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RESEARCH CENTRE FOR WASTE TO WEALTH MANAGEMENT

CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT

ODISHA, INDIA

(2020-23)

Version 1/2023

Message from the RC Coordinator

Comprehensive waste management means a coherent system of measures concerning the reduction of waste generation, sustainable waste disposal, effective reclamation, and recycling strategies to refrain from waste generation, thus aiming at the most efficient way of waste management, economic reduction of the costs involved in waste handling and prediction of the nuisances and after-effects of waste accumulation.

One of the worth citing example and interesting disclosure is that during the Swachhata campaign held in October last year to commemorate the Gandhi Jayanti, the cleaning of Government of India offices in New Delhi and subsequent disposal of electronic scrap from discarded mobile phones, computers, etc. had generated revenue of over Rs.62 crores when it was taken to the market.

There is a need to create awareness about several waste products which can generate income without much effort and in this regard, it is referred to the use of cooked oil from the kitchen which could be sold off at the rate of around Rs.20 per litre to the industry which had the technology to convert it into alternative fuel. Similarly, Fly Ash produced through the combustion of coal which could be utilized for making bricks for construction, etc. All these were new resources of livelihood, simply through optimum utilization of waste products.

All stakeholders should ensure that the necessity to protect the natural environment is duly taken into account at every stage of the construction/purchase - consumption/usage - disposal/scrapping chain in the campus, including the operations carefully designed based on waste hierarchy and reinstatement of the campus ecosystem, especially from the toxic and hazardous waste.

Dr. Narayan Gouda

Coordinator of Research Centre

for Waste to Wealth Management

CONTENTS

MEMBERS OF RESEARCH CENTRE

Dr. Narayan Gouda
(Co-ordinator)

Dr. Sangram K. Swain

Dr. Pratap Chhotaray

Dr. Jyoti Prakash Giri

Dr. Limbraj Pholane

Dr. Vijay Miditana

Mr. Rakesh Behera

Mr. Bikash Samantray

Ms. Somalika Pradhan

Mr. Kulabhusan Pradhan

Dr. C. N. Kowthaman

Mr. Krushna Ch. Sethi

Mr. I. S. Ramakoti

Dr. Abanikanta Bhadra

Ms. Subhashree

Chapter – 1

Waste to Wealth Research Centre

1.1. Introduction

India currently generates 62 million tons of waste every year. Owing to the lack of adequate waste management, the country is facing excessive environmental pollution which in turn affects public health. The quantity of materials discarded can be reduced if they are used more efficiently. Sustainable waste management is the need of the hour.

Centurion University of Technology and Management being a skilled University strives to practice the Swachhata mantra through each of its endeavours. It realizes the essentials of sustainable and holistic waste management in reducing its environmental footprint and providing a safe and healthy work environment for the staff, students, and visitors.
Centurion University believes that nothing is priceless and valueless. Everything including the waste generated from different uses can be converted to wealth. For effective and sustainable waste management, the Research Centre for Waste-to-Wealth Management is established at Centurion University of Technology and Management in the year 2020.

1.2. Mission and Vision of the Research Centre

1.2.1. Our Mission:

The Centre for Waste to Wealth at the CUTM works in line with SDGs 3,6,7,9,11,12,13, 14, 15, and 17. The mission is spearheaded by the RC coordinator along with a team of 14 members who work in different categories of waste management. The goal of the mission is to identify, create, and implement technologies for the treatment of waste in order to produce energy, recycle materials, and extract valuable resources. Additionally, the mission will look for and support the advancement of contemporary technologies that promise to produce a clean, green environment. By utilizing science, technology, and innovation to develop circular economic models that are commercially feasible for waste management to expedite garbage handling.

1.2.2. Our Vision:

The Vision of the centre is to find new technologies that can contribute to a cleaner, greener environment and assist their development. The centre focuses on the following areas that involve

- Packaging Solution using Agriculture Residue
- Parameter Optimization in Sewage Treatment Process
- Products using Plastic Waste
- Fabric using Biowaste
- Innovation in the handmade paper-making process
- Innovative utilities from Paper Waste
- Segregation and Processing of E-Waste

- Creating awareness in the community regarding different waste management
- Making the campus a zero-waste campus.

And to streamline waste handling across the university campuses and also partner with the local civic bodies in sharing the knowledge and expertise to boost and augment waste management by leveraging science, technology, and innovation.

1.3. About The Research Centre

The Research Centre for Waste to Wealth Management comprises a team of faculty and research scholar from different disciplines such as Chemistry, Mechanical Engineering, Chemical Engineering, Civil Engineering, Computer Science, Environmental Science, and Agricultural Science. Waste management is aligned with the **5 Rs** – ***Rethink, Refuse, Reduce, Reuse, and Recycle*** and the Research Centre for Waste-to-Wealth Management explores innovative waste management solutions to treat waste towards producing useful recycled materials, generate energy and create valuable resources. To achieve the same, under this centre, the following different sub-units are in operation to convert waste into wealth.

- **Paper and Cloth waste management:** Innovative ways to make handmade papers and different products out of waste paper and cloths.
- **Liquid waste management:** To manage the liquid waste and look after the operation & maintenance of Sewage Treatment Plants (STPs).
- **Kitchen waste management:** To manage the kitchen waste, particularly food waste, and look after the operation & maintenance of Bio-composter.
- **Plastic waste management:** Utilization of plastic waste to produce construction material.
- **Agri-waste management:** Deals with eco-friendly products from agri-wastes.
- **Electronics waste management:** Collection, segregation & sending of the e-waste for recycling.

Apart from the above initiatives, the University is also striving to strengthen its waste management facilities by signing MoUs with relevant organizations and employing cutting-edge technologies.

1.4. Expected Outcomes

- Wastes can be reduced, recycled, and reused.
- Following Sustainable Development Goals (SDGs) can be achieved
  SDG 3: Good health and Well Being,
  SDG 6: Clean Water and Sanitation,
  SDG 7: Affordable and Clean Energy,
  SDG 9: Industry, Innovation, and Infrastructure,
  SDG 11: Sustainable Cities and Community,
  SDG 12: Responsible Consumption and Production,
  SDG 13: Climate Action,
  SDG 14: Life Below Water,

SDG 15: Life on Land,
SDG 17: Partnership for the Goal.

- Creates and sustains Green Economy avenues.
- The mission of Swach Bharat Swasth Bharat can be accomplished.
- The Goals of the National Smart Cities Mission can be achieved.
- Soil, water, and air pollution are prevented by utilizing waste materials.
- New skills are developed for shaping lives and empowering communities.

Chapter -2

Waste to Wealth Units and their Activities

2.1. Introduction

The Research centre for Waste to Wealth Management is involved in the production of Paper Bags, Diaries, Files, Note pads, and Pen (Likhan) from Waste Papers and clothes; Ceramic Craft Items, Pottery and Chalks from clays; and Paver Blocks (concrete) using waste Plastics. Some research activities are also going on such as making eco-friendly plates and bowels from straw wastes; heavy metals removal from treated sewage water by phytoremediation method; making Paver blocks, bricks, and wall panels from plastic wastes; bricks from waste rubber tires; Transparent Packaging Material and Liquid fuel from waste plastics; Fluorescent Carbon Nanomaterials from bio waste, and Biogas from organic wastes.
Apart from this, the centre is also involved in paper Publications, Patents/Copyrights, Research projects, Consultancy, Start-ups, Collaboration/Partnership with different Organizations and Institutes, organizing Webinars/Conferences/Seminars/Workshops, offering of Skill courses, Lab development, Student Internships, Student club activities, awareness campaigns and competitions in the waste management domain.

2.2. Hand Made Paper Unit

The handmade paper unit at CUTM, Bhubaneswar campus, Odisha is a solution to solve all environmental problems raised due to cloth and paper wastes generated inside the University campus.
The waste paper and cloth are produced inside the campus from various sources at both academic and hostel zones. These wastes have been reused to produce the value-added desirable products. The paper and cloth waste are made pulp at our facility and then hand papers are made. Hand paper sheets are modified to make several beautiful products.
A handmade paper that

- does not utilize wood for its manufacturing
- is free from all chemicals
- is dried using the most eco-friendly means of energy
- is a bio-degradable product.
- is excellent for writing
- has greater tensile, bursting, tearing, and double-fold strength compared to conventional papers.
- is recyclable
- is available at an affordable cost

Uses of Hand-Made Paper:

The handmade papers are used for office stationery, writing pads, conference folders, computer printouts, drawing and documentation sheets, certificate and degree awards, for making fancy products and diaries, for making photo frames, paper bags, and a variety of other decorative and showcase products.

Raw Materials Used for Hand-Made Paper:

A wide range of raw materials such as paddy and wheat straw, jute, rags, cotton rags, hosiery cuttings cotton linter, tailor cuttings, fibers (Jute /hump), bagasse, cotton stalks, grasses, waste paper, etc., are used in making handmade paper. They are available abundantly and regularly from different sources. The proposed unit makes permanent arrangements for procuring raw materials in bulk from various suppliers.

Manufacturing unit requirements:

- Water
- Power
- Building shed
- Drying shed
- Labour /workforce
- Chemicals

Equipment / Machines used for handmade paper making:

- Rag Chopper
- Beaters
- Pulp Tanks
- Calendar machine
- Agitator
- Hydraulic press
- Cylinder mould
- Vat power drives machine
- Iron box etc. are major tools and equipment used

Handmade Paper Manufacturing Process:

Various standard equipment are available for handmade paper production. The important among them are:

(a) Rag chopper- It is used for cutting the rag into fine pieces suitable for beating in a beater machine. Beater Machine-The pulp from the pulper machine is sent to the beater machine for the formation of fine pulp which plays an important role in the formation of a board of good quality. Auto Vat - used for the forming of paper sheets in the traditional Indian manner. A measured quantity of diluted pulp is spread evenly onto a wire mould, which is clamped in between two wooden deckles in a water tub. The excess water in the pulp is drained mechanically by manual operation.

(b) Hydraulic press -- presses the post of newly formed sheets to remove excess water
(c) Calendaring machine-- It's a series of hard pressure rollers used to form or smoothen a sheet
(d) Cutting machine-- Is used for waste cutting
(e) Weighing balance-- For weighing or measuring the weight of raw materials as well as other required items.

Manufacturing Process: The process of making handmade paper involves a series of steps that are briefly discussed below. Sorting and dusting: the raw material that is to be used is manually sorted and foreign materials like buttons; plastic, synthetic fibers, etc. are removed. To remove dust and dirt the material is shaken vigorously.

Rag Chopping: The sorted and dusted material is chopped into pieces of equal size.

Beating: The raw material is mixed with water and harmless chemicals and beaten in a Hollander beater. This consists of a U-shaped trough, with a drum; on the outer side of this drum are iron blades that cut the raw material to make a pulp out of it. There is a washing drum as well that cleans the pulp and drains the dirty water. The quality of the paper to be made determines the consistency of the pulp. Sheets of handmade paper can be made in two ways.

Dipping Method: This method is normally used for fine or thin paper. The pulp is diluted with water and put into a masonry trough or vat. The lifting mould (a mesh on a wooden frame) is dipped into the trough, shaken evenly, and lifted out with the pulp on it. The consistency of the pulp in the tank should be kept constant all the time.

Lifting Method: This method is used for all paper and especially for card paper. A fixed quantity of pulp is poured evenly onto a mould, which is then clamped between two wooden deckles (frames) and then dipped into a water tank. The mould is then lifted using a lever mechanism that allows the excess water to drain away.

Couching: Once the sheet is formed, the wet paper is transferred onto a cloth like muslin or felt sheet, and a stack of interleaved sheets is made.

Pressing: A hydraulic press is used to remove the excess water from the sheets. Pressing reduces the thickness of the paper and the sheets become more compact. This process improves the physical properties of the paper and helps in drying.

Drying: Even after the sheets have been pressed, they still contain about 50% to 65% of the moisture. The sheets are hung in the sunlight to dry. Solar dries can speed up the process and the space required for drying. Coloured papers are dried in the shade to prevent the sun from bleaching the color.

Cleaning and Sizing: Small particles of dirt and other foreign matter are removed manually with a sharp instrument. The cleaned sheets are coated with a layer of starch to improve the quality of the paper and prevent feathering. This process is called sizing. This can be done manually using a brush or by dipping the sheet into a vat containing sizing chemicals.

Calendaring: The sheets are then placed between metallic plates and passed through spring-loaded rollers in a calendaring machine. This makes the paper smooth and increases the gloss of the paper.

Cutting: The sheets are cut neatly according to the required size using a cutting machine.

Some of the products made from Waste Papers and clothes:

2.3. Paper Pen Making Unit

CUTM, Bhubaneswar campus has a paper pen manufacturing unit where eco-friendly and crafted pens are made from waste paper. The pen thus produced is available under the brand name as “LIKHAN”.

Materials requirement for paper pen making:

- Refill
- Waste newspapers/papers
- Glue
- Punching machine
- Eyelet

Procedure of the Paper pen making:

- Collecting some wastes newspaper or normal papers and new refills
- After that take a piece of newspaper or any paper of 54.5 cm x 13.8 cm dimension for a 14.4 cm refill.
- Fold the paper into half and put the refill in that fold by adding some glue and leave it for 1 – 2 min.
- Now roll the paper along with the refill by adding some glue on its inner surface and after that pen is ready.
- For a better look, we add some fabric colour on its back side.
- Now make the pen cap of size 7.5 cm by same paper rolling process.

- Close one end of that roll with some glue. And ribbit an eyelet at that end for good looks. Now the pens are ready to use.

2.4. Ceramic and Terracotta Products Unit

Centurion University of Technology and Management, Odisha has a ceramic and pottery unit at the Bhubaneswar campus where various ceramic and pottery items are produced. This unit is also a centre of attraction for most of our visitors, students, and faculties for its beautiful and attractive products.

Uses of Ceramic and Pottery Items:

The products that are produced in our University unit are commonly useful ones, such as vessels for holding liquids or plates or bowls from which food can be served. These are also used as gift items for our visitors, guests, and others.

Raw Materials Used for Ceramic and Pottery Unit:

The raw materials used in the manufacture of ceramics range from relatively impure clay materials mined from natural deposits to ultrahigh purity powders prepared by chemical synthesis. Naturally occurring raw materials used to manufacture ceramics include silica, sand, quartz, flint, silicates, and aluminosilicates.

Manufacturing unit requirements:

1. Clay
2. Hand tools
3. Carving and decorating tools
4. Glaze and colorants
5. Potter’s wheel
6. Worktable
7. Shelves/racks for storage and display of your clay wares
8. Kiln
9. Pugmill
10. Business card
11. Product Catalog

Manufacturing Process:

The basic steps include purifying, mixing, forming, green machining, drying, presinter thermal processing, glazing, firing, final processing, and packaging.

Several procedures are used to purify the ceramic material. Water-soluble impurities can be removed by washing with deionized or distilled water and filtering, and organic solvents may be used for removing water-insoluble impurities. Acid leaching sometimes is employed to

remove metal contaminants. Magnetic separation is used to extract magnetic impurities from either dry powders or wet slurries. Froth flotation also is used to separate undesirable materials.

Sizing and classification separate the material into size ranges. Sizing is most often accomplished using fixed or vibrating screens.

The purpose of mixing or blunging is to combine the constituents of a ceramic powder to produce a more chemically and physically homogenous material for forming. Pug mills often are used for mixing ceramic materials. Several processing aids may be added to the ceramic mix during the mixing stage. Binders and plasticizers are used in dry powder and plastic forming; in slurry processing, deflocculants, surfactants, and antifoaming agents are added to improve processing.

In the forming step, dry powders, plastic bodies, pastes, or slurries are consolidated and molded to produce a cohesive body of the desired shape and size. Dry forming consists of the simultaneous compacting and shaping of dry ceramic powders in a rigid die or flexible mold.

After forming, the ceramic shape often is machined to eliminate rough surfaces and seams or to modify the shape. The methods used to machine green ceramics include surface grinding to smooth surfaces, blanking and punching to cut the shape and create holes or cavities, and laminating for multilayer ceramics.

After forming, ceramics must be dried. Drying must be carefully controlled to strike a balance between minimizing drying time and avoiding differential shrinkage, warping, and distortion. The most commonly used method of drying ceramics is by convection, in which heated air is circulated around the ceramics. Air drying often is performed in tunnel kilns, which typically uses heat recovered from the cooling zone of the kiln. Periodic kilns or dryers operating in batch mode also are used. Convection drying also is carried out in divided tunnel dryers, which include separate sections with independent temperature and humidity controls. An alternative to air drying is radiation drying in which microwave or infrared radiation is used to enhance drying.

Prior to firing, ceramics often are heat-treated at temperatures well below firing temperatures. The purpose of this thermal processing is to provide additional drying, vaporize or decompose organic additives and other impurities, and remove residual, crystalline, and chemically bound water.

For traditional ceramics, glaze coatings often are applied to dried or bisque-fired ceramic ware before sintering. Glazes consist primarily of oxides and can be classified as raw glazes or frit glazes. In raw glazes, the oxides are in the form of minerals or compounds that melt readily and act as solvents for the other ingredients.

Firing is the process by which ceramics are thermally consolidated into a dense, cohesive body comprised of fine, uniform grains.

2.5. Dustless chalk-making Unit

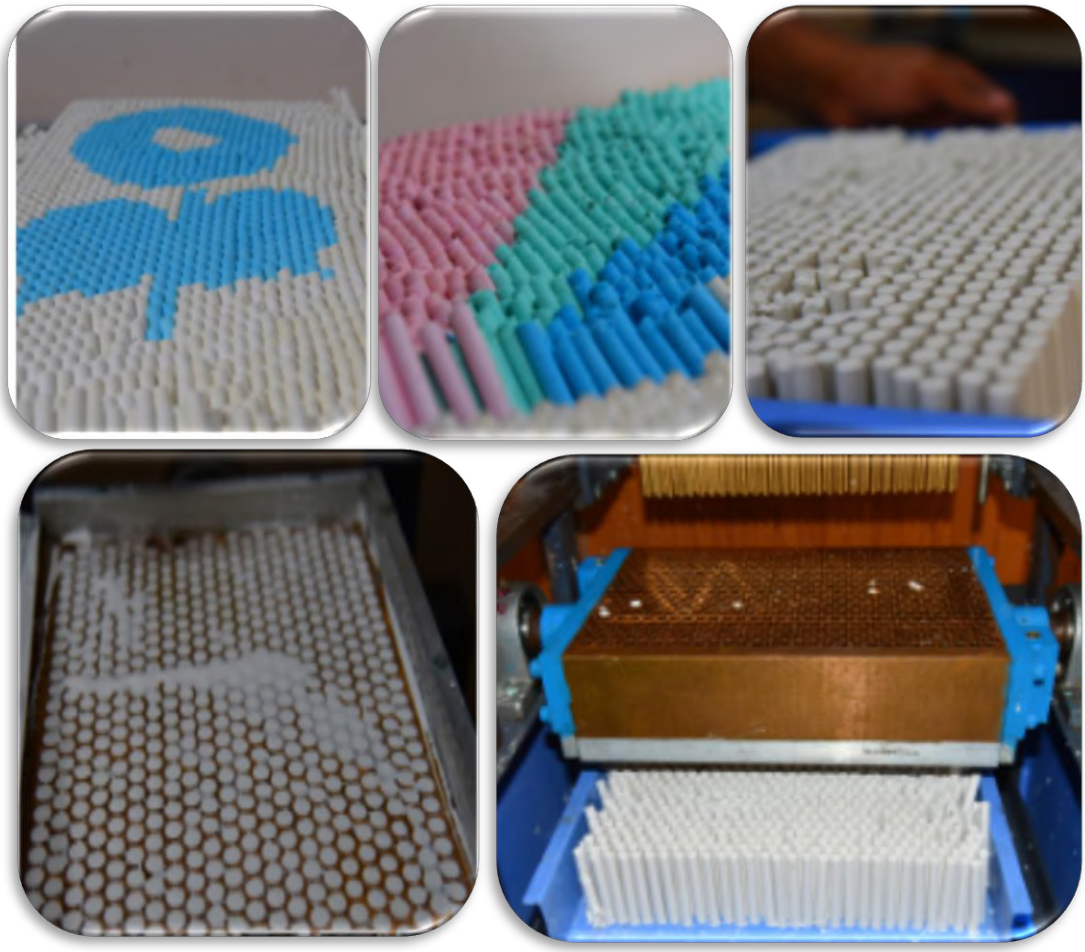
In our University at Bhubaneswar Campus, Odisha we are having a dustless chalk production unit. The unit is providing the chalks that are required by our University for different campuses. The moist dustless chalks have the advantages of moisture maintenance, no flying dust during writing and wiping, no change of fuzziness, fluent writing, no slippage, clear writing, and no hand sticking, and materials in use have no problems of toxicity, harm and the treatment of wastewater and waste liquid.

Materials requirement for making Dustless Chalk:

1. Water
2. Dustless Chalk Powder
3. Badam/Nut oil
4. Diesel

Dustless Chalk Manufacturing Process:

- First, we take 3 liters of water and 2.5 kg of dustless chalk powder.
- Then we mix the powder and water for 1 minute.
- Take a mixture of 30% badam oil and 70% diesel and brush the holes of the chalk mold until fully greased.
- Then pour the dustless chalk mixture into the holes of the machine.
- We wait for the chalks to dry for 1 minute and take out the chalk by the chalk ejecting mechanism of the machine.



2.6. Paver and Pavement Blocks Unit

CUTM, Bhubaneswar campus is manufacturing the paving blocks using cement, aggregates, sands, and waste plastics. Cement bags are collected from local suppliers. Aggregates supplied by local crusher and sand are obtained from the local river bed. The waste plastics (HDPE) are collected from campus food stalls as well as from nearby villages. After collection, plastics are dried under the sun for a few days and then shredded into small pieces.

Pavement Blocks Manufacturing Process:

The Pavement blocks are prepared at the CUTM campus in various shapes such as dumbbell, square, zigzag, hexagonal, and kerb stone whereas the dumbbell and square shape blocks are having a thickness of 60mm and zigzag and hexagonal 80mm. For this M30 grade of concrete is used with cement 15%, coarse aggregate at 55%, fine aggregate (sand) at 29%, and shredded waste plastic at 1%. For manufacturing this block, first, all the ingredients are fed to the concrete mixture in dry condition and mixed it properly. After that, the required amount of water is added to the dry mix in the concrete mixture, and run the mixture for a few minutes to confirm the homogeneous mix of the entire fraction of materials later remove from it.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Jatni, Odisha, India
Centurion faculty building, Jatni Rd, Jatni, Odisha 752050, India
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2.7. Eco Craft Unit

Eco-craft innovatively manufacturers and supplies recycled, recyclable stationery and craft products, and various greener packaging needs. eco-craft manufactures an impressive array of paper-based craft products with a strong sense of sustainability. With a firm environmental policy and numerous products made from recycled materials, they've managed to span the paper-based product market whilst minimizing their carbon footprint.

2.8. Bio-Composter

Food wastes generated inside the campus including canteens and staff quarters are converted into bio-compost through biological decomposition in KWIK Bio-Composter.

Components of KWIK Bio-Composter:
Composting Chamber: where the kitchen waste and other organic wastes are mixed and biologically decomposed.
Inlet Hopper: used to feed the raw organic wastes.
Control Panel: which controls the machine operations.
Leachate Trays: To collect excess water
Rollers
Power Transmission Unit

Working Principle:

KWIK COMPOSTER is a fully automatic Bio-Mechanical Composter and a continuous organic waste converter. It offers a greener and cleaner alternative to the problem of organic waste disposal. It works on sustainable micro-organism-based technology. KWIK Composter converts the organic waste added to the machine into nitrogen-rich compost by reducing its volume by almost 60%-70% of the original. Organic waste includes kitchen waste or anything that comes from plants or animals and is bio-degradable.

Approximately 7 quintals of kitchen waste are generated per day in the Bhubaneswar campus. All the waste is converted to 170 kg of manure and is used in the garden. Two composters/digesters are used to convert kitchen waste to manure. One digester's capacity is 5 quintals and the other one's capacity is 2 quintals. The bio-compost thus produced is used for gardening, nursery, and mango orchards inside the campus.

Around 2 quintals of food waste are generated daily in Paralakhemundi campus. Total food waste is collected in the drums provided in each mess, canteen, Restaurant, and Dhabas inside

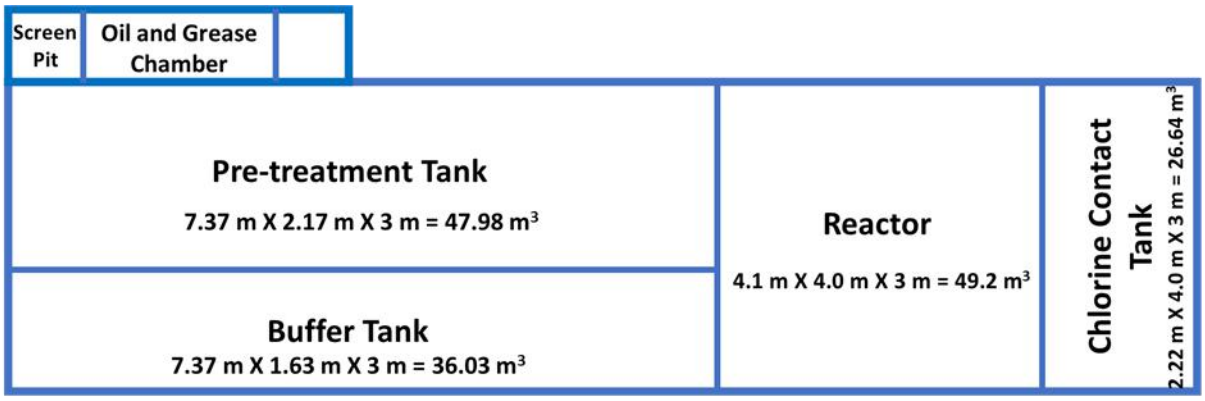
the campus and transferred to the composting pits. These food wastes are laid layer wise by adding pusha organic decomposer mixture on each layer and are converted into compost. The pit is covered with soil when it is completely filled with food waste and allowed to decompose for 45 days. The compost thus produced is used in different agriculture farms of CUTM.

2.9. Sewage Treatment Plant (STP)

Wastewater on the campus is generated from different sources like domestic wastewater from different hostels and staff quarters, administrative and academic buildings, and canteens present on the Campuses. Some wastewater is also generated from different cleaning activities. The wastewater is collected and treated in the Sewage water Treatment plants (STPs).

The treatment process includes:
Step-1: screening of bigger size waste particles like leaves, kitchen waste, straw etc.
Step-2: Removal of oil and grease from the oil and grease chamber.
Step-3: Settlement of sludge in the pre-treatment tank and storage of the water in the buffer tank.
Step-4: Aeration of sewage water for 8 hours per cycle in the presence of the microorganism in the reaction tank.
Step-5: Decantation of treated water into the Chlorine contact tank where a calculated amount of disinfectant is added and supplied for the irrigation purpose.

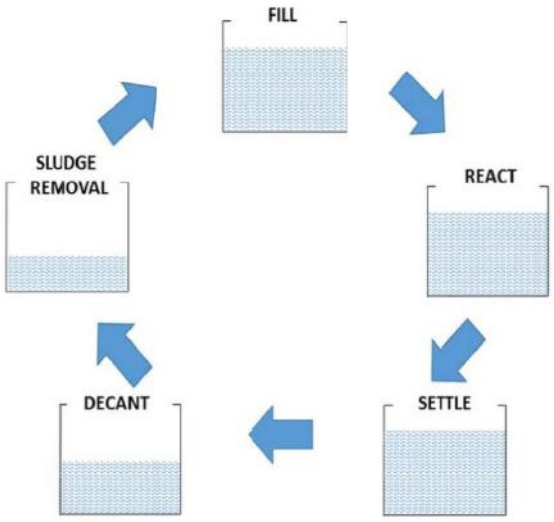
Layout of STP:



The wastewater treatment plant functions according to the activated sludge principle in the impounding process (SBR process). With this, the pollutants are taken out of the wastewater by floating micro-organisms (activated sludge) and converted into biomass. The wastewater enters the pre-treatment chamber. This chamber is needed to allow sedimentation of coarse material. It is also known as mechanical pretreatment. Coarse materials sink to the bottom and the pre-treated effluent flows over into the next chamber with the help of a natural gradient. The second chamber is the buffer tank serving as storage until the effluent is being pumped into the reactor.

Within the Reactor, the wastewater is being treated in three nos. eight-hour duration cycles per day. One cycle consists of the following phase:

1. Filling/Loading Phase.
2. Reaction.
3. Settling phase
4. Decanting
5. Sludge Removal



Initially, the reactor will be filled with a certain amount of water with the help of the airlift pumps. To treat the effluent, microorganisms are required which are responsible for the decomposition of the organic waste within the effluent. Due to the controlled infusion of air, the microorganisms multiply, resulting in a rapid reduction of the organic substances in the effluent. The Control Unit controls a compressor (Blower) and four magnetic valves which control the plant based on the SBR- timing principle. The loading, sludge return, and treated water disposal pipe works on the airlift principle. To initiate the transport of water respectively the aeration the corresponding valve opens. With a delay of two seconds, the blower starts. Reversely, when switching off the blower will switch off first, then the valve will close with a two-second delay.

There are four STPs working in the Paralakhemundi campus. Each STP has a treatment capacity of 75000 liters of wastewater per day. Thus, daily around 3 lakh liters of wastewater is treated in Paralakhemundi campus. CUTM, Bhubabaneswar campus has one STP which treats about 3 lakh liters of wastewater per day. CUTM, Vizianagaram campus has one STP plant with a treatment capacity 2lakh litres per day. All the STPs treat the wastewater throughout the year. Treated water is used for watering the campus gardens, lawns, playgrounds, and agricultural fields.

Maintenance of STPs

2.10. Vermicomposting Unit

Different kinds of organic wastes including vegetable wastes, grass cutting from lawns, leaves fallen on the ground, garden cuttings generated inside the campus are converted into vermicompost in the established vermicompost unit in different CUTM campuses. The vermicompost thus produced is used in different farms, nurseries, gardens, and orchards present inside the University campuses. Some vermicompost is also sold to different organizations and farmers.

Process for the production of vermicompost:

- **Raw materials requirements:**

Cattle dung, Dry leaves, Kitchen waste, Farm waste, Paddy straw, Cattle Shed waste, Banana tree

Different types of vermicompost beds:

1. Cement pits
2. Cement Ring
3. HDPE

- **Bed preparation:**

Layers from bottom are filled in the following order:

1. Big gravels: 5cm thickness
2. Small gravels: 5cm thickness
3. Sand; 5cm thickness
4. Soil: 5cm Thickness
5. Decomposed farm residue: 5cm Thickness
6. Cattle and Residue: 5cm Thickness
7. Paddy straw – 5cm Thickness
8. Pre-decomposed cattle dung slurry spray

After the preparation of the complete bed about 3kg of earthworms are uniformly released at the top of the bed. Finally, the pit should be covered with moist gunny bags for maintaining humidity.

Different species of earthworms used:

Two types of earthworms are being used

1. Red worms – *Lumbricus rubellus*
2. Red wigglers – *Eisenia foeitidae*

Vermicompost Production Process:

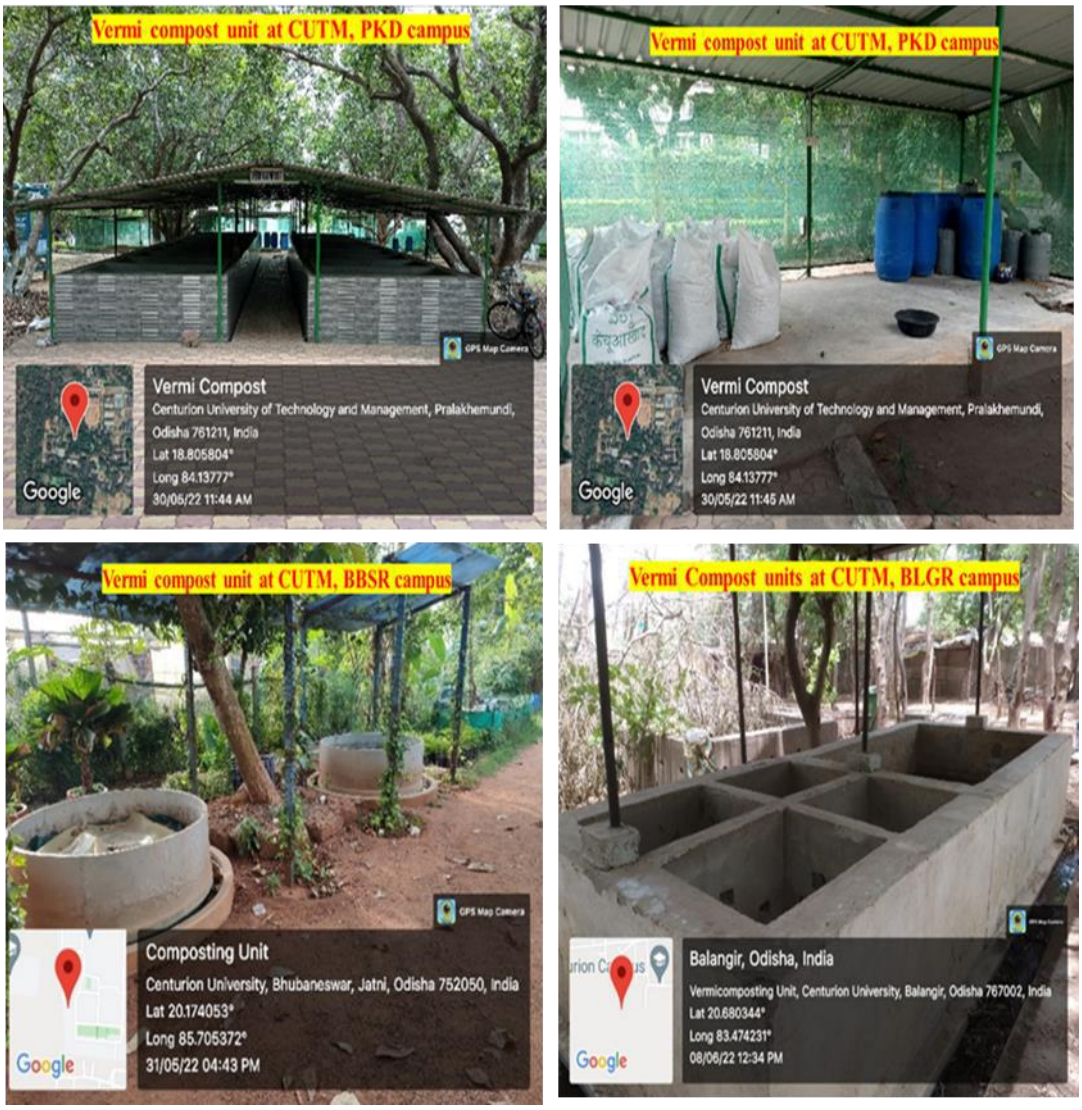
- Collection of wastes and processing including shredding and separation of non – degradable material.
- Preparation of earthworm bed a concrete base is required to put the water of Vermicompost preparation. Loose soil will allow the worms to go into soil while watering all the dissolvable go into along with water.
- Collection of Earthworm after vermicompost collected, sieving the compost material to separate fully composted material. The partially composed material will be again put into the vermicompost bed.
- Shifting the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

Harvesting of vermicompost:

1. The compost is ready when the material is moderately loose, grumbly and colour of the compost is dark brown.
2. The castings are formed at the top layer of the pit and need to be collected periodically (once a week)

Storage of vermicompost:

The harvested vermicompost needs to be stored in a cool and dark place away from sunlight.



2.11. Biogas Plants

Centurion University has a 2 m^3 capacity Deenbandhu fixed dome biogas plant at Paralakhemundi campus and a 2m^3 capacity FRP floating drum biogas plant each at Paralakhemundi and Bhubaneswar campus.

The biogas is produced by the anaerobic digestion of the organic waste material. The composition of the Biogas is given below:

Composition of gas	Content (%)
Methane	55-65
Carbon dioxide	35-45
Hydrogen	Trace
Hydrogen sulphide	Trace amount
Ammonia	Trace

Mechanism of Biogas Production:

The digestion of the organic waste matter is occurred in the absence of air i.e., the anaerobic condition. The degradation takes place in the four different stages:

i) **Hydrolysis:** Most of the organic waste materials subjected to bio-methanation contain the macromolecules like cellulose, hemi cellulose, lignin etc., which are insoluble in water. In the first step of gas production, these macromolecules are subjected to breakdown into micro-molecules with the help of some enzymes, which are secreted by the bacteria. So, the major end product of this step is the glucose.

ii) **Acidogenesis*:*** The components released during the hydrolytic breakdown become the substrate for the acid forming bacteria. The acid forming bacteria convert the water-soluble substances into volatile acid. The major component of the volatile acid is the acetic acid. Beside this some other acids like butyric acid, propionic acid etc. and gases like CO_2 and H_2 are also produced. The forming bacteria during the conversion process utilize the amount of oxygen remaining in the medium and make the environment anaerobic.

iii) **Acetogenesis**: In this step, the fermented products are oxidized into simpler forms. Substrates for acetogenesis consist of various fatty acids, alcohols, some amino acids and aromatics. In addition to hydrogen gas, these compounds primarily form acetate and carbon dioxide.

iv) **Methanogenesis*:*** This is the last stage of biogas generation. N this stage the methanogenic bacteria convert the volatile acids formed in the se4cond step by the acidogenic bacteria to methane and carbon dioxide. Some excess CO_2 in the medium is also converted to methane gas by reacting with the hydrogen present in the environment.

The reactions in the above four phases to go on simultaneously. In the first three stages the two groups of bacteria are very active. During their processes of conversion they utilize the amount of oxygen present in the environment and make the whole system almost oxygen free during their process of respiration. In the fourth step the methanogenic bacteria are active. These groups of bacteria are highly sensitive to oxygen while the previous two groups are not so sensitive. This is the reason why the methanogenic bacteria are called obligate anaerobic bacteria. It has bee also noticed that the microorganisms are very much dependent on each other. The amount of acetic acid formation is directly related to the methane generation. More the acetic acid formation more will be the amount of methane generation.

Components of biogas plants:

i) **Mixing tank -** The feed material (dung) is collected in the mixing tank. Sufficient water is added and the material is thoroughly mixed till a homogeneous slurry is formed.

ii) **Inlet tank -** The substrate is discharged into the digester through the inlet pipe/tank.

iii) **Digester -** The slurry is fermented inside the digester and biogas is produced through bacterial action.

iv) **Gas holder or gas storage dome -** The biogas gets collected in the gas holder, which holds the gas until the time of consumption.

v) **Outlet tank-** The digested slurry is discharged into the outlet tank either through the outlet pipe or the opening provided in the digester.

vi) **Gas pipeline -** The gas pipeline carries the gas to the point of utilization, such as a stove or lamp.

Operation and Maintenance:

About 50 kgs of cattle dung are used for the generation of 2 m^3 gas per day. The acquired quantity of dung along with an equal quantity of water is put into the mixing tank daily. After plugging the inlet pipe the contents are thoroughly mixed. Materials like straw, trash, etc. are removed and the slurry is then led into the digester by removing the plug at the opening of the inlet. After feeding, the inlet opening is again closed by the plug. The inlet tank is cleared with the water and the washing is drained out through the hole provided at the lowest point of the floor of the inlet tank. Inorganic materials like sand, mud, etc. will get washed away while cleaning the mixing tank. After digestion of the slurry about 2 m^3 gas is produced daily and the

digested slurry is got out through the outlet tank automatically. The digested slurry is used as

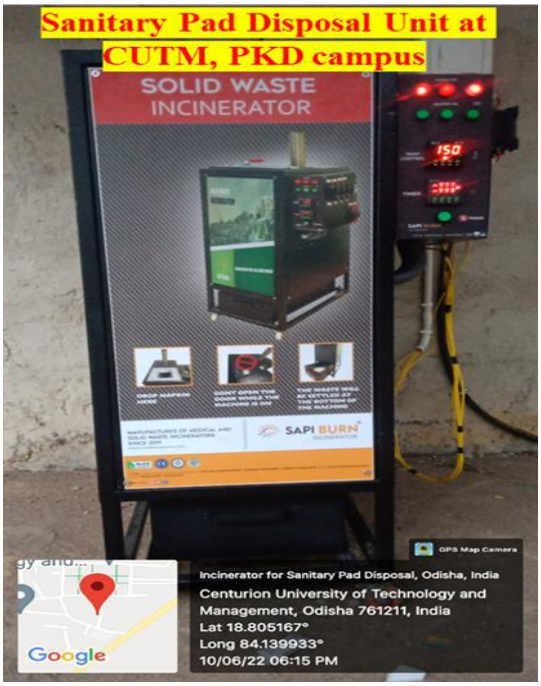
an organic manure for the plants in the garden. The biogas thus produced is used by one of the families residing inside the Tribal village at CUTM, Paralakhemundi campus. The digested slurry is used to grow vegetables in the gardens situated in the Tribal village.

2.12. Solid Waste Management

Solid wastes are collected in different bins placed at various locations on the campus. Biodegradable wastes are used for composting while non-biodegradable wastes are handed over to the municipality for safe disposal.

2.13.Biomedical Waste Management

The biomedical solid wastes are segregated and stored in specified colored bins that are collected from the end user sites and stored at a central location, a restricted area within the campus before handing it over to the biomedical waste treatment facility. For the biomedical waste treatment facility, the University has signed an MoU with the **Saniclean Private Limited.** Saniclean collects the closed bags filled with BMW by their staff from the premises for the proper disposal of the waste. Apart from this, several incinerators are installed in each ladies' hostel for the safe disposal of used sanitary pads.



2.14.E-waste Management

E-wastes are collected and segregated in the campus and are handed over to Shree Ganesh Recycling Pvt. Limited for the proper recycling as per the MoU.

Chapter – 3

Research Centre Achievements and Activities

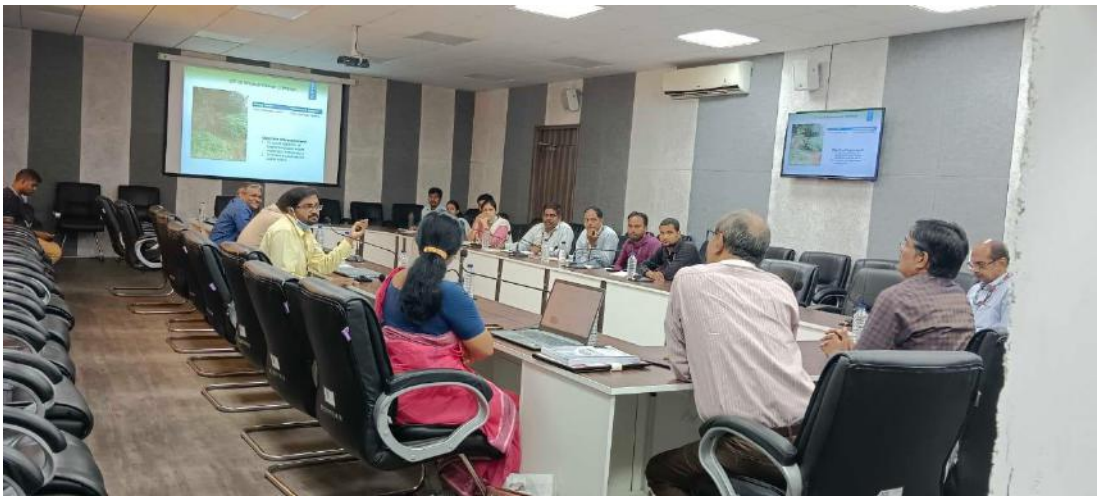
3.1. Consultation Meeting and Awareness Programme

A stakeholder's consultation meeting on "Solid Waste Management" was successfully conducted in collaboration with UNDP on 7th January 2022 at CUTM, BBSR campus. Executive officer of Jatni municipality and Jajpur municipality had joined the meeting as keynote speakers.

Dr. Sangram Keshari Swain participated in NITI Aayog - UNDP 3rd Regional Workshop on "Urban Plastic Waste Management" held at Puri on 4th March 2022. He represented our university and research centre

A community awareness programme on “Waste Segregation and Management” was conducted for green warriors on 15th March 2022.

A retreat programme for our research centre was organized on 23rd April 2022 to assess the journey so far and to chalk out the future course of action.



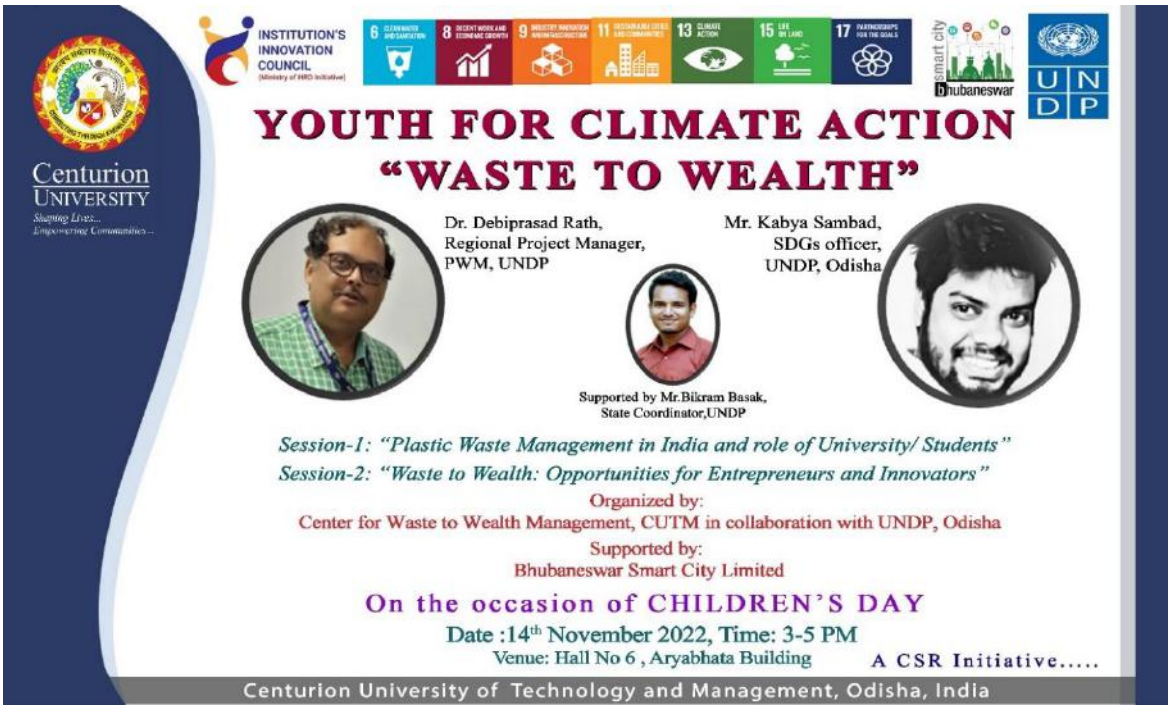
Dr. Sangram Keshari Swain has been invited by the Government of Odisha and UNDP as Panellist during the panel discussions on " Craft and Waste" in the international Craft Summit-2023" at Jajpur on 20th and 21st January 2023.

A team from Jatni Municipality has visited the Infrastructure and Construction Action Learning Lab to see the manufacturing process of paver blocks using plastic wastes.

3.2. FDPs/ Workshops/ Webinars Organized

The Research Centre for Waste to Wealth Management in collaboration with the Department of Chemistry, Centurion University of Technology and Management, Odisha organized a webinar on "Wealth Creation through Plastic Waste Management" on the eve of "National Pollution Prevention Day" i.e., on 2nd December 2022.

The session on "Youth for Climate Action - Waste to Wealth" was organized by Research Centre for Waste to Wealth Management and CSR Cell, on the occasion of Children's Day (14th November 2022) in collaboration with the United Nations Development Programme



(UNDP) supported by Bhubaneswar Smart City Limited in Hall No. 6, Aryabhatta Building, Bhubaneswar campus, Centurion University of Technology and Management, Odisha, India.

A webinar on "Waste Management in Pre and Post-Disaster Scenario" was organized on 7th November 2022 in collaboration with UNDP, Odisha.

A talk was delivered on pollution and its control on 2nd Dec. 2021 by Dr.Narayan Gouda and Dr.Rosy Mallik. It was related to SDG 11 and 13.

A workshop on Microbial sewage water treatment was conducted on 15th February 2022. Mr. Vijay Kanda conducted the workshop.

A webinar was conducted on 3rd June 2022 on "sustainable biofuels". Dr. Hemant Kumar presented the talk. This was organized in collaboration with "centre for Phytopharma". This webinar was related to SDG 7

A Webinar on “Solid Waste Management and Circular Economy” was conducted on 21st November 2021.

A webinar was conducted on “Trichoderma: A possible option to solve the problem of stubble burning” on 5th July 2021. The talk was delivered by Dr. Amitava Rakshit. The webinar was related to SDG 11.

The webinar was conducted on 27th April 2021 on “scope of Biogas technology”. The webinar was related to SDG 7.

A webinar on “Environmental friendly management of dust generated from gas cleaning plant” was conducted on 21st June 2021. The webinar was related to SDG 9.

The “Innovative Approaches Towards Plastic Waste Management” webinar was conducted on 17th June 2021”. The webinar was related to SDG 11 and 13.

Waste Disposal: A commercial challenge for the Mankind" webinar was conducted on 29th June 2022. This was conducted in a hybrid mode and attended by students and faculties. The webinar was related to SDG 12.

3.3. Research Activities

3.3.1. Making of high-strength Paver blocks from different plastic wastes

Plastic waste is produced inside the campus from various sources. Our objective is to utilize these super-strength materials and explore their strength to make new materials. The paver blocks are made from waste plastics by our research centre.

Paver blocks and wall panels from plastic waste

3.3.2. Liquid Fuel from Plastic Waste and waste biomasses

Pyrolysis setup **Liquid fuel by co-pyrolysis of plastic waste**

3.3.3. Biodegradable tableware from Agri-waste

The paper plates are the products from the Agri-waste management sub-center. By using waste rice straw, the lignin was extracted initially in a chemical methodology. Thereafter, the cellulose and hemicellulose are made into pulp using our dedicated instruments. The pulps are then used to make hand-paper sheets followed by plates. In this way, the Agri-waste can be value-added. Further research is required to make those plates waterproof so that liquid foods can be eaten without leaching. Terracotta and pottery products are also prepared from clay. These items can be used at home for decorative purposes.

3.4.External Grants and Funding

A three-year project from DST-SERB worth 18 lakhs titled “Surfactant Based Spectroscopically Active Ionic Liquids for Possible Biomedical Applications” started in November 2022. Prof. Moloy Sarkar from NISER Bhubaneswar is the mentor for this project (TARE scheme) (Ongoing).

3.5.Training Programme Conducted

- A three days training programme on "Sewage Treatment Plant: Design, Operation & Maintenance” conducted from 27th - 29th March 2023.

- One day Workshop on "Agro Engines" conducted on 31 March, 2023.

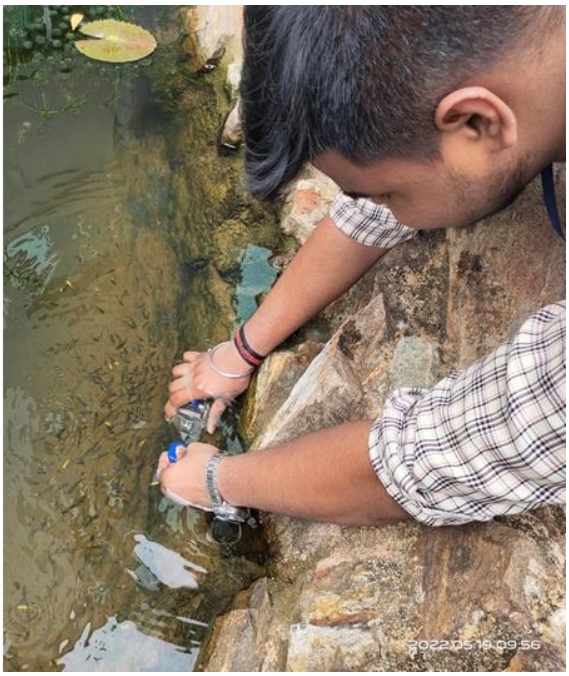
3.6.Summer Internship

Internship at CUTM deals with waste paper utilization for making various products, dustless chalk production, and liquid fuel production from waste biomass and plastic.

This internship at CUTM deals with biogas production from kitchen waste and water analysis to remove heavy pollutants by the adsorption process. Several natural adsorbents were used for water purification.


ELECTRIC POTTER WHEEL
SPECIFICATION
Type
WA 1 Model
Motor Specification
1/8 HP Single Phase
(40,80 160 rpm)
12" dia MS Plate


Infinix NOTE 10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3.7. Students Activities

Students of CUTM, along with some faculty members visited nearest Jatni municipality corporation Odisha to see the process of waste management, waste segregation, and fertilizer making from waste on 27th May 2022. Jatni municipality executive officer explained about the facilities.

3.8. List of MoUs/ Agreements Signed

- MoU for hand papermaking with Auroville Papers having its Registered Office at Auroville, Tamilnadu
- MOU for ECO Craft (Initiative for Eco-Handicraft using Waste) with Well Paper Auroville having its Registered office under Auroville foundation, Tamil Nadu.
- A letter of exchange signed with SHREE GANESH RECYCLING PVT. LIMITED having its Registered office at 131, Punjabi Colony, Satyanagar, Bhubaneswar-751007 for plastic waste management.
- MOU for Waste Management for Waste Management with SHREE GANESH RECYCLING PVT. LIMITED having its Registered office at 131, Punjabi Colony, Satyanagar, Bhubaneswar-751007.
- MoU for biomedical waste management with Saniclean Private Limited**.**
- An agreement with Jatani and Paralakhemundi Municipality for the collection and disposal of solid wastes from CUTM campus on a daily basis.

3.9. Publication Details

3.9.1. Journal Articles:

- G. Sabat, N. Gouda*, A. K. Panda, Pyrolysis of low-rank coal: Thermo-kinetic analysis and product characterization, Environmental Quality Management, **2022**, 31 (4). https://doi.org/10.1002/tqem.21911
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- U. K. Sahu, S. Mandal, S. Sahu, N. Gouda, R. K. Patel, Preparation And Characterization Of Mesoporous Cerium Oxide For Toxic As(V) Removal: Performance And Mechanistic Studies, Journal of Environmental Engineering and Landscape Management, **2022**, Vol. 30 (2), 321–330. https://doi.org/10.3846/jeelm.2022.16749
- S.S. Mohapatra, N. Gouda, & R.K. Singh, Investigation on Thermokinetic Study and Optimization of Sugarcane Bagasse Thermal Pyrolysis, Sugar Tech, **2022**. https://doi.org/10.1007/s12355-022-01171-x
- N. Gouda*, I. S. Ramakoti, S. Dhal, Simulation for Argon Ion Exposure to Layered Calcium Oxide, Indian Journal of Natural Science, **2022**, 13 (72), 43314-43317.
- N. Gouda*, I. S. Ramakoti, S. Dhal, Investigation of Lithium-Ion Bombardment on Dichloromethane Using SRIM, Indian Journal of Natural Science, **2022**, 13 (72), 43037-43040.
- I. S. Ramakoti, N. Gouda, P. Biswal, Polymer nanocomposites from waste thermoplastics, Indian Journal of Natural Science, **2022**, 13 (72), 42010-42015.
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- A. R. Choudhury, G. Sabat, N. Gouda, A. K. Panda, Production of hydrocarbon rich fuel from abandoned beehive by pyrolysis, Environmental Progress and Sustainable Energy**. 2021**, 40, e13472. https://doi.org/10.1002/ep.13472
- Narayan Gouda, A.K. Panda, Thermal Degradation of Different Biomass to Fuel: Optimization of Process Parameters by Response Surface Methodology, Biointerface Research in Applied Chemistry, 2020, 11 (2), 8931-8945. https://doi.org/10.33263/BRIAC112.89318945
- N.Gouda, I.Nazmul , S.Dhal, P. K. Rath, Solar Cell- A Potential Candidate for Charge Particle Detection, Indian Journal of Natural Science, **2020**, 10 (60), 20882-20884.
- N. Gouda, Satyanarayan Dhal, P. Gayatri and P.K.Rath, Simulation of 50keV Argon ion on ZnO Nanoparticles using SRIM, Indian Journal of Natural Sciences, **2020**, 10(60), 20898-20901.

- N.Gouda, S. Dhal, P. K. Rath and Y. Mugul, Simulation of 50 keV Argon ion on SrO2 Nanoparticles using SRIM, Indian Journal of Natural Sciences, **2020**, 10 (60), 20938-20940.
- N.Gouda, S. Dhal, P. K. Rath , N. N.Deshmukh and M. Mishra, Study of NaI and CsI Scintillator for Radiation Detection, Indian Journal of Natural Sciences, **2020**, 10 (60), 20941-20943.
- Narayan Gouda, D. Jyoti, S. N. Dhal, SRIM Simulation of 50 keV Argon Ions impact on CuO Nanoparticles, Shodh Sanchar Bulletin, 2020, 10 (40), 58-61.
- Narayan Gouda, A. Satapathy, S.N. Dhal, P. K. Rath, SRIM: A tool to predict the defects on ceramic (Cu2O) nanoparticle using argon ion bombardment, Shodh Sarita, 2020, 7 (28).
- Satyanarayan Dhal, Narayan Gouda, Collision Dynamic Simulation of Sodium-Ion Having Energy 200 keV on Vanadium Nanoparticles using IM3D, Indian Journal of Natural Sciences, **2020**, 11(66), 28930-28934.
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- Shanmugam, V, Babu, K, Garrison, TF, et al. Potential natural polymer-based nanofibres for the development of facemasks in countering viral outbreaks. J Appl Polym Sci. 2021; 138:e50658. https://doi.org/10.1002/app.50658
- Shanmugam, V., Pavan, M. V., Babu, K., Karnan, B., Fused deposition modeling based polymeric materials and their performance: A review, *Polym. Compos.* 2021, 42 (11), 5656. https://doi.org/10.1002/pc.26275
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- Chhotaray, P. K., Biswal, S. K., Pandey, S. (2020) Development of novel hybrid ionic fluids for efficient CO2 capture and cellulose dissolution. J. Mol. Liq. 312, 113477. 24.
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- Somalika Pradhan, Santosh Kumar Sahu, Jitendra Pramanik, Nitesh Dhar Badgayan, "An insight into mechanical & thermal properties of shape memory polymer reinforced with nanofillers; a critical review", Materials Today: Proceedings, 2021, ISSN 2214- 7853, https://doi.org/10.1016/j.matpr.2021.07.504. (Scopus)
- Sameer Panda, Debadutta Mishra, Somalika Pradhan, "A Cogitation on Treatment and prevention of High-Altitude Sickness", 2022, Vol 9, Issue 2 ISSN:2348-5191, DOI:10.21276/ambi.2022.09.2.rv01 (WoS)
- Somalika Pradhan, Bikash Samantaray, "In silico Analysis of Polyvinyl Alcohol and Silicon Oxide Compatibility in a Blend", Indian ∪ +91-8895698976 + pradhan.somalika18@gmail.com 2 | P a g e Journal of Natural Sciences, 2020 Vol.10, Issue 60 ISSN: 0976 – 0997 (WoS)

- Somalika Pradhan, “In Silico Analysis of Polymer blend between polyvinyl alcohol and Cellulose”, Shodh Sarita, 2020, Vol 7, Issue 28 (WoS)
- Somalika Pradhan, “A Review on Multi Dimensional uses of Bauhinia variegata Plant”, Indian Journal of Natural Sciences, 2021, Vol 11, Issue 63, ISSN: 0976 – 0997 , Pages – 492-497 (WoS)
- Somalika Pradhan, “Novel Approach to Caffeine Extraction Recrystallization and Findings using Liquid-Liquid Method”, Indian Journal of Natural Sciences, 2020, Vol 10, Issue 59, ISSN: 0976 – 0997, Pages – 18860-18863 (WoS)
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- Sucharita Senapti, D.T. Santosh and L.P. Pholane, Techno economic feasibility of drip irrigation for vegetable cultivation. International Journal of Agricultural Sciences, 2021, 17(2), 634-643. DOI:10.15740/HAS/IJAS/17.2/636-643
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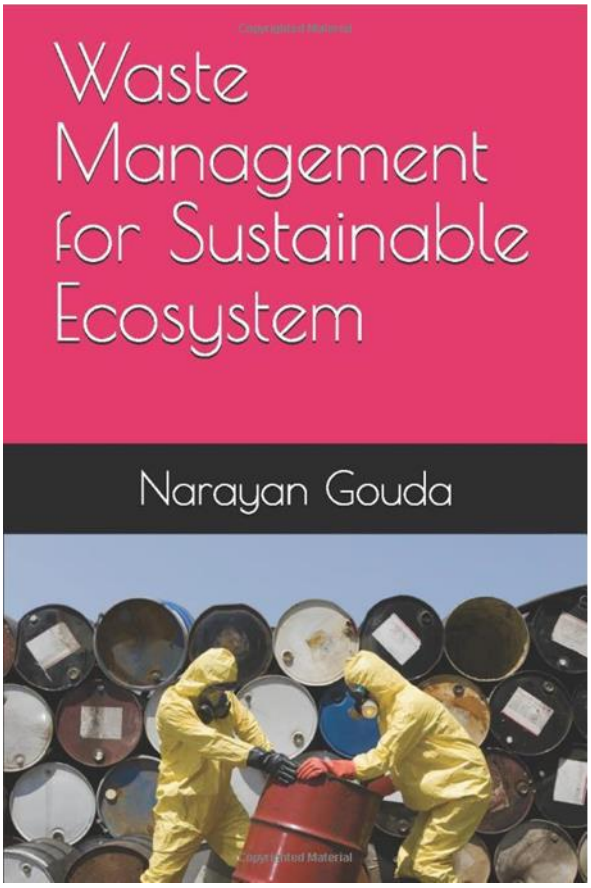
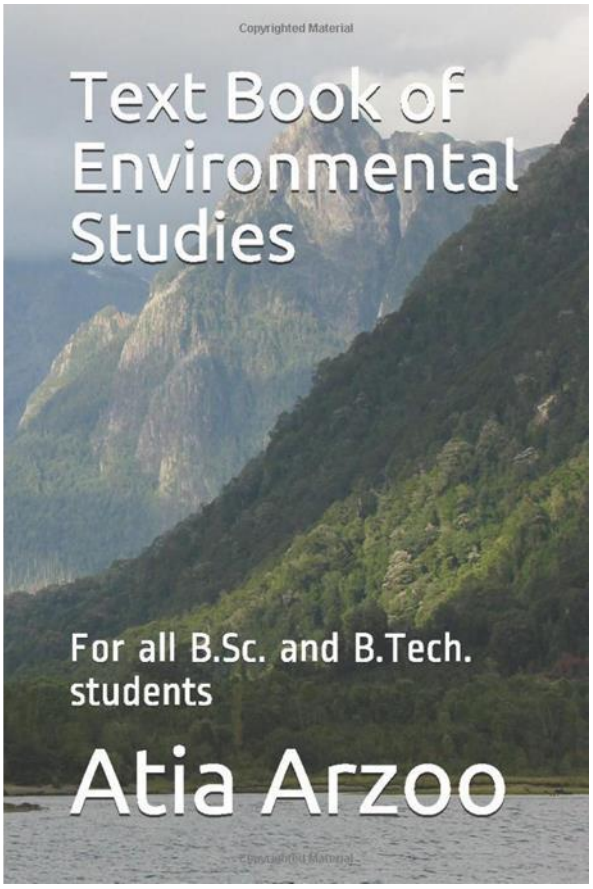
- C.N. Kowthaman, Nachi Murugan, Prasath (2023) A comprehensive review on influence of nano additive blended fuel in performance and emission characteristics of compression ignition engine " International Journal of Ambient Energy". (Accepted)

3.9.2. Books:

- Atia Arzoo, Text Book of Environmental Studies: For all B.Sc. and B.Tech. students, Amazon Self Publishing, 2020.
- Narayan Gouda, Waste Management for Sustainable Ecosystem, Amazon Self Publishing, 2020. (All RC members contributed the chapters for this book)





3.9.3. Book Chapters:

- S.K. Swain, Production of Eco-friendly Handmade Paper from Waste Paper and Other Ways, Multidisciplinary Issues in the Contemporary World book, Empyreal Publishing House, December 2022, pp 61-71.
- S.K. Swain, E-Waste Management in India Issues and Strategies, Multidisciplinary Issues in the Contemporary World book, Empyreal Publishing House, December 2022, pp 52-60.
- C.N. Kowthaman, Dhurga Madhab Mahapatra "Evaluation and optimization of biogas production from de-oiled microalgae Botryococcus braunii grown in microbial fuel cell" accepted in "Algae Based Bioelectrochemical Systems for Carbon Sequestration, Carbon Storage, Bioremediation and Bioproduct Generation" Elsevier publication (October 1, 2023, edition)

3.9.4. Patents:

1. Design and Construction of prefabricated skeleton structures (Published).

Application No: 202241050364

Published on: September 16, 2022

2. IoT-based food waste recycling machine (Granted)

Application No:377851001

Granted on: 23rd January 2023

3.9.5. Copyrights:

Two Copyright (Applied)

1. Best Practices for Electronics Waste Management in the Indian Context
2. Innovative Ways of Hand Paper Making in Managing Waste

Future Goals

- Research and Publications in Waste Management domains
- Filing Patents/ Copyrights on innovative waste management processes and designs.
- Development of new and marketable products from Waste materials.
- To make collaborations and partnerships with different institutions, research organizations, and private sectors working on Waste Management.
- To offer internship programmes for students and other stakeholders.
- To start new domains, skills, and workshop courses in the waste management area
- To conduct Webinars/Conferences/ Seminars/Workshops in order to enhance the knowledge and develop the capacity building of faculties and students.

Summary of Research Centre Activities

(15th Aug 2020 to 30th April 2023)

Items	Details	Status
Publication	2 Books (consisting of 21 book chapters)	Published (Amazon self-publishing)
	Book Chapters	3
	45 research articles	Published
Question Bank (Job Role)	8	300 question from each job role has been submitted.
Project Proposal	1	Granted
Patents	2	1 granted and 1 published
Copyrights	2	Applied
Products	6	Ongoing
Capacity Building	Simulia, Catia, and Bioivia Materials studio	Acquired preliminary idea, practiced, and product designed
MoU	5	Signed
Workshop mode course	3	Completed
FDP/Webinars	15	Conducted
Summer Internship	20 students had registered	Completed their internship
Training Programmes	2	Conducted

GLIMPSES

Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

CORPORATE OFFICE

HIG-4 I JAYADEV VIHAR I OPPOSITE PAL HEIGHTS I BHUBANESWAR I
KHURDA I ODISHA I INDIA I PIN - 752050

CAMPUS

BHUBANESWAR I PARALAKHEMUNDI I RAYAGADA I BOLANGIR I I BALASORE I CHATRAPUR

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