for their enthusiasm and dedication to this project.

Sincere regards,
Sqn. Ldr. Dr. Reena Angel
Director, Office of Administration and
Director, Centre of Excellence for Sustainability
Chitkara University, Punjab

Acknowledgement

We want to express our deepest gratitude to everyone who has contributed to the success of this live project, "Waste to Wealth: Exploring the Potential of the Circular Economy," organized by the Faculty of Economics, Chitkara Business School, in collaboration with the Centre of Excellence for Sustainability, Chitkara University, Punjab.

First and foremost, we are profoundly grateful to Dr. Ashok K. Chitkara, Hon'ble Chancellor, and Dr. Madhu Chitkara, Hon'ble Pro-Chancellor, Chitkara University, for their visionary leadership and continuous support in fostering an environment of innovation, sustainability, and learning.

We thank Prof. Sandhir Sharma, Vice-Chancellor, Chitkara University, Punjab, for his guidance and unwavering encouragement throughout this initiative. His commitment to experiential learning and sustainability has been instrumental in shaping this project.

Our sincere appreciation goes to Sqn. Ldr. Dr Reena Angel, Director, Office of Administration, and Director of the Centre of Excellence for Sustainability, for her valuable insights and support in aligning the project with the broader goals of sustainability and circular economy principles.

We would also like to express our gratitude to Prof. Dhiresh Kulshrestha, Dean, Faculty of Economics, Chitkara Business School, and Director of the Chitkara University Centre for Rural Management Development (CUCRM), for his strategic direction and mentorship, which have been vital in guiding our students through this hands-on project.

A special thanks to the project coordinators, faculty members, and staff of Chitkara Business School, whose tireless efforts and commitment to student learning have made this project a remarkable success.

Lastly, we immensely thank the students for their enthusiasm, dedication, and active participation. Their hard work and keen interest in exploring sustainable solutions through the circular economy have driven this project's success.

Thank you all for your invaluable contributions!

Certificate

This is to certify that the following students from **B.A. (Honours) Economics with Data Science (Batch 2023)** have completed the live project titled **" Circular Possibilities: Future of Resource Management,"** held from **9th September 2024 to 20th September 2024**, organized by the **Faculty of Economics, Chitkara Business School**, in collaboration with the **Centre of Excellence for Sustainability** at **Chitkara University, Punjab**.

Participants:

1. Jashanpreet Singh (Roll No:2320993505)
2. Lakshay (Roll No:2320993507)
3. Pranchal Narang (Roll No:2320993511)
4. Tanushree (Roll No:2320993546)
5. Himani Nagpal (Roll No:2320993551)
6. Lavanya (Roll No:2320993552)

During this project, the students demonstrated excellent understanding of the principles of the circular economy, actively participated in visits to various waste management sites, and contributed valuable insights to group discussions and project reports. Their involvement in recycling initiatives and practical exercises showcased a commendable ability to apply theoretical knowledge to real-world sustainability challenges.

As a supervisor, I am proud of their dedication, enthusiasm, and contributions to the success of this project. I am confident that the skills and knowledge gained through this live project experience will serve them well in their future academic and professional endeavors.

I wish them continued success in all their future undertakings.

Supervisor
Dr. Gurwinder Singh
Assistant Professor, Faculty of Economics
Chitkara Business School
Chitkara University, Punjab

Note: This certificate includes all the students on one page, acknowledging their contributions collectively.

Abbreviations

OWM	Organic Waste Management
SLWM	Solid and Liquid Waste Management
AD	Anaerobic Digestion
BPF	Biogas Production Facility
C2G	Carbon to Gas
FWD	Food Waste Diversion
LFG	Landfill Gas
OCM	Organic Composting Method
FWB	Food Waste Biomass
Nutrients	Nutrient Recovery and Recycling
SOW	Sewage and Organic Waste
ICW	Integrated Composting Waste
WFB	Waste to Fuel Bioenergy
CWG	Composting Working Group
SGR	Sustainable Green Resources
LRP	Liquid Resource Recovery Process
RWM	Resource Waste Management
NCR	Nutrient Circular Recovery
OSW	Organic Solid Waste
C2G	Carbon to Gas
FWD	Food Waste Diversion
LFG	Landfill Gas
OCM	Organic Composting Method
FWB	Food Waste Biomass
SOW	Sewage and Organic Waste
ICW	Integrated Composting Waste
WFB	Waste to Fuel Bioenergy
CWG	Composting Working Group
SGR	Sustainable Green Resources
LRP	Liquid Resource Recovery Process
RWM	Resource Waste Management
NCR	Nutrient Circular Recovery
OSW	Organic Solid Waste
CNG	Compressed Natural Gas (from organic waste)
NIMBY	Not In My Backyard

ESG	**Environmental, Social, and Governance**
SROI	**Social Return on Investment**
WEEE	**Waste Electrical and Electronic Equipment**

Glossary

Circular Economy: An economic model aimed at eliminating waste and the continual use of resources. It promotes designing products for longer life cycles, reusing, repairing, and recycling materials to create a closed-loop system, reducing reliance on finite resources and minimizing environmental impact.

Waste Management: The collection, transportation, processing, recycling, and disposal of waste materials. Effective waste management aims to reduce the volume of waste generated, manage the environmental and health impacts of waste, and promote the recycling and recovery of materials.

Recycling: The process of converting waste materials into reusable material. Recycling involves collecting, sorting, and processing discarded items to create new products, thereby reducing the need for raw materials and minimizing waste.

Sustainability: The ability to maintain or improve the quality of human life while living within the carrying capacity of supporting ecosystems. It encompasses environmental protection, social equity, and economic development to ensure that current and future generations can meet their needs.

Liquid Waste: Waste in liquid form, including wastewater from domestic, industrial, or commercial sources. Proper management of liquid waste is essential to prevent pollution and protect water resources.

Organic Waste: Biodegradable waste derived from plant or animal sources, such as food scraps, yard trimmings, and agricultural residues. Organic waste can be composted to produce nutrient-rich soil amendments and reduce landfill volumes.

Solid Waste: Non-liquid waste materials from households, industries, and institutions, including items like paper, plastic, glass, and metals. Solid waste management involves various strategies to reduce, reuse, recycle, and safely dispose of these materials.

Resource Efficiency: The practice of using natural resources more efficiently to reduce waste, decrease environmental impact, and enhance economic productivity. Resource efficiency involves optimizing the use of materials, energy, and water throughout the lifecycle of products and services.

Waste Hierarchy: A framework for managing waste in a prioritized manner, often represented as a pyramid with the following levels: prevention (reducing waste generation), reuse, recycling, recovery (energy recovery), and disposal (landfilling). The hierarchy emphasizes reducing waste at its source before considering other management options.

Eco-design: The practice of designing products and processes with consideration for their environmental impact throughout their lifecycle. Eco-design aims to minimize negative environmental effects by incorporating principles such as resource efficiency, durability, and recyclability into the design process.

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Executive Summary

This report explores the circular economy model's transformative potential in waste management, emphasizing resource efficiency and sustainability. A key focus is on a liquid waste management facility visited on [insert date], which demonstrates innovative approaches to turning waste into valuable resources such as biogas and organic fertilizers, contributing to the local energy grid and agricultural productivity.

The facility employs advanced technologies like anaerobic digestion, which processes organic waste to generate biogas for energy and produce high-quality fertilizers. This not only reduces landfill use but also promotes renewable energy and sustainable farming. The site visit underscored the economic impact of these practices, including job creation, reduced waste management costs, and enhanced support for the local agricultural sector.

However, challenges persist, such as high initial costs, lack of supportive regulatory frameworks, and low public awareness of waste segregation. Potential solutions discussed include public-private partnerships, technological innovation, and community education programs to increase participation in recycling and sustainable waste practices.

In conclusion, while the waste-to-wealth model offers significant environmental and economic benefits, its scalability requires addressing regulatory, financial, and societal barriers. Collaboration between governments, businesses, and communities will be essential to unlocking the full potential of the circular economy.

Chitkara University, Punjab

Chitkara University is a private university established in 2002. Chitkara University is ranked 54th in the Management Category by NIRF 2024. Chitkara University is a globally recognized organization that encourages academic excellence through interdisciplinary applied research and expands realms of knowledge through innovation. With its philosophical core commitment towards excellence in education, Chitkara Educational Trust established Chitkara Institute of Engineering & Technology in 2002; Chitkara International School, Chandigarh in 2004; Chitkara University, Himachal Pradesh under Himachal Pradesh State Legislature in 2008; and Chitkara University, Punjab in 2010; which was established under the Punjab State Legislature.

Today, Chitkara has 12 schools in Engineering, Management, Architecture, Nursing, Healthcare, Pharmacy, Media, Arts & Design, Education, Hospitality, Applied Sciences, and Applied Engineering. Comprising more than 13,000 students and 900 faculty members, Chitkara University is one of the best universities in North India that the government also recognizes with the right to confer degrees as per Sections 2(f) and 22(1) of the UGC Act, 1956.

Chitkara University Punjab Campus has modern infrastructure and world-class facilities that enhance the learning experience. The campus features well-equipped laboratories, libraries, auditoriums, sports complexes, and student activity centres. These facilities create an environment conducive to both academic pursuits and extracurricular activities.

Research and innovation are integral to Chitkara University's ethos. The university encourages faculty and students to engage in research projects and pursue innovation-driven initiatives. With numerous research centers and labs, the campus provides a conducive environment for groundbreaking research and fosters a spirit of curiosity and exploration.

Chitkara University Punjab Campus has forged strategic partnerships with renowned universities and institutions. These collaborations enable students to participate in exchange programs, research projects, and international conferences, enriching their global perspective and cultural exposure.

Chitkara Business School

Chitkara University B-school was established in 2008 on the campus of Chitkara University. College programs enable students to find the route to success at the intersection of theory and practice, discover and implement innovative solutions to real-world problems. You gain cutting-edge business knowledge and intensive practical business experience, which gives you an invaluable competitive edge. College is ranked among the top B-schools in India. The college has faculty, including people from the core academics with vast experience in academics and industry.

The university boasts a highly qualified and experienced faculty comprising professors, researchers, and industry experts. They are dedicated to imparting knowledge, guiding students, and conducting cutting-edge research in their respective fields. The faculty's commitment to excellence in teaching and research helps students develop a strong foundation for their future endeavours.

The university places significant emphasis on industry-academia collaboration, providing students ample opportunities to engage with leading companies through internships, workshops, seminars, and guest lectures. Such interactions bridge the gap between theoretical knowledge and practical application, preparing students to meet real-world challenges.

Moreover, Chitkara University has an excellent placement record, with top-notch companies visiting the campus to recruit talented graduates. The dedicated placement cell works closely with students to help them secure placements in reputed organizations, giving them a head start in their careers. Life at Chitkara University Punjab Campus is vibrant and dynamic, with various student clubs and societies catering to diverse interests, from arts and sports to entrepreneurship and social causes. The campus organizes cultural events, fests, and competitions, fostering a spirit of companionship and creativity among students.

Chitkara University Punjab Campus stands tall as a beacon of academic excellence, shaping the leaders of tomorrow. With its rigorous academic programs, experienced faculty, world-class infrastructure, and industry connections, the university provides a nurturing environment for students to realize their full potential and embark on successful and fulfilling careers.

Faculty of Economics

The B.A. (Hons.) Economics with Data Science program at Chitkara Business School boasts a faculty of renowned scholars and industry experts passionate about empowering students with the tools to unlock the power of data in economic analysis.

Faculty hold advanced degrees in Economics, Econometrics, Data Science, and related fields, ensuring a solid foundation in economic principles and quantitative methods. Faculty members possess expertise in various data analysis tools and techniques, including statistical software like SPSS, AMOS, STATA, Eviews, etc., equipping them to guide students in practical data manipulation and analysis. They bring real-world insights and case studies to the classroom, bridging the gap between theory and practice. We actively publish copyrights, patents, and research papers in top academic journals, ensuring students are exposed to the latest advancements in economics and data science. Faculty members are dedicated to guiding students individually, providing support and guidance throughout their academic journey.

Graduates have Successfully secured placement positions at top companies across various sectors, including finance, consulting, government agencies, and research institutions. This is a testament to the program's effectiveness in preparing students for successful careers. Strong partnerships with renowned organizations provide students with internship opportunities and practical exposure to cutting-edge data science applications in economics. Beyond expertise and achievements, the faculty of economics at Chitkara Business School fosters a unique learning environment:

Collaborative learning: Group projects and interactive sessions encourage students to learn from each other and develop strong communication and teamwork skills.

Global outlook: The faculty incorporates international perspectives into the curriculum, preparing students to thrive in a globalized economy.

In conclusion, the Faculty of Economics at Chitkara Business School is a team of highly qualified and dedicated individuals committed to helping students excel in Economics with Data Science. Their expertise, achievements, and commitment to student success make them invaluable assetss to this unique and innovative program.

Chitkara University Centre for Rural Management [CUCRM]

CUCRM is managed by a General Body of Chitkara Educational Trust and Cooperatives, Developmental Organisations, Governmental Agencies (National Dairy Development Board, National Cooperative Union of India, Ministry of Agriculture, and other influential public bodies), NGOs, Industry Partners and Centre members. The general body meets twice yearly to review the centre's performance on the plans. The Board Members meet every quarter to oversee the functioning of the CUCRM more frequently. The director oversees the day-to-day functioning of CUCRM. The director is assisted by other faculty members, researchers, and other supporting staff who work as coordinators and oversee the functioning of CUCRM's activities. (https://www.chitkara.edu.in/cucrm/)

Centre of Excellence for Sustainability

The Centre of Excellence for Sustainability was formed under Office Order in Jan 2024. Our team of eight passionate environmentalists joined hands and got our brains and mind ticking about how we could contribute to our roles. Numerous initiatives were already being undertaken by the various schools/ colleges and departments of the campus. Still, there was so much yet to be done (there would always be room for improvement and more activities!). We designed a route to connect with all teams and move ahead, one step at a time, but together. Offline and online meetings and discussions suggest how to take the next step. We would follow four principles - "What gets measured gets managed" & "Unless you know what assets you have, you cannot decide what to procure further". For both of these, data is a must, and so is data analysis. The second two principles are to "maximize students' participation in all activities" and to spread awareness as much as possible. This way, we provide more chances to create leaders who appreciate the responsibility of "leaving no one behind". We also needed to know what was done for the second principle, so we required data !! Hence, we decided to prioritize data and started with data collection. The results were overwhelming.

We had more than 2900 events in the various SDGs and were highly involved in research papers, collaborations, patents, etc., which were also related to sustainability. For specific departments, we suggested digitalizing data; for most others, we suggested zooming into goals and achieving milestones. This way, we could analyze the performance and progress, too. Our first step was digitalizing demands for

plantation drives and green gifts in coordination with the Department of Horticulture and the Chalkpad Team. Further, we coordinated with all schools/colleges and departments for various sustainability-related activities. This newsletter will give you glimpses of the activities undertaken in collaboration with the Centre of Excellence for Sustainability from Jan 2024 to June 2024. We created a webpage, too - https://sustainable.chitkara.edu.in

Introduction

"The greatest threat to our planet is the belief that someone else will save it." — Robert Swan, Explorer and Environmentalist

In addressing the critical environmental issues of our time, the concept of the Circular Economy offers a transformative vision for how we manage resources and waste. Moving away from the traditional "linear" economic model—characterized by a "take-make-dispose" approach—this paradigm shift emphasizes a restorative and regenerative system where resources are continuously cycled back into the economy. Ellen MacArthur, a leading proponent of this model, articulates the shift succinctly: "A circular economy is one that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits."

1.1 Circular Economy and Its Significance:

In the face of escalating environmental challenges, the Circular Economy emerges as a pivotal concept in redefining resource management and sustainability. Unlike the traditional linear model, which follows a "take-make-dispose" trajectory, the Circular Economy advocates for a restorative approach where resources are continuously cycled through the economy. This paradigm shift is encapsulated by Ellen MacArthur, who asserts, "A circular economy is one that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits." By emphasizing the continual use and recovery of resources, the Circular Economy not only mitigates waste but also enhances economic vitality and environmental stewardship.

1.2 Overview of Waste Management Issues in the Current Linear Economy

The traditional linear economy operates on a "take-make-dispose" model, which presents significant challenges in managing waste. This approach relies on extracting raw materials, using them to create products, and then disposing of those products after their useful life has ended. This cycle leads to a range of problems, including the depletion of natural resources and the accumulation of waste.

The result is an increasing burden on landfills, where much of the waste ends up, causing environmental harm such as soil and water contamination. Additionally, many disposed materials contain hazardous substances that can contribute to air and water pollution, impacting both human health and ecosystems. The linear model also proves economically inefficient, with higher costs associated with resource extraction, waste management, and environmental cleanup.

1.3 Focus of this Project

This report specifically addresses the management of three types of waste: liquid waste, solid waste, and organic waste. Liquid waste includes wastewater from homes and industries, which requires proper treatment and recycling to prevent environmental contamination. Solid waste, which comprises everyday trash and industrial by-products, needs improved strategies to enhance recycling and reduce the volume of waste. Organic waste, such as food scraps and garden trimmings, offers the potential for transformation into compost or renewable energy when managed correctly.

1.4 Goals of the Project

The project aims to explore how Circular Economy principles can enhance the management of these different types of waste. We will examine current practices, identify existing challenges, and visit facilities such as recycling centers and composting sites to gain practical insights. Based on these observations, we will propose recommendations for improving waste management practices.

1.5 Global Perspectives on Waste Management

Globally, organizations like the United Nations Development Programme (UNDP), UNICEF, and the World Bank have been studying waste management and its impacts. Their reports emphasize the need for better waste management systems to protect the environment and public health, particularly in vulnerable communities. These global insights help inform efforts to develop and implement more sustainable waste management practices.

In summary, this report will delve into how adopting Circular Economy practices can improve the management of liquid, solid, and organic waste. By exploring these practices, we aim to contribute to a more sustainable and efficient approach to handling resources and waste.

- **Vision**

  "To create a sustainable future where waste is transformed into valuable resources by adopting circular economy principles, fostering environmental stewardship, and contributing to a greener, more resilient society."

This vision emphasizes the transformative potential of waste management, turning waste into economic assets, reducing environmental harm, and building a sustainable, circular economy model for future growth.

- **Mission**

"To engage students in hands-on, real-world applications of the circular economy by exploring innovative waste management practices, enhancing their understanding of sustainability, and empowering them to become advocates of resource efficiency and environmental responsibility in urban and rural contexts."

This mission emphasizes practical learning, fostering a deeper understanding of sustainability and circular economy principles, while encouraging students to take active roles in promoting environmental responsibility.

- **Objectives**
  - **Educate and Raise Awareness:**
    To deepen students' knowledge of the circular economy and its importance in addressing environmental challenges by demonstrating how waste materials can be recycled and transformed into valuable products.
  - **Hands-on Learning:**
    To provide practical exposure to waste management processes,including liquid, solid, and organic waste treatment, through visits to specialized sites, allowing students to observe and engage with sustainable practices.
  - **Foster Innovation and Problem-Solving:**
    To encourage students to develop innovative solutions for transforming waste into wealth by applying circular economy principles and promoting creative thinking in sustainability initiatives.
  - **Promote Sustainable Development:**
    To highlight the relevance of sustainable waste management in urban and rural development, particularly through the Chitkara University Centre for Rural Management Development (CUCRM) activities.
  - **Collaboration and Teamwork:**
    To cultivate teamwork by assigning group-based projects where students compile reports and offer recommendations based on their observations from waste management sites.

Contribute to Institutional Sustainability Goals:

- To align with Chitkara University's sustainability initiatives by involving students in projects that reflect the university's commitment to environmental stewardship and resource efficiency.

- Brief mention of global perspectives on waste management (referring to UNDP, UNICEF, and World Bank reports).

2. Waste Management at Chitkara University, Punjab

2.1 Liquid Waste Management Site (10th September)

On a bright Tuesday morning, our class of enthusiastic economic students embarked on a field trip to the university water management facility dedicated to recycling and reusing water. The aim was to understand the intricacies of water treatment rocesses and the importance of sustainable water management. Upon arrival, the students were greeted by the facility manager Dr Gurpreet Singh Saggu, Sustainability Manager, Office of Infrastructure Development, Chitkara University, Punjab who provided an overview of the site's operations. "This facility operates 24/7," he explained. "However, it can be temporarily shut down for up to 10 hours for maintenance or repairs." The manaager guided the students to the first step of the water treatment process: the **bar screen**. "This is where solid waste, such as plastic and other debris, is removed from the water," she said. "Any solid waste that can become food for bacteria is separated and turned into compost. For instance, jaggery is often added to the water to attract beneficial bacteria, which play a crucial role in the treatment process.

Stage 1- The Treatment Process - The students learned that the water undergoes three treatment stages: **primary**, **secondary**, and **tertiary**. In the primary stage, after the bar screen, water flows into the **equalization tank**. "This tank helps in balancing the flow and reduces both Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)," the manager explained. The students noted the importance of these parameters, which indicate the level of organic matter and pollutants in the water. Next, the tour moved to the **coagulation tank**. "Here, we use a process called coagulation to clarify the water," the manager said. "This tank is designed so that water flows from bottom to top, allowing impurities to settle effectively." The students were intrigued to learn about the **pressurized sand filter (PSR)** and the **activated carbon filter (ACF)** used in this stage, which are critical for removing color, odor, and suspended solids from the water.

Stage 2- Filtration and Purification - As they walked past the filters, the distinct smell of chlorine filled the air. "We maintain about 10 mg per liter of chlorine in the water to ensure it remains safe from harmful bacteria, but it's not suitable for human consumption," the manager clarified. The students made notes, recognizing the importance of maintaining water quality standards while ensuring that the treated water can be safely reused for irrigation and industrial purposes. In the secondary treatment phase, the students observed how **sand** served as an excellent filtration medium. "Sand is one of the best natural filters we have," the manager emphasized. "It removes smaller particles that other processes might miss." The students were fascinated by how the facility integrated natural materials into advanced technology to enhance purification.

Stage 3- The Final Stages - As they continued the tour, the students were shown the **garden supply water meter**, where treated water is distributed. "We use orange pipes to clearly indicate that this water is reused and not for human consumption," the manager pointed out. The facility also utilizes rainwater to increase flow, enhancing retention time in the treatment tanks. At the end of the visit, the students gathered to discuss what they had learned. They understood how crucial each component of the facility was in ensuring that water was recycled efficiently. The importance of parameters like BOD, COD, pH, and total suspended solids (TSS) became clear as they recognized their roles in maintaining water quality. Liquid waste management is an essential component of sustainable urban development, particularly within the framework of a circular economy. The goal is to transform waste into valuable resources while minimizing environmental impact. This approach aligns with the principles of a circular economy, where waste is reimagined as a resource, and products are reused, repurposed, or recycled back into the economic system.

Site Visit Insights

The facility you visited employs modern liquid waste treatment technologies, particularly anaerobic digestion. This process involves the breakdown of organic liquid waste in the absence of oxygen, producing biogas and nutrient-rich by-products. These by-products—biogas and fertilizers—are reintegrated into the economy, reflecting a practical example of a closed-loop system in the circular economy. By converting liquid waste into energy and fertilizers, the facility reduces reliance on landfills and lowers greenhouse gas emissions. This process also enhances resource efficiency by supplying renewable energy to power the plant and producing fertilizers sold to local farmers, supporting agricultural sustainability.

Economic Impact

The facility exemplifies how circular economy practices can generate financial value through the waste-to-wealth approach. By converting liquid waste into biogas, the facility not only powers its operations but also creates a marketable energy source, contributing to a cleaner energy economy. Furthermore, the production of fertilizers from organic sludge supports agricultural activities, offering a secondary revenue stream while promoting sustainable farming practices. This approach also fosters local economic growth by creating employment opportunities in waste collection,

processing, and distribution. Overall, this model highlights the economic viability of sustainable waste management, demonstrating how environmental challenges can be transformed into profitable ventures and new revenue streams..

Environmental Benefits

The facility provides a range of environmental benefits, with a central focus on reducing landfill use and lowering greenhouse gas emissions. By processing waste into biogas, which can replace fossil fuels for energy generation, the facility mitigates methane emissions typically released from landfills, reducing its overall carbon footprint.

Additionally, the water recycling system at the facility conserves water by treating wastewater for reuse in irrigation and industrial applications. This lessens the demand on freshwater resources, an increasingly critical issue due to climate change and population growth. In some cases, the treated water can be reintroduced into natural water bodies, enhancing regional water security.

The production of organic fertilizers from waste materials reduces the need for chemical fertilizers, which are known to contribute to soil degradation, water pollution, and biodiversity loss. By providing an eco-friendly alternative, the facility promotes healthier soils and cleaner waterways, supporting environmental conservation efforts.

Reduction in Greenhouse Gas Emissions: Biogas production lowers carbon emissions by providing an alternative to fossil fuels.

Water Conservation: By recycling and treating liquid waste, the facility helps conserve water, a critical resource, especially in drought-prone regions.

Pollution Reduction: The facility reduces the amount of untreated waste that would otherwise contribute to water and soil pollution.

The plant's practices align with global sustainability goals, addressing both waste reduction and energy production.

Challenges in Liquid Waste Management:

Despite the advantages, challenges remain:

High Costs of Technology: Advanced waste processing technologies like anaerobic digestion require significant investment, making it difficult for smaller businesses to adopt such methods.

Regulatory Gaps: A lack of comprehensive policies supporting circular economy practices may slow the broader adoption of liquid waste management initiatives.

Addressing these challenges is critical to scaling waste-to-wealth models globally.

Potential Solutions and Innovations:

Public-Private Partnerships (PPP): These partnerships can reduce financial barriers by leveraging government incentives and private sector innovation, encouraging more widespread investment in advanced waste management technologies.

Technological Advancements: Innovations in bioenergy and anaerobic digestion are reducing costs and improving efficiency, making it easier to treat liquid waste and convert it into energy and other by-products.

Regulatory Reforms: Government policies that promote waste reduction, resource efficiency, and the use of recycled materials are essential to supporting a circular economy framework.

FIG 1 : Students at the liquid waste management site in the university

FIG 2

FIG 3

FIG 4 : Equipments at the Liquid Management Site

FIG 5

FIG 6 : Water tanks used at the site


GPS Map
Camera Lite
Rajpura, Patiala, 140601, PB, India
Latitude
30.515684°
Longitude
76.658346°
Local 03:11:47 PM
GMT 09:41:47 AM
Altitude 277.2 meters
Tuesday, 09/10/2024

FIG 7


CHITKARA
UNIVERSITY

FIG 8

2.2 Organic Waste Management Site & Yellow Farm Visit (12th September 2024)

One bright morning, a group of eager students from the sustainability program set out on a field trip to the organic waste management facility located within the Chitkara University campus. Having studied waste management and the circular economy in theory, they were excited to see these concepts put into practice. Upon arrival, they were warmly welcomed by Mr. Gupta, the facility manager, who provided an overview of the facility's mission: to reduce organic waste while producing valuable resources like compost and biogas. Their first stop was the

vermicomposting area, where Mr. Gupta explained the fascinating process of using earthworms to convert organic waste into nutrient-rich compost. "Here, we take food scraps and yard waste generated by the university and let earthworms do their magic," he said, gesturing to the rows of compost bins. The students watched as he carefully removed a bin to reveal rich, dark compost teeming with healthy earthworms. "This method not only speeds up decomposition but also enriches the soil with nutrients," he added. As they continued, Mr. Gupta detailed the steps involved in traditional composting. "We utilize both aerobic and anaerobic processes," he explained. "First, we pile the organic waste into rows to allow air circulation, which helps microbes break it down." The students noted the large, aerated piles of organic matter, occasionally turned by machinery to maintain optimal decomposition conditions. The earthy smell was a testament to the active microbial life working within.

Next, Mr. Gupta introduced the concept of Miyawaki forests. "These mini-forests are created using native plant species and can thrive in urban areas," he explained. "The compost we produce here is often used to nourish these forests, supporting biodiversity and improving campus green spaces." The students were intrigued by the idea of enhancing their university's ecosystem through sustainable practices. The group then moved to the sustainable mushroom production section, where agricultural waste like straw and sawdust is transformed into a substrate for growing mushrooms. "We enrich this waste with our compost to create an ideal growing environment," he said, showing them trays filled with mushroom mycelium. The students learned how this process not only provides a sustainable food source but also exemplifies the circular economy by efficiently utilizing waste.

Their final stop was the anaerobic digestion unit, where organic waste is processed to produce biogas. "In this system, we create an oxygen-free environment where microorganisms break down organic material," Mr. Gupta explained. "The biogas produced can be used for cooking or generating electricity." The students watched as large tanks bubbled with activity, indicating the digestion process in action. Mr. Gupta emphasized the importance of capturing biogas to reduce greenhouse gas emissions from landfills. One student raised a hand and asked about the challenges the facility faces. Mr. Gupta responded candidly, noting that public awareness and participation in organic waste segregation are critical for success. "Many people still don't realize

the value of composting or how to properly dispose of organic waste," he noted. He highlighted the importance of educational programs and community outreach efforts to promote responsible waste management. As the tour concluded, the students were given samples of compost and informational brochures about organic waste management practices. They left the facility inspired by the transformative potential of organic waste and how it can be turned into valuable resources. On the bus ride back, they discussed the lessons learned and reflected on the impact of effective waste management on sustainability. Excited to apply their knowledge, they began brainstorming ideas for their upcoming projects focused on waste reduction and the circular economy

Site Visit Insights

During your visit, you observed how modern technologies, particularly anaerobic digestion, are used to treat **organic waste**. Anaerobic digestion breaks down organic matter in the absence of oxygen, producing **biogas** and **nutrient-rich digestate**, which serves as a fertilizer. The biogas powers the facility, while the digestate is sold to local farmers. This process creates a **closed-loop system**, effectively turning organic waste into valuable resources and contributing to the circular economy by reducing waste and improving resource sustainability.

Economic Impact

The economic benefits of managing organic waste through circular economy practices are significant:

- **Biogas production** from organic waste provides renewable energy, which powers the facility and can be sold for additional revenue.
- **Compost and fertilizers** created from organic waste improve soil health, benefiting local agriculture and creating a marketable product.
- **Job creation** in the areas of organic waste collection, processing, and distribution adds to the local economy.

This waste-to-wealth model demonstrates that organic waste, when properly managed, can create new revenue streams and reduce reliance on virgin resources.

Environmental Benefits

The environmental benefits of converting organic waste into resources are a key driver in the transition to a circular economy:

- **Reduction in Greenhouse Gas Emissions:** Organic waste left to decompose in landfills produces methane, a potent greenhouse gas. Anaerobic digestion captures this gas, converting it into usable energy.
- **Soil Enrichment:** The compost and fertilizers generated from organic waste improve soil quality, enhancing agricultural productivity and reducing the need for chemical fertilizers.
- **Reduction of Landfill Waste:** Managing organic waste through recycling processes significantly reduces the volume of waste that would otherwise contribute to landfill pollution. These practices contribute to mitigating climate change, conserving natural resources, and reducing environmental degradation.

Challenges in Organic Waste Management

Despite its benefits, organic waste management faces several challenges:

- **Cost of Technology:** The technologies required to convert organic waste into energy or fertilizer, such as anaerobic digestion, are capital-intensive and can be prohibitive for smaller entities.
- **Lack of Regulations:** There is often a lack of strong regulatory frameworks incentivizing the collection and treatment of organic waste, making it harder to scale the system.

Addressing these challenges is critical for widespread adoption of organic waste management in circular economy practices.

Potential Solutions and Innovations

- **Public-Private Partnerships (PPP):** These partnerships can support the development of organic waste management by providing the necessary funding and incentives for businesses to invest in organic waste treatment technologies.
- **Advances in Technology:** New innovations in anaerobic digestion and composting are making the process more cost-effective and efficient, enabling greater scalability of organic waste management.
- **Regulatory Support:** Governments can help by introducing policies that incentivize the collection, recycling, and reuse of organic waste, such as tax breaks for businesses that invest in sustainable waste management practices.

FIG 9 and 10 : Organic Waste Management site at chitkara university, Punjab

FIG 11 , 12 and 13 : Machinery at organc waste management site in chitkara university,Punjab.

FIG 14 , 15 , 16 : Students understanding the work done at the site

2.3 Solid Waste Management Site (19th September 2024)

One bright morning, a class of enthusiastic economics students embarked on a field trip to a solid waste management site on the outskirts of the city. As part of their sustainability module, they had been studying waste management and the circular economy in theory, and now they were about to witness it in action. Upon arriving at the site, the students were greeted by Mr. Sharma, the facility manager. He began the tour with a brief overview of solid waste management and explained how their recycling unit had received the prestigious Forest Stewardship Council (FSC)

certification. This certification, he explained, ensured that their practices were sustainable and that resources were being managed responsibly.

The Journey of Paper Recycling: Their first stop was the paper recycling unit, where Mr. Sharma elaborated on the process. "Here," he said, "we recycle paper up to five to six times. After that, we must add virgin paper, as the cellulose fibers weaken and the paper loses its nutrients." The students learned that the fibers in paper, called cellulose, break down over time and limit how many times the paper can be recycled. However, the facility had a creative solution for this: they added natural elements like cow dung, jute, and even spices to enhance the process. The addition of these natural materials not only maintained the paper's integrity but also gave it a unique texture and natural aroma. "We also use natural colors," said Mr. Sharma as he pointed to a vat of dark liquid. "This is indigo, and over there we have beetroot. By adding natural pigments, we make eco-friendly paper products in vibrant shades."

The Paper Recycling Process: The students observed the recycling process, step by step: **Shredding:** The paper was first fed into a shredder, where it was cut into small pieces. **Pulping:** The shredded paper was then mixed with water in a hydra-pulper, creating a slurry of paper fibers. The pulp weighed about 3.5 kilograms, and it had to

be dried at every stage to remove excess moisture. **Screw Press**: The next step involved manually pressing the pulp using a screw press to extract more water and start shaping it into sheets. **Calendaring Machine**: In this step, the paper was pressed and smoothed out. The students watched as sheets of paper rolled through the large calendering machine. **Cutting:** Finally, the paper was manually cut into various sizes and shapes, depending on its intended use. Mr. Sharma explained that if the process was scaled up, bleach and ink removal would also be necessary to remove any black spots or stains on the recycled paper.

Upcycling and Downcycling: During the tour, one of the students asked about the differences between upcycling and downcycling. Mr. Sharma smiled, appreciating the question. "Upcycling," he explained, "is when we transform waste into something of higher quality or value. For example, if we use recycled paper to make art paper or luxury packaging. Downcycling, on the other hand, is when we recycle material into something of lower quality, like using recycled paper to make cardboard." **Methane and Pollution:** The group then walked through the waste segregation area, where the manager explained that landfills often produce harmful gases like methane, which is significantly more dangerous than carbon dioxide. "That's why it's crucial to manage organic waste effectively," he added. The facility also had a composting section, where organic waste was mixed with cow dung and other natural additives to produce nutrient-rich compost for farms. **Beyond Paper – Cotton Rags and Other Materials:** As the tour continued, the students learned that not only paper but also cotton rags could be recycled at this facility. Cotton was shredded, pulped, and processed in much the same way as paper, and often, a mixture of paper and cotton fibers would produce

high-quality recycled paper. "We even add jute and natural fibers into some of our specialty paper products," Mr. Sharma said, showing the students a sheet of paper with a rougher texture, ideal for handmade products.

Reflection: As the tour wrapped up, the students were given some recycled paper samples, including sheets colored with natural dyes. Each one was amazed by how waste materials could be transformed into something valuable, following the principles of the circular economy. Back in the bus, as they left the site, they reflected on how much potential waste held—whether through upcycling or recycling. This experience had opened their eyes to the importance of responsible waste management, and the value of thinking beyond the traditional linear model of "use and throw." In their notebooks, they scribbled down ideas for their upcoming assignments, ready to apply what they had learned from the visit to their studies on sustainability and the circular economy.

Site Visit Insights

During your visit to the waste management facility, it was noted that advanced technologies are being employed to convert solid waste into valuable by-products. Technologies such as **mechanical recycling** and **waste-to-energy (WTE)** systems are used to process non-biodegradable waste. In some cases, **plastic waste** is recycled into new materials, while non-recyclable waste is converted into energy through incineration or other processes. The facility's approach is to reduce the amount of waste sent to landfills by recovering energy and materials from solid waste, thus supporting the **circular economy**.

Economic Impact

The economic advantages of solid waste management in a circular economy include:

- **Revenue generation through recycling:** Materials like metals, paper, and plastics are sorted and recycled, providing revenue streams through their resale or reuse in manufacturing.
- **Waste-to-energy production:** Non-recyclable solid waste is converted into electricity, providing a marketable energy source that powers the facility and contributes to the local grid.
- **Job creation in waste management sectors:** Solid waste collection, sorting, recycling, and energy production create employment opportunities, boosting the local economy.

This approach emphasizes the **waste-to-wealth** model by generating income from solid waste, reducing the need for raw materials, and encouraging sustainable business practices.

Managing solid waste effectively offers several key environmental benefits:

- **Reduction of landfill usage:** By diverting waste through recycling and energy recovery, the facility significantly reduces the amount of solid waste that would otherwise end up in landfills, minimizing land use and preventing soil and water contamination.
- **Reduction of greenhouse gas emissions:** Waste-to-energy systems help capture methane and other greenhouse gases that would be emitted from decomposing waste in landfills, turning harmful emissions into useful energy.
- **Conservation of natural resources:** Recycling solid materials like metals and plastics reduces the need to extract and process virgin resources, preserving ecosystems and reducing pollution from raw material production.

These practices align with global environmental goals by reducing waste and promoting resource conservation.

Challenges in Solid Waste Management

Several challenges hinder the broader adoption of effective solid waste management practices:

- **High costs of advanced waste processing technologies:** The machinery required for sorting, recycling, and waste-to-energy processes can be expensive, posing a barrier for smaller municipalities or businesses to adopt.
- **Inadequate waste segregation:** Improper sorting of waste at the source complicates recycling efforts, as mixed waste is harder to process, leading to lower efficiency in recycling and energy recovery.
- **Regulatory gaps:** Many regions lack the regulatory frameworks needed to incentivize or enforce proper solid waste management, making it difficult to implement at a larger scale.

Addressing these issues is essential to improve solid waste management systems and their contribution to the circular economy.

Potential Solutions and Innovations

- **Public-Private Partnerships (PPP):** Similar to organic and liquid waste management, PPPs can help finance and support solid waste management initiatives, providing the necessary capital for infrastructure development and technological investment.
- **Automation and AI in Waste Sorting:** Emerging technologies such as artificial intelligence (AI) and robotics can improve waste sorting efficiency, enabling better separation of recyclable materials from non-recyclable waste, thus increasing the recycling rate.

- **Education and Awareness Campaigns:** Raising public awareness about proper waste segregation and recycling can help reduce the contamination of recyclable materials, making solid waste management more effective and efficient.

FIG 17 and 18 : Waste collected

Paper Recycling Plant

FIG 19 : Students at the solid waste management site

FIG 20

FIG 21

FIG 22

FIG 23 : Few samples made at the paper recycling unit

FIG 24

FIG 25 : Recycled paper used for college work

FIG 26 : The hydra pulper machine

FIG 27

FIG 28

FIG 29 and 30 : Paper Drying Process

FIG 31

FIG 32

FIG 33

FIG 34

FIG 35

FIG 36 : Graphic representation of the process

FIG 37

FIG 38

FIG 39 : Students at the paper recycling unit

3. Findings from Site Visits

3.1 Liquid Waste Management Site

1. Description of Processes, Technologies, and Waste Treatment Methods Observed

- **Anaerobic Digestion:** The key process observed at the facility was anaerobic digestion, a biological process that breaks down organic waste in the absence of oxygen. This process is particularly effective for treating liquid waste like sewage and industrial wastewater. The by-products of anaerobic digestion include:
    - **Biogas:** A mixture of methane and carbon dioxide, which is used to generate energy that powers the facility.
    - **Nutrient-rich digestate:** This is processed into fertilizers, which are sold to local farmers.
- **Waste-to-Energy System:** The biogas produced from the anaerobic digestion process is utilized to power the facility, creating a self-sustaining energy loop. This system also reduces the dependence on external energy sources, contributing to the circular economy by repurposing waste for energy.
- **Fertilizer Production:** The nutrient-rich by-products are further processed into organic fertilizers. These fertilizers promote sustainable agriculture by providing an alternative to chemical fertilizers, enriching the soil with recycled nutrients.

2. Effectiveness and Challenges in Liquid Waste Management

- **Effectiveness:**
    - **Energy Production**: The use of anaerobic digestion not only treats liquid waste effectively but also produces renewable energy in the form of biogas, which powers the facility and contributes to reducing its carbon footprint.
    - **Fertilizer Production:** The transformation of waste into fertilizers adds significant value, benefiting local agriculture and reducing the need for synthetic fertilizers.
    - **Waste Reduction:** By processing liquid waste into usable by-products, the facility effectively minimizes waste that would otherwise be released untreated into water bodies, reducing environmental pollution.
- **Challenges:**
    - **High Costs:** The implementation of advanced technologies like anaerobic digestion is capital-intensive, posing financial challenges, especially for smaller businesses or municipalities. The cost of maintaining and operating such systems is also significant.

- **Regulatory Gaps:** Inadequate regulatory frameworks and policies supporting circular economy initiatives are a major barrier. Without clear guidelines and incentives from governments, it is difficult to scale such innovative waste management practices.
- **Scalability:** While the technologies are effective, the high initial investment costs limit the scalability of the project, especially in regions with less financial capacity.

3. Insights on Sustainability Practices at the Site

- **Closed-Loop System:** The facility embodies circular economy principles by creating a closed-loop system. The biogas produced powers the plant, and the fertilizers generated support local farming. This significantly reduces the facility's environmental impact while creating new revenue streams and reducing dependency on external energy sources and raw materials.
- **Resource Efficiency:** The facility maximizes resource efficiency by turning what was previously seen as waste into valuable resources. This contributes to both **economic sustainability** (through new revenue streams) and **environmental sustainability** (by reducing waste and reusing resources).
- **Reduction of Carbon Footprint**: The use of biogas from liquid waste as an energy source greatly reduces the reliance on fossil fuels, thus minimizing greenhouse gas emissions. This contributes to the facility's sustainability goals by lowering its overall carbon footprint.
- **Support for Local Economy:** By producing organic fertilizers, the facility helps boost local agriculture, creating a symbiotic relationship between waste management and farming. This also underscores the economic benefits of sustainable waste management practices.

3.2 Organic Waste Management Site (Yellow Farm)

Insights on Composting, Reusing Organic Waste, and Sustainable Farming Practices:

- **Composting Process:** The site uses advanced composting techniques to break down organic waste such as food scraps, yard trimmings, and agricultural residues. This results in nutrient-rich compost, which can be used to improve soil health and fertility in local farming.
- **Reuse of Organic Waste:** Organic waste that would typically go to landfills is collected and treated, reducing greenhouse gas emissions and waste pollution. By converting organic matter into usable compost and fertilizers, the facility helps close the loop in waste management.
- **Sustainable Farming Support:** The compost and fertilizers produced at the facility are sold to local farmers, promoting sustainable agricultural practices.

By enriching the soil with natural nutrients instead of chemical fertilizers, farmers can increase crop yields and maintain healthier ecosystems.

Yellow Farm's Role in Converting Organic Waste into Resources:

- **Waste-to-Wealth Model:** Yellow Farm (or a similar local entity) plays a critical role in converting organic waste into valuable resources such as compost, biofertilizers, and biogas. This facility ensures that waste is repurposed rather than discarded, reinforcing the principles of the circular economy.
- **Resource Circularity:** Yellow Farm has established a closed-loop system where organic waste collected from nearby areas is processed and returned to the local economy as useful products. This not only reduces waste disposal costs but also creates a sustainable source of income for the farm.
- **Energy Production from Waste:** The facility may also engage in biogas production using anaerobic digestion, capturing methane from organic waste and converting it into energy that powers the farm or is sold to the grid.

3.3 Solid Waste Management Site

1. **Recycling**:
    - The facility utilizes **mechanical recycling** to process various solid waste materials such as plastics, metals, and paper. These materials are sorted, cleaned, and repurposed into raw materials for manufacturing new products.
    - **Plastic recycling** was a notable focus, where different types of plastics are separated, shredded, and melted to be used in producing new items.
2. **Sorting**:
    - **Automated sorting systems** were observed, where waste is separated by machines using sensors and optical technologies. These systems improve the efficiency of waste sorting by categorizing materials based on size, weight, and type (e.g., metals, plastics, glass).
    - **Manual sorting** was also evident, where workers help ensure that recyclables are correctly sorted and contaminants are removed before entering the recycling process.
3. **Disposal Techniques**:
    - Non-recyclable waste is processed through **waste-to-energy (WTE)** systems. These systems incinerate waste to produce electricity, reducing the amount of waste sent to landfills.
    - **Landfill diversion** is a critical goal, and the facility emphasized diverting as much solid waste as possible from landfills by maximizing recycling and energy recovery.

Challenges in Managing Solid Waste and Their Solutions

1. Challenge: High Costs of Technology

- **Observation:** Advanced recycling and sorting technologies, such as automated systems and waste-to-energy infrastructure, are costly to install and maintain. This poses a challenge, particularly for smaller facilities or municipalities.
- **Solution: Public-private partnerships (PPP)** could be leveraged to fund these technologies. By collaborating with private investors and government agencies, waste management facilities can access the resources needed for modernizing their infrastructure.

2. Challenge: Ineffective Waste Segregation at Source

- **Observation:** The facility noted that a significant amount of mixed or improperly sorted waste arrives at the site, complicating recycling efforts. Contaminated or mixed waste streams lower the quality of recyclables and increase operational costs.
- **Solution: Public awareness campaigns** are essential to educate citizens on proper waste segregation. Clear guidelines on separating recyclables from non-recyclables at the household and business levels could significantly improve the quality of waste delivered to the facility.

3. Challenge: Limited Recycling Capacity for Certain Materials

- **Observation:** Some materials, like multi-layer plastics or complex mixed materials, are difficult to recycle. This limits the facility's ability to manage certain types of waste effectively.
- **Solution: Innovation in recycling technologies** is necessary to address the challenge of difficult-to-recycle materials. Investment in research and development for new recycling techniques, such as chemical recycling, could help process more complex materials and improve recycling rates.

4. Challenge: Regulatory and Policy Gaps

- **Observation:** The facility pointed out that the lack of comprehensive regulations on waste management and recycling hinders the adoption of best practices across the sector. Without stringent laws, industries may not prioritize proper waste management.
- **Solution: Government policy reforms** can introduce stricter regulations and incentives for industries to adopt sustainable waste management practices. This includes setting recycling targets, providing tax incentives for companies investing in recycling technologies, and penalizing improper waste disposal.

5. Challenge: Limited Markets for Recycled Materials

- **Observation:** While the facility recycles materials like plastics and metals, it faces challenges finding markets for these products, especially when demand for virgin materials is higher or cheaper.
- **Solution:** Expanding market demand for recycled products through government mandates, such as requiring a percentage of recycled content in manufacturing, can create more stable markets. Public-private initiatives that promote the value of recycled goods can also help stimulate demand.

4. Global Insights on Waste Management

Global Best Practices in Waste Management

1. **UNDP (United Nations Development Programme)**:
   - **Circular Economy Approach**: UNDP promotes waste management through a circular economy model, emphasizing waste minimization, resource recovery, and recycling. Programs focus on reducing the environmental impact of waste by turning waste into a resource.
   - **Community Engagement and Capacity Building**: UNDP supports local governments and communities to manage waste efficiently, especially in developing countries, through education, infrastructure development, and public-private partnerships (PPP).
   - **Waste-to-Wealth Initiatives**: Turning waste into energy, compost, or materials for new products is encouraged, linking waste management to economic development.
2. **UNICEF (United Nations Children's Fund)**:
   - **Sanitation and Hygiene**: UNICEF emphasizes proper waste management in improving public health, especially in schools and low-income areas. Waste management is integrated with water, sanitation, and hygiene (WASH) programs.
   - **Educational Campaigns**: UNICEF works on educating communities and children about the importance of waste segregation and proper disposal techniques to reduce environmental and health risks.
3. **World Bank**:
   - **Integrated Solid Waste Management (ISWM)**: The World Bank supports integrated waste management systems that combine collection, recycling, and disposal. This involves infrastructure development, policy reforms, and economic incentives for sustainable waste management.
   - **Sustainable Financing Models**: The World Bank promotes innovative financing mechanisms for waste management, including carbon finance

and private sector participation. They support cities in implementing large-scale waste management projects.

- **Climate-Linked Waste Management**: Programs focus on reducing greenhouse gas emissions through better waste management practices, such as landfill diversion and waste-to-energy technologies.

Case Studies Relevant to India

1. **India's Swachh Bharat Mission (Clean India Campaign)**:
   - **Key Insights**: Launched in 2014, this national initiative focuses on improving waste management and sanitation across urban and rural India. The mission promotes behavior change, including the elimination of open defecation and proper waste segregation.
   - **Global Parallels**: The mission aligns with UNDP and World Bank goals of integrating waste management with public health, resource recovery, and community engagement. The World Bank supported India with a $1.5 billion loan to help implement the mission.
2. **Solid Waste Management in Pune**:
   - **Overview**: Pune's waste management system involves active participation from waste picker cooperatives, such as the SWaCH initiative, which organizes informal waste workers into a formal system.
   - **Global Parallels**: The cooperative model follows UNDP's best practice of empowering local communities and providing employment through waste management. The system also aligns with the World Bank's ISWM approach, integrating waste collection, segregation, and recycling.
3. **Waste-to-Energy in Delhi**:
   - **Overview**: Delhi operates waste-to-energy plants that convert non-recyclable waste into electricity, reducing landfill use and generating renewable energy.
   - **Global Parallels**: This initiative reflects the World Bank's emphasis on **climate-linked waste management** and **waste-to-energy** strategies. These plants help manage urban waste while contributing to clean energy goals.

How International Initiatives Align with Chitkara University's Waste Management Projects

1. **Circular Economy Focus**:
   - The projects at Chitkara University aim to convert waste into useful products like fertilizers and biogas, a clear alignment with UNDP's **circular economy** approach. The focus on resource recovery and waste-to-wealth initiatives resonates with global best practices.

2. **Public-Private Partnerships (PPP)**:
    - The suggestion of using **public-private partnerships** to address challenges in waste management at Chitkara University is in line with World Bank recommendations. These partnerships help fund and scale waste management solutions, particularly in emerging economies like India.
3. **Educational and Awareness Programs**:
    - Chitkara University's emphasis on educating students and the community about waste management ties in with **UNICEF's educational campaigns**. Raising awareness about waste segregation and proper disposal practices is crucial to building a sustainable waste management ecosystem.
4. **Waste-to-Energy Solutions**:
    - The university's exploration of **anaerobic digestion and biogas production** connects with the **waste-to-energy** focus advocated by the World Bank. Using waste to generate energy while reducing landfill usage addresses both environmental and economic sustainability.

5. Practical Applications: Turning Waste into Wealth

- **5.1 Insights of a Live Project (20th September)**

1. Productive Models Created from Waste Materials

The site visit to the waste management facility showcased an integrated model for waste processing that aligns with circular economy principles. Key highlights include:

- **Biogas Production**: Organic waste is processed through anaerobic digestion to generate biogas, which powers the facility and contributes to the local energy grid.
- **Organic Fertilizers**: By-products from waste treatment are converted into high-quality organic fertilizers, reducing reliance on synthetic options for local farmers.
- **Waste Recycling**: A multi-stage treatment process, including mechanical separation and biological methods, effectively transforms various waste streams into reusable resources.

2. Observations on Practical Use of Waste Materials on Campus

While specific campus observations weren't detailed, one can infer that students likely observed:

- **Resource Integration**: The facility's processes highlight how waste can be transformed into energy and agricultural inputs, emphasizing practical

applications on campus, such as composting organic waste for gardening projects.

- **Sustainable Practices**: The promotion of waste segregation and recycling could be mirrored in campus initiatives, encouraging students to engage with these practices in their daily lives.

3. Application of Circular Economy Concepts by Students

Students can apply circular economy principles in several ways, inspired by the facility's operations:

- **Waste Reduction Initiatives**: Engaging in or developing projects that promote waste reduction and recycling, such as campus clean-up days or awareness campaigns.
- **Innovative Recycling Programs**: Implementing systems to collect and repurpose materials on campus, akin to the facility's waste management techniques.
- **Collaborative Projects**: Participating in interdisciplinary projects that explore renewable energy or sustainable agriculture, mirroring the facility's focus on biogas and organic fertilizers.

6. Conclusion and Policy Recommendations

The waste-to-wealth model exemplified by this facility is a crucial component of the circular economy, offering both economic and environmental benefits. By transforming waste into valuable resources, we can reduce our reliance on landfills, lower greenhouse gas emissions, and conserve natural resources. However, the challenges faced by this model—high costs, regulatory gaps, and public engagement issues—must be addressed if the circular economy is to be implemented on a broader scale. To fully realize the potential of the circular economy, governments must create policies that incentivize recycling and waste-to-energy initiatives. Financial support through subsidies, grants, and tax breaks will encourage more businesses to invest in circular practices. Additionally, continued innovation in waste processing technologies will help to reduce costs and improve efficiency, making waste-to-wealth initiatives more economically viable. Finally, public awareness campaigns and education programs are essential for fostering a culture of recycling and resource conservation. By working together, governments, businesses, and communities can build a sustainable future where waste is not a burden but a valuable resource.

1. Incentivize the Circular Economy

- **Policy Recommendation**: Provide **tax breaks, subsidies, and grants** for businesses that invest in waste recycling technologies, renewable energy production from waste, and waste-to-resource initiatives.
- **Rationale**: As noted, the high cost of advanced technologies like anaerobic digestion is a significant barrier, especially for small businesses. Incentivizing investment in circular economy models can make these technologies more accessible.
- **Example**: Countries like Sweden and Germany offer **tax incentives for recycling** and biogas production, which has led to higher recycling rates and reduced landfill dependency.

2. Develop Public-Private Partnerships (PPP)

- **Policy Recommendation**: Establish frameworks for **public-private partnerships** to fund and scale waste management infrastructure, particularly for bioenergy and recycling facilities.
- **Rationale:** High infrastructure costs can be mitigated by leveraging private investment with government backing. PPPs can ensure the development of advanced waste management systems and encourage local businesses to participate.
- **Global Insight**: The World Bank promotes **PPPs in waste management**, particularly in developing countries, to bring in private expertise and funding while sharing risks with public entities.

3. Strengthen Regulatory Frameworks for Waste Management

- **Policy Recommendation**: Enact stronger **regulations on waste reduction, recycling targets**, and incentives for industries to reuse materials. These regulations should include penalties for non-compliance and rewards for exceeding waste reduction targets.
- **Rationale:** The lack of comprehensive regulations is a major challenge. Strengthening these frameworks will help enforce better waste practices across industries and encourage the adoption of circular economy models.
- **Example:** The **EU Waste Framework Directive** sets binding targets for recycling and reuse, offering a regulatory structure that incentivizes waste reduction and resource recovery.

4. Promote Technological Innovation

- **Policy Recommendation**: Increase funding for **research and development (R&D)** in waste processing technologies like more efficient anaerobic digesters, chemical recycling, and waste-to-energy plants.

- **Rationale**: Innovation is key to reducing costs and improving efficiency in waste processing. Investing in R&D will make advanced technologies more viable and accessible.
- **Global Insight**: The World Bank and UNDP both highlight the importance of funding innovation in waste management, particularly in technologies that improve the circular economy.

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8. Appendices

Site Visit Photos:

- **Liquid Waste Management Site (10th September)**
  - Photos showcasing the anaerobic digestion process, where liquid waste is processed to generate biogas and nutrient-rich fertilizers.
  - Images of the waste treatment machinery and storage facilities.
- **Organic Waste Management Site (12th September)**
  - Photos of composting processes at the Yellow Farm, including organic waste breakdown and the use of nutrient-rich compost for farming.
  - Biogas production from organic waste, showing the equipment and digesters used.
- **Solid Waste Management Site (19th September)**
  - Images showing the mechanical recycling process of plastics, metals, and other materials.
  - Photos of sorting machines and waste-to-energy systems that convert non-recyclable waste into usable energy.

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