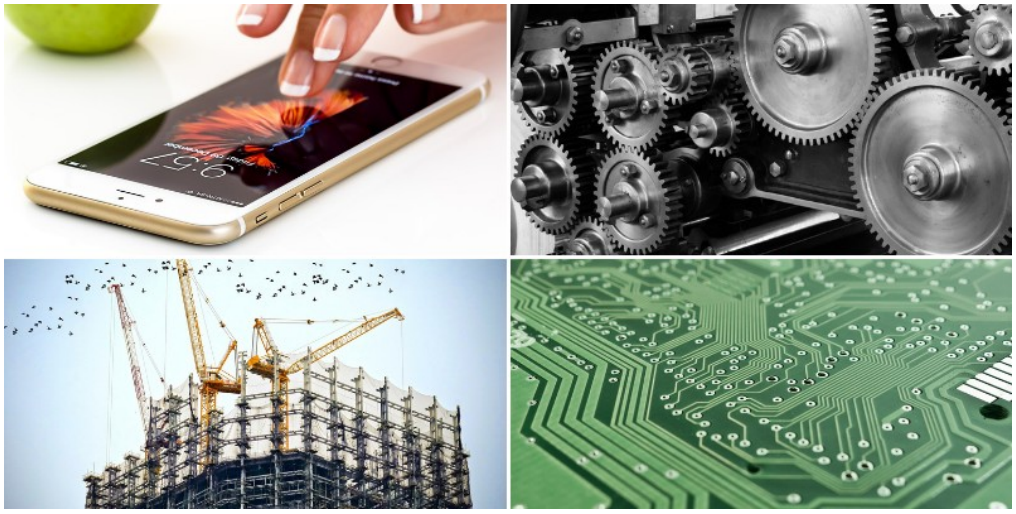
विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY
सत्यमेव जयते

AMRITA TEC

DST-AMRITA
TECHNOLOGY
ENABLING
CENTRE



Dr. Krishnashree Achuthan

Amrita Vishwa Vidyapeetham, Amritapuri Kollam, Kerala - 690546

I. Overview

This report has the following sections:

- Section 1 - A snapshot summary of all activities and outcomes of the Technology Enabling Centre (TEC) established at Amrita.
- Section 2 - An introduction and overview of the objectives of the Technology Enabling Centre established at Amrita and its wide-ranging outreach in the past year.
- Section 3 - Focus on Technology Mining. The process established towards technology mining, TRL establishment and assessment process are also covered. Shortlisted projects under development that TEC has been involved with its problem definition, partnerships and/or procurement of funding. This section also has a list of technologies commercialised after multiple rounds of talks and discussions. The technologies transferred to corporates and/or startups are also highlighted. A shortlisted set of innovations to be commercialised are also provided in this section.
- Section 4 - Addresses the ever-expanding need for reaching out to Industry associations and Government bodies specifically for technology enablement as part of TEC's roles and responsibilities
- Section 5 - Details the deep dives with MSMEs clusters in Kerala and Tamilnadu states. The understanding towards their needs through journalistic and scientific investigations have been detailed.
- Section 6 - An overview of Amrita TEC initiated industry engagements towards technology co-creation
- Section 7 - Events and Visits to Industries
- Section 8 - Training sessions, Seminars and Webinars. The training programs were developed based on needs assessment while incorporating emerging trends.

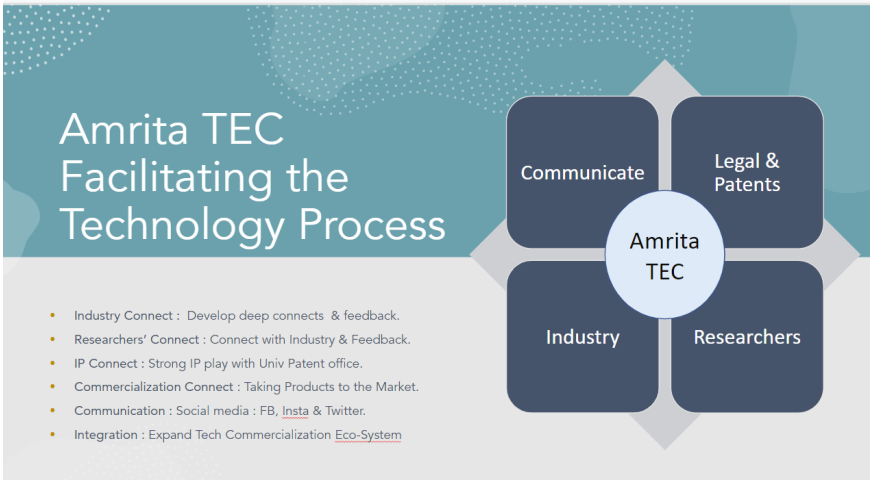
Snapshot Summary

1. Technologies Mined - 120
2. Technologies in the Pipeline - 12
3. Technologies in Development - 14
4. Technologies Commercialised - 6
5. Technologies Transferred - 8
6. Patents Granted - 22
7. MSME Problem Identification - > 15
8. Industry Co-Creation Projects
9. Consultancy Projects

2. Introduction - DST-Amrita TEC Centre

I. Vision and MIssion

DST-Amrita TEC's vision is to build a nurturing ecosystem to enable MSMEs, Industries and Academia to jointly address pressing technology needs of our society.. Through ignition of the innovative and entrepreneurial spirit, DST-Amrita TEC hopes to collaborate and commercialise sustainable technological solutions that impact human life.



TEC was involved in mining of technologies that are at different technology readiness levels (TRLs). Suggestions and services have been to several technology teams. They have revolved around industry connect, IP connect, increased exposure and aiding in raising their TRL levels.

Various services that we hope to provide MSMEs, Industry and Academia include:

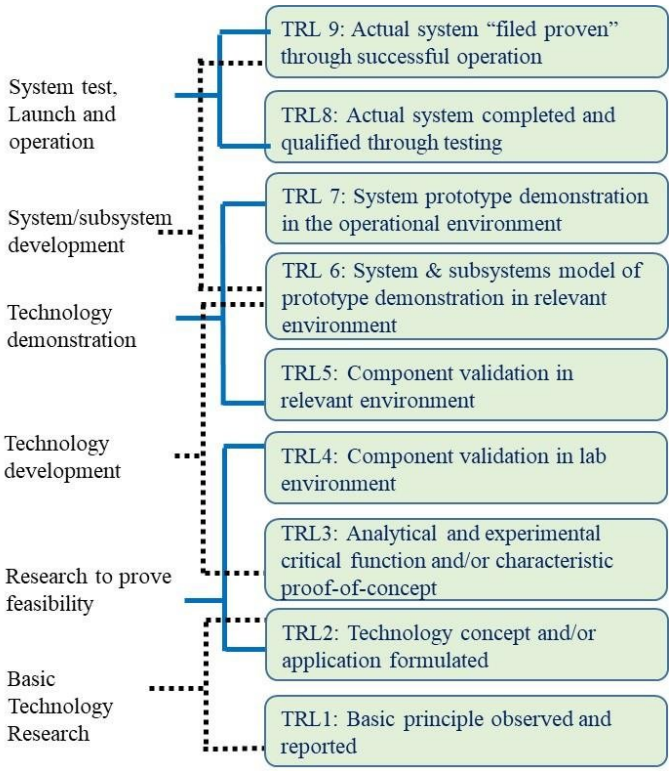
3. Technologies Mined, Developed, Commercialised and Transferred

Technologies Mined

Technology mining is a focus area of DST-Amrita TEC centre. These technologies have been sourced from multiple antecedents. These include Amrita Vishwa Vidyapeetham's intellectual property portfolio, DST recommended AMT project lists in addition to DST-Amrita TEC's nodal centres and startups that have approached us.

II. Technology Readiness Levels For Technologies Mined

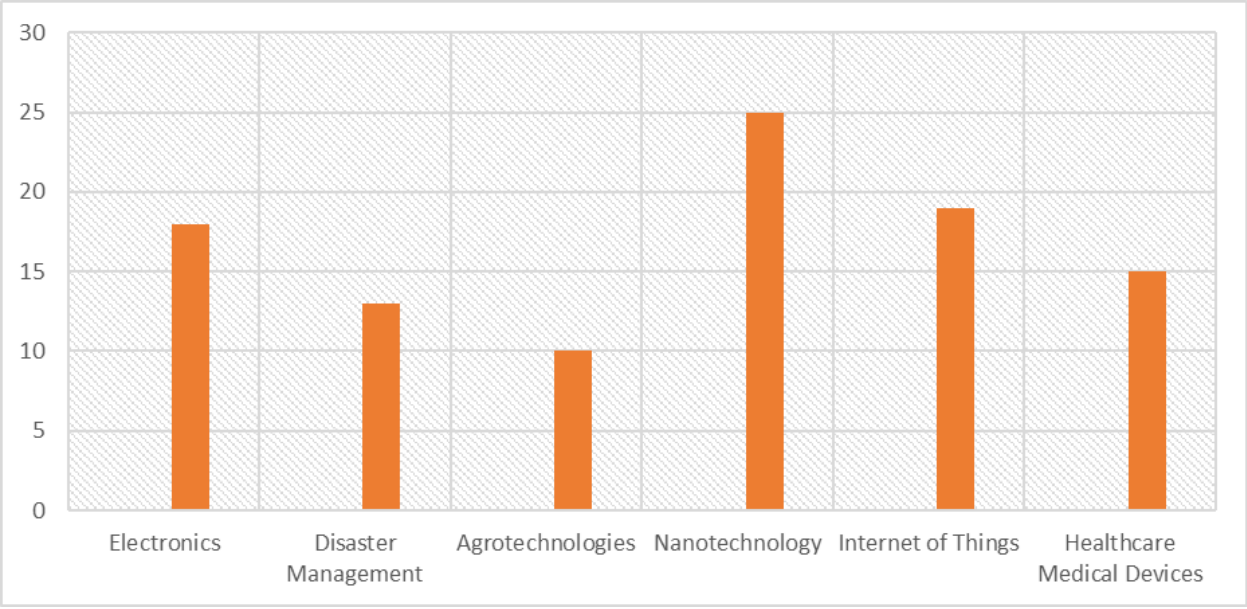
The process of technology mining involves seeking innovators to share data on their innovation in a prescribed format. This is followed by a presentation by the innovator. Based on specific questions related to technology readiness levels, the TEC committee identifies TRLs against each of the innovations.



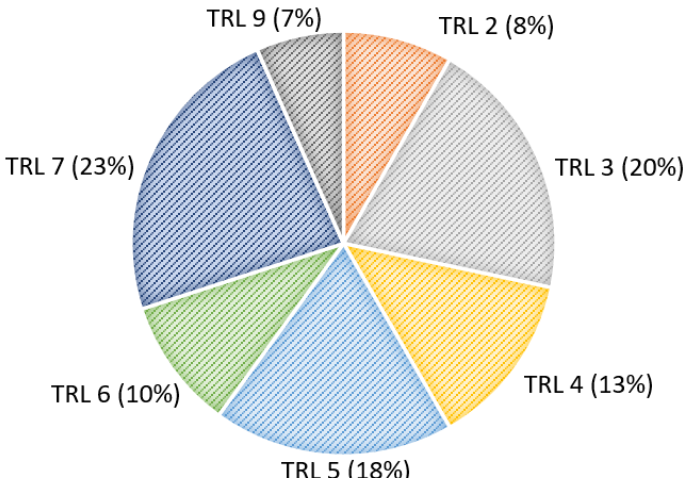
Source: S. Yasseri et.al, I.J.Coastal And Offshore Eng, 2018

Classification of Technologies Mined by TEC Team

The technologies mined were broadly classified as follows. The products were based on core technologies such as nanotechnology, electronics, internet of things technologies, healthcare or disaster management.



Classification of TRLs



Source	Number of Technologies	Current Status
Amrita Vishwa Vidyapeetham & Others (GoI, Research Institutes such as IIT Kanpur, VIT, CSIR, Nodal Centres)	About 120 technologies are mined within Amrita and external agencies.	About 30 of them are selected for the next stage and they are under various stages of research and development and some of these projects are funded by the Govt. Agencies and CSR activities

Technologies Developed

Technologies Developed	Time Period	Applications
UV-Sanitizer (Amrita Prabha)	2020-2021	COVID Intervention
Amrita PAPR	2020-2021	COVID Intervention
Self-Driving Wheel Chair	2020-2021	Healthcare
Robotic Cocunut Tree Climber	2020-2021	Agro-Tech
Bar Bending Machine	2021-2022	Skills Development
5-in-1 Device	2021-2022	Healthcare
Pranavayu	2021-2022	COVID Intervention

Lab-on-a-Chip	2021-2022	Healthcare
Glucose Monitoring Device	2021-2022	Healthcare
Banana fiber cleaning machine	2021-2022	Economic Empowerment for Rural India
Secure IoT Technologies	2021-2022	Industry 4.0

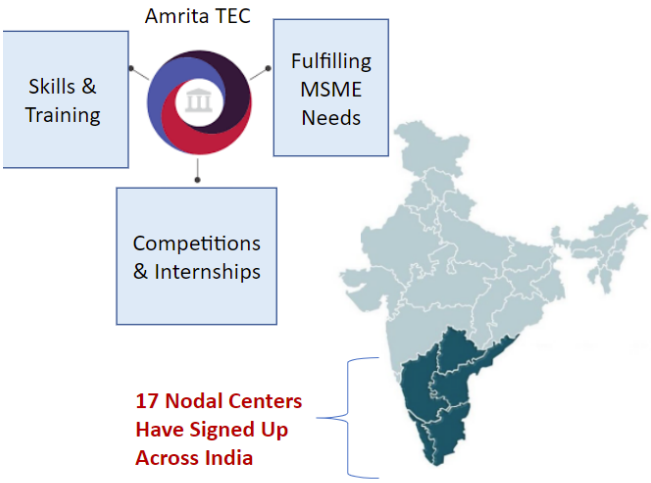
Technologies in the Pipeline

Technologies in Pipeline	**Time Period**	**Applications**
Early Forest Fire Dectection	2020-2021	Govt
Electric Vehicle Chargers	2020-2021	Electric Vehicle Sector
5-in-1 Device	2020-2021	Healthcare (Specially Rural Health)
Lithium Ion Battery	2020-2021	Electric Vehicle Sector
Development of MOOC Platform	2020-2021	Public Sector
Universal Measuring Machine	2021-2022	Educational Institutions
Prosthetic hand	2021-2022	Healthcare
Solar Trycycle	2021-2022	Energy Sector
Cashewnut Shelling	2021-2022	MSME Automation
Fly Ash Brick	2021-2022	Waste to Value Added Products
Rice Field Effluent Treatment	2021-2022	Waste to Value Added Products, Benefitting MSME Sector
Automation of Plywood Curing Process	2021-2022	MSME Automation
Flood Monitoring and Alert Device	2021-2022	Disaster Management
Smart Meters	2021-2022	Industry 4.0

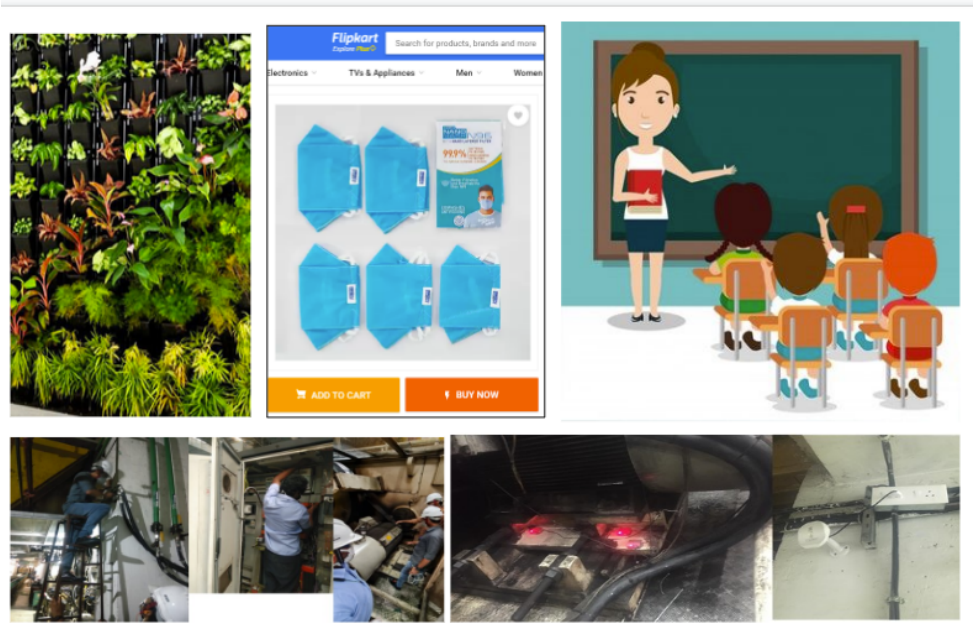
III. Best Practices Towards Building Technologies in the Pipeline

A. Needs from MSME's, industry and government are divided into problems that can be tackled as part of student projects under faculty supervision and mentorship. Faculty are invited to visit the concerned industry to get a first-hand understanding of the problem and its nuances. These observations are then brought back to campuses and multidisciplinary teams deliberate in order to drill down solvable problems as part of Phase I engagement. Student teams are identified to address the problem and in most cases, this contribution is plugged into their term projects . Funds if needed are communicated to TEC teams.

B. Working with other institutes in the country and identifying their technologies in order to help them commercialise. Institutes fill out an Interest Form and establish the concept of Nodal centres. Assistance with design and technology enablement with corporate partners via showcase events are planned for the benefit of these instititions.



Technologies Commercialised



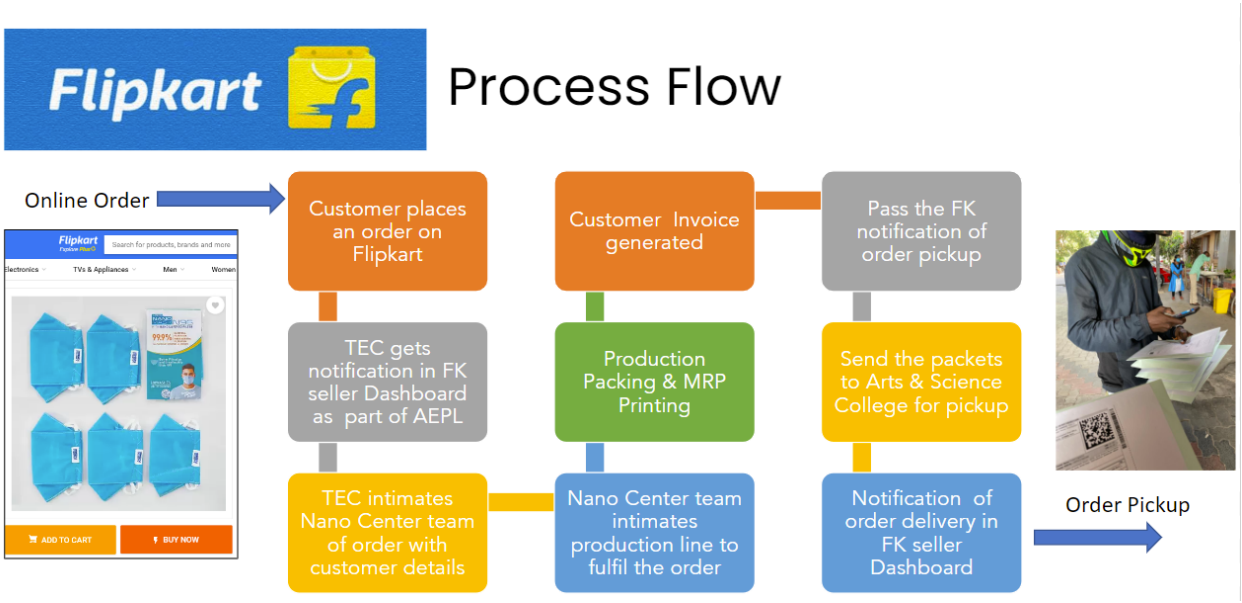
Technologies Commercialised	Time Period	Applications
Smart Sensors and Smart Factory Solutions	2020-2021	Industry 4.0
N96-NanoMask	2020-2021	COVID Intervention

Ruhnevile Biomedical OPC Pvt Ltd	2021-2022	Climate Change
Traboda	2021-2022	Industry 4.0
A-VIEW (MOOC Pedagogy Platform)	2021-2022	Educational and Skills Development
Powered Air Purifier Respirator (PAPR)	2021-2022	COVID Intervention

IV. Best Practices Towards Commercialisation

One of the ways that Amrita TEC has enabled commercialisation is through use of social media and online sales in addition to distributors for various products. Few examples are given below:

A. Online Distribution Channel Partners



B. Porter's Five Force Analysis on Products

We share here an example of Porter's five force analysis done towards Powered Air Purifier Respirator - A COVID Intervention.

Powered Air Purifying Respirator (PAPR) is a protection equipment technology used to supply purified air to medical professionals working in infection-prone areas such as COVID wards, to prevent infection and disease from the aerosolized virus particles. It is also gaining its importance as a kind of personal protective equipment (PPE)

which is used by workers in an atmosphere where the air is contaminated by fumes, dusts, fumes, harmful gases or vapours. An air purifying respirator market provides clean and breathable air through face masks, and hoods which helps to remove air pollutants. The global powered air purifying respirators market size is anticipated to reach USD 3.81 billion by 2030, registering a CAGR of 6.1%.

Factors contributing to growth

- Increasing pollution and the number of airborne diseases is increasing the demand for air purifying respirators in the global market.
- Increasing awareness about the importance of worker safety at the workplace leads to increase in demand for air purifying respirator market.
- Increasing usage of air purifying respirators in the field wherein a worker needs to be protected from chemicals, toxic gases, radiological, and nuclear hazards.

PAPR Kit

Porter's Five Force Analysis

Threat of Entry:

The threat to new entrants is low as the medical equipment business is a capital and R&D intense business. Hence the possibility for competition from new entrants is very low.

Bargaining power of suppliers:

The components of the PAPR kits do not have any raw materials that are scarce, and have high fluctuation in price. Also there is no raw material that has a monopoly with suppliers through market share or technology or patents. Hence the bargaining power of the supplier is significantly low.

Bargaining Power of the Buyer:

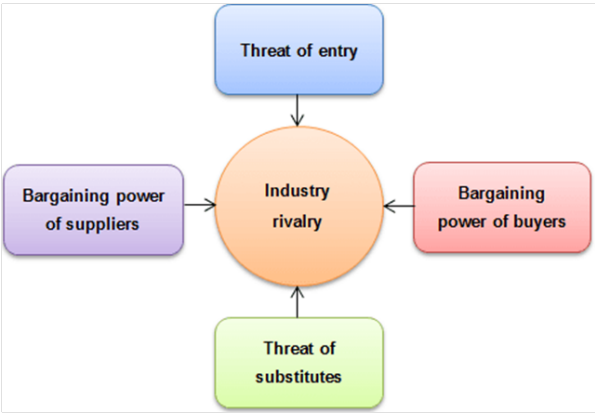
The PAPR is a protective wearable medical device. Hence the willingness to pay for a proven product is high. However a volume based pricing is to be adapted to different institutions based on their buying volume and frequency.

Threat from Substitute:

There is no close substitute that currently exists as an alternative for the product.

Industry Rivalry:

Every industry looking to improve its net profitability through high profit margin or huge market share with penetrating pricing we strive to serve the lowest and most vulnerable starta of the society. Also the cost of the imported kits is more than Rs 1,00,000/- and now the cost of the indigenously developed PAPR kit is less than Rs 30,000/- per kit even making the cost

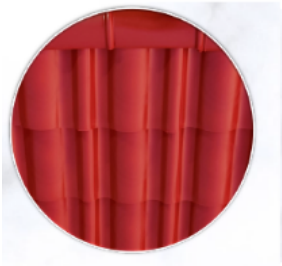


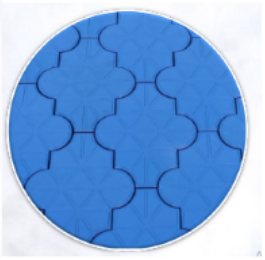
Competitive Advantages

- Safer Breathing with 99.995% Virus Filtration
- Easy to Wear <1.5 Kgs.
- Feel calm – Lesser Noise Level <68 dB.
- Airflow > 10CFM.

competence by a big margin that the commercial manufactures who are selling it around Rs 70,000/-	

Technologies Transferred





Technologies Transferred	Time Period	Applications
Ultra-lightweight & lightweight Hybrid Thermally Insulating Blastproof & Fireproof Composites - Netaji Subhas Advanced Materials	2020-2021	Defence and Internal Security
Plastic to Tiles - R-Cube	2020-2021	Waste to Value Added Products
Saukhyam Sanitary Pads - Ayurarogya Foundation	2020-2021	Waste to Value Added Products
E-V Charger to Midgrad Electric	2021-2022	Electric Vehicle Sector
Bio-filter Based Waste Water Treatment to Purnam Biotech	2021-2022	Waste to Value Added Products
Haksh-E Robotics	2021-2022	Educational and Skills Development
Gurukripa Electrolyzers	2021-2022	Climate Change

Disaster Management Sensors (Landslide Detection)	2021-2022	Disaster Management

Technologies Planned for Commercialization

Technologies Considered for Commercialization	Time Period	Applications
Washable adhesive and related products	2021-2022	Multi-industry (Pharma, Healthcare, Semiconductors)
Development of supply Market Intelligence System with supplier selection and performance monitoring for auto ancillary industry	2021-2022	Automotives
Agarose based wound dressing material	2021-2022	Healthcare
Smart Foundry 2020	2021-2022	Industry 4.0
Additive Manufacturing, Coating and Lasers	2021-2022	Industry 4.0

Patents Granted

US / India	Title	Granted In
· US Patent 11,343,273	Method of Reducing DoS Attacks Using Voice Response in IoT Systems granted on May 24, 2022	2022
· US Patent 11,332,297	Protective Packaging and Delivery	2022
· US Patent 11,311,250	Spectroscopic Monitoring for the Measurement of Multiple Physiological Parameters	2022
· Indian Patent 395189	System and method for Providing Rapidness and Precision in the Control of Robotic Structure	2022
· Indian Patent 394485	Mobile Infrastructure for Coastal Region Offshore Communication	2022
· Indian Patent 389663	Methods and Formulations for Screening and Treatment of Prostate Cancer	2022

· US Patent 11,212,964	Method of Controlling an Automated Drone for Harvesting Produce	2022
· Indian Patent 380578	Porous Composite Fibrous Scaffold for Bone Tissue Regeneration	2021
· Indian Patent 379561	A Device for Sensing Fluid Pressure	2021
· US Patent 11,145,012	Using Cyber-Physical System-Enabled Microgrid System for Optimal Power Utilization and Supply Strategy	2021
· US Patent 11138678	Optimal Communication Architecture for Smart Distribution Power Grid	2021
· Indian Patent 377951	MRI and CT Contrast-Enabled Composite Implants For Image Guided Tissue Regeneration and Therapy	2021
· US Patent 11,125,754	Detergent Compatible Assay for Protein Estimation	2021
· US Patent 11,110,078	Composition and Method For Treatment of Diseases Associated With Central Nervous System Inflammation	2021
· Indian Patent 369608	Adaptive Energy Management System and Method for Real Time Landslide Detection	2021
· Indian Patent 369426	High Performance LiMn2O4 Cathode For Li-IQN Battery Applications and Preparation Method Thereof	2021
· Indian Patent 368254	Artificial Humanoid Robotic Hand and Process of Manufacturing Thereof	2021
· US Patent 11,009,480	Lab on Chip Device for Multi Analyte Detection and Method of Fabrication Thereof	2021
· Indian Patent 366415	Core-Shell Nanomedicine Loaded WIth Multiple Drug Molecules	2021
· Indian Patent 365839	The Art, Method And Manner Of Nanosurface Modification Of Titanium Implants For Orthopedic Or Dental Applications granted April 30, 2021	2021
· Indian Patent 363458	Radio-Wave Responsive Doped Nanoparticles For Image Guided Therapeutics	2021
· US Patent 10,893,931	Strong, Flexible, and Thrombus-free Woven Nanotextile Based Vascular Grafts and method of Production There Of	2021

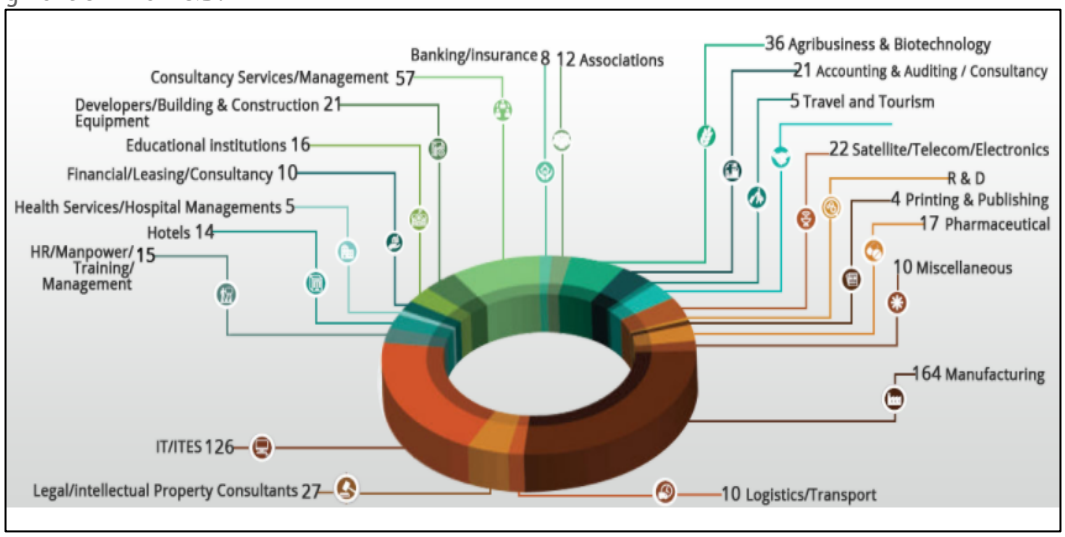
4. Industry & Govt. Bodies Tie-Ups for Technology Enablement Through TEC

V. MOU with Gururaj Deshpande Centre (GDC) for Innovation and Entrepreneurship IIT Madras, Chennai

Amrita TEC and Gururaj Deshpande Centre (GDC) – IIT Madras, Chennai signed an MOU to collaborate in assisting researchers towards market creation, innovation and entrepreneurship through a combination of 8-week acceleration program resulting in customer discovery, product development towards product market fit. 8 teams have gone through this acceleration program and refined their problems based on inputs and mentorship.

VI. MOU with Bangalore Chamber of Industry & Commerce (BCIC)

Bangalore Chamber of Industry & Commerce (BCIC)'s mission is to assist large and medium enterprises by promoting and protecting their business interests, encouraging technology transfers, technology up-gradation and R&D.



BCIC's Member Profile

TEC@ Amrita Wins BCIC's Emerging Stars Participation Award in February, 2021.

The award was given to facilitate participants, who made the programs successful.

VII. Engagements with Industry and Industrial Associations in Coimbatore, Tamilnadu

Amrita TEC team is exploring partnerships with Coimbatore District Small Scale Industries Association (CODISSIA), Indian Institute of Foundrymen (IIF), Coimbatore Tirupur District Micro and Cottage Entrepreneurs Association (COTMA),The South India Engineering Manufacturers' Association (Siema), Tamilnadu Association of Cottage and Micro Enterprises (TACT), Coimbatore SIDCO Industrial Estate Manufacturers' Association, Tamilnadu Small and Tiny Industries Association (TANSTIA), The South India Spinners Association (SISPA), Foundries Development Foundation (FDF)

Amrita TEC team visited the IIF and met with the Chairman Mr. Balraj to understand the problems faced by the Foundry Industry. The Amrita Team also met with Dr. Bhagayanathan, Faculty at SREC, Dr. Nithianandam, Sr. General Manager, Barani Ferrocast Pvt. Ltd.

Meeting with South India Spinners' Association officer bearers - President, Vice-President, Treasurer for an opportunity to address the association members to explain the activities of TEC and tie-up for technology development.

Mr. Sureshkumar P, Operational Head, Foundries Development Foundation (FDF) visited Amrita Campus and met with Dr. Sasangan Ramanathan, Dean-Engineering and Dr. Govindaraju, Faculty in Mechanical Dept. A first of its kind initiative in the country FDF was keen on signing the MOU with Amrita for Research and Skill Development. The facility is coming up near Coimbatore and can be utilised by the Research Scholars, Faculty and Students for Research & Development.

Discussions are underway to sign MOU Amrita TEC & FDF for Research and Skill Development

Dr. B Vinodh Kumar, General Manager, CODISSIA Defence Innovation and Atal Incubation Centre (CDIIC) visited the campus and met with Dean - Engineering, Dr. Sasangan Ramanathan and Dr. Prashant R. Nair, Vice-Chariman, IQAC and discussion is in progress to sign an MOU with CDIIC for Research and Product Development.

Amrita Team – Dr. Prashant R. Nair, Vice-Chairman IQAC; Dr. Sivakumar, Chairman & Professor, Aersopace Engineering, Dr. Govindaraju, Faculty Dept of Mechanical Engineering and Mr. Venkatesh R visited the 5 Base Repair Depot (BRD), Air Force Station (AFS), Sulur, on the invitation of Dr. Vinodkumar, GM, CDIIC.

The Symposium was to indigenize the spares required for repairs of the aircrafts and other equipments. Their focus areas included primarily indegenization of spare parts since there is a great need in the country.

Meeting with President and Vice-President of SIDCO, Coimbatore. DST-Amrita TEC centre will work with them on technology development, training and skill development. They are extremely keen on engagement.

VIII. Meeting with Cochin Special Economic Zone (CSEZ) Members, Kerala for Technology Transfer & Innovation for MSMEs

Amrita TEC is closely working with Cochin Special Economic Zone (CSEZ) members for the technology transfer and Innovation in technology to boost productivity, an DST, GOI and Amrita TEC initiative.

Mr. Surendran K.N and Dr. Shiju Sathyadevan participated in the event and addressed the consortium members and briefed about the activities of the TEC. The TEC team will be formally engaging with consortium members to try and understand the issues faced by them.

IX. Foundry Association

X. Amrita TEC - K-DISC Tie Up

The Kerala Development and Innovation Strategy Council, (K-DISC) is a strategic think-tank and advisory body constituted by the Government of Kerala. K-DISC aims at bringing out path breaking strategic plans that reflect new directions in technology, product and process innovations, social shaping of technology and creating a healthy and conducive ecosystem for fostering innovations in the State. Amrita TEC is pursuing MoU with K-DISC

XI. Amrita TEC - Laghu Udyog Bharati

Laghu Udyog Bharati (LUB) Is a non profit organisation working among MSMEs with thousands of registered members. It is one of India's largest Industry Networks in India, with branches in every state and members in every district of India, working towards the welfare of MSMEs in India. They have grass-root level insights into the challenges faced by the MSMEs as well as changing industry trends & practices on the ground

Amrita TEC is associating with them to identify the problems and requirements of member industries.

XII. Access and Partnership with National and State Laboratories - Widening the TEC Ecosystem

TEC team has discussed with following national and state laboratories for support to help innovators and MSMEs

- National Aerospace Laboratories (Computer Aided Engineering Lab)
- Centre for Materials for Electronics Technology (C-MET), Govt. of India, Thrissur
- National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram
- School of Chemical Sciences, MG University, Kottayam
- Automotive Test Systems (Automotive Research and Technology Centre), Amrita Vishwa Vidyapeetham, Coimbatore
- Robert Bosch (Automotive Electronics Lab), Coimbatore
- Keysight Technologies (Advanced Wireless Communications Lab), Amritapuri, Kollam, Kerala
- IDEINLAB ARCHITECTS (Energy efficient Materials Lab)
- South Indian Textile Research Association (SITRA), Coimbatore
- National Centre for Biological Sciences, Bengaluru
- Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru
- Centre for Cellular and Molecular Platforms, Bengaluru
- Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram
- Centre for Development of Advanced Computing (C-DAC), Thiruvananthapuram
- UGC-DAE Consortium for Scientific Research, Indore.

XIII. MoU with Coimbatore Management Association (CMA)

Coimbatore Management Association (CMA) (https://coimbatoremgt.in), affiliated to All India Management Association (www.aima.in), New Delhi, is one of the oldest management associations in the country, established in 1954 in Coimbatore. CMA represents all industry clusters in Coimbatore like pumps, motors, foundry, pumpsets & textile machinery with an

overwhelming majority of its members from MSME segment. Amrita TEC and CMA signed an MoU for mutual cooperation on 12 November 2021. CMA was represented by Mr. Jayakumar Ramdass, CMA President & Director, Mahendra Pumps & Dr. Nithyanandan Devaraaj, CMA Secretary & Executive Director, Amex Alloys.

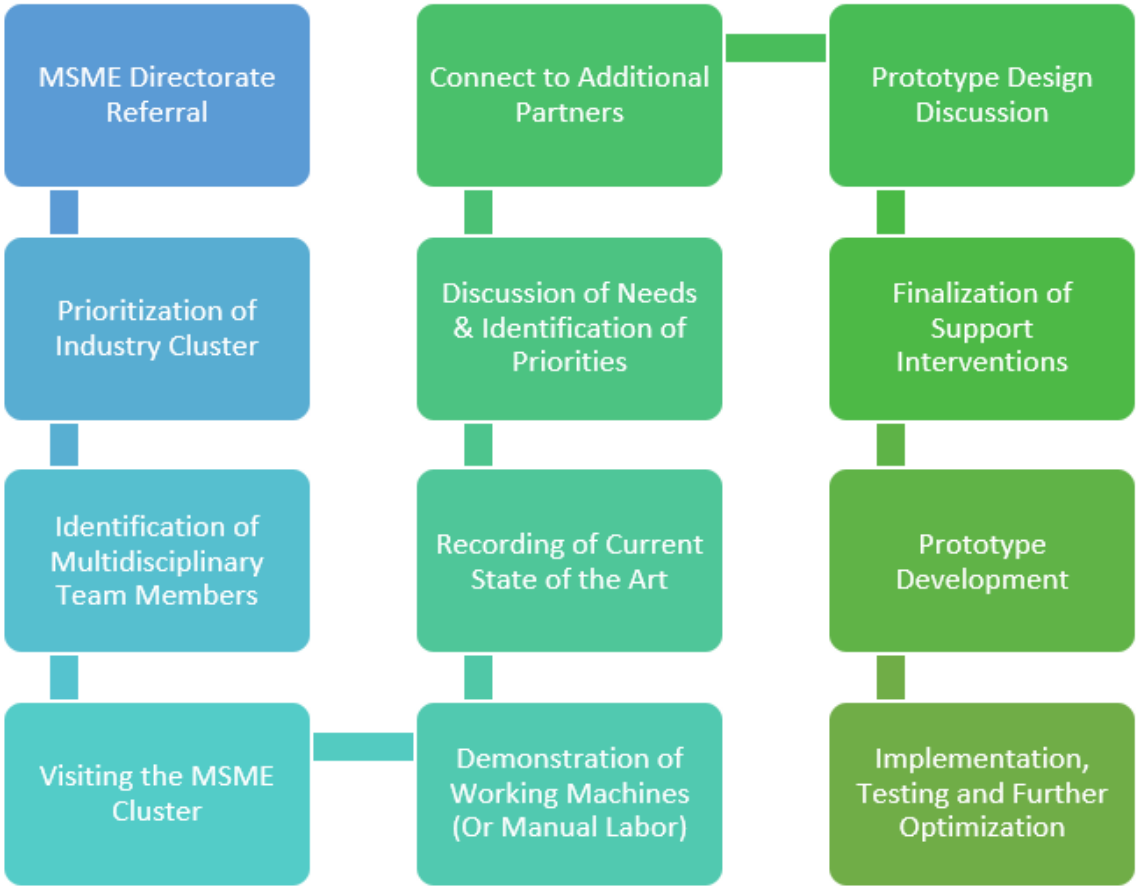
Areas of collaboration include research, consultancy, training & certificate programs, and technology support for mining/assessment/development/commercialization/transfer for various CMA member industries. Amrita TEC is keenly exploring technology enablement opportunities with CMA .

5. MSME Needs Assessment Carried by TEC

The TEC team has visited various MSMEs and MSME clusters in Kerala and Tamil Nadu. Some of the visits were followed up for detailed needs assessment study. There were also visits for a tie up in technology enablement and TEC will be signing MOUs with some industrial associations in the next couple of weeks. Here is the report of the activities done by Amrita TEC during the last six months.

List of Regions DST-Amrita TEC has reached out to.

XIV. Process Adopted to Refine MSME Needs Assessment



XV. Treatment of Effluent Water from Rice Mills Under the Kerala Rice Mills Cluster (KRMC)

Kalady Rice Millers Consortium Pvt. Ltd. (KRMC), a consortium situated in Ernakulam district of Kerala comprising 36 rice mill owners in and around Kalady was formed to function as a common facilitation centre for the rice milling industry. The said common facility centre was set up under flagship scheme of Micro Small Enterprises-Cluster Development Programme (MSE-CDP) of Ministry of MSME, Government of India.

The members from consortium approached the MSME Development Institute, Thrissur seeking assistance in technology for treatment of effluent water from rice mills who in turn approached Amrita Technology Enabling Centre (TEC) to implement a possible solution/ technology for effluent treatment of water from rice mills.

Conventional parboiled rice production generally requires a large amount of water, say approximately 1000 Litres per MT for soaking of the paddy. Approximately 2000 MT of paddy is processed in the mills in and around Kalady and together they consume about 2 Million litres of water which is drained off to recover the paddy and if not properly treated, results in water pollution and odour nuisance. Water pollution is caused by high content of organic matter in the soaked water. The modern rice mills process large quantities of paddy by hot soaking and discharge the soak water repeatedly over a localised area which stagnates and raises the ire of the local population. Rice mill effluent treatment methods earlier are chemical based and/or capital intensive and not widely adopted and as a result, rice mills are almost always in violation of statutory pollution control norms. At present, the technology used by the said consortium is outdated and they are willing to migrate to new cost-effective technology

The wastewater generated from a rice mill contains a wide range of organic and inorganic contaminants. The effluent is typically dark colured and foul smelling. Typical effluent quality of rice mill effluent of two mills in the Angamaly – Kalady - Perumbavoor region, Raw Effluent 1 and Raw Effluent 2 is given in Table 1 below. Variations of pH are encountered owing to different paddy characteristics, the parboiling process and the quality of water used. Suspended solids increase both biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Numerous chemicals are added at various stages of processing such as pre-cleaning, dehusking, polishing etc. Rice mill effluent contains lignin, phenol and colour components that enhance the COD of the effluent along with the chemicals used in processing and pesticide residues.

Particulars	**Raw effluent 1**	**Raw effluent 2**	**Statutory limit (KSPCB)**
pH	5.3	5.0	6 to 9
BOD	7390	8000	30 max
COD	9100	10000	250 max

Sus.solids	180	200	100 max
Oil & Grease	12	15	10 max

As mentioned in the problem statement, the conventional techniques are chemical-based and/or capital intensive. Additionally, the rice processing industry is water intensive. Hence there is a need to develop cost effective effluent treatment technologies. It is also necessary to devise strategies to reduce water consumption, and reuse wastewater.

Based on the rice mill effluent data available with the Amrita team and the requirements specified in the communication from KRMC, an effluent treatment scheme was presented to KRMC. The challenge is in treatment of rice mill effluent is to remove BOD and COD along with colour and other contaminants in a cost effective and efficient manner. This work will focus on developing a suitable and viable technology that can be adapted by existing plants as well as new units. The proposal aims at evaluating the preferable waste treatment technologies to achieve cleaner production, resource and emission reduction for ensuring statutory compliance as well as continual improvement. We propose to incorporate an integrated aerobic - anaerobic approach along with conventional treatment methods to bring down the contaminant load and treatment cost while exploring options to reduce the quantity of effluent discharged. The advantage of integrated approach is that the excess sludge produced in the aerobic reactor is recycled to the anaerobic unit thereby reducing the organic loading rate, ensuring better waste stabilisation and reducing the size and operating cost of downstream effluent treatment units. The proposed configuration for the anaerobic reactor is Up-Flow Anaerobic Sludge Blanket (UASB) reactor or Moving Bed Bio-Reactor (MBBR) or a combination of UASB and MBBR. Both UASB systems are less expensive, require less energy, and produce lower amounts of secondary pollutants than conventional techniques. In contrast with the conventional treatment, MBBR involves the combination of conventional Activated Sludge Process (ASP) and biofiltering mechanism. MBBR has been proven to stabilise waste water with good BOD and COD removal efficiencies. Besides the high removal efficiency for BOD and COD, it offers the additional advantage of lesser space requirement than conventional systems and can be easily augmented to existing treatment plants. It is also proposed to integrate a biogas plant that can supply the necessary fuel required for the heating requirements of the rice processing plant and also reduce the organic load of the effluent treatment plant.

The roles of waste streams as secondary resources would be integrated to process design studies. In general, reducing waste water can be accomplished by (i) reducing a plant's fresh water demand by process operation improvements and (ii) increasing waste water reuse in the process and utility systems as illustrated in figure 3. This system can be implemented if the outlet water from one operation can satisfy the requirements of another operation or in some cases, the same operation. Identification of such streams for efficient water usage is done using Pinch Analysis by constructing a profile of the source and demand streams as illustrated in figure 3.

KRMC gave an overview of the effluent treatment plant at their facility in Kalady. It was decided that a team from Amrita will visit the ETP facility at KRMC.

Since electrochemical technologies have emerged as promising and efficient methods, the project will also explore the economic viability (energy consumption and operating cost) of utilising electrochemical coagulation in waste water treatment.

The tools proposed for the study include process optimisation of integrated aerobic – anaerobic treatment method using response surface methodology, pinch analysis for water reuse and waste reduction and design improvement. As cleaner production involves complex interactions with economic and social performance, an analysis in this respect is also envisaged in the proposed work.

The advantages of the proposed waste treatment scheme are as follows:

1. 90% of the BOD is removed by the biogas treatment UASB, both of which are very cost effective and have low power consumption.

2. Reduction in power requirement for the rice mill as part of the heat energy required for heating and boiling paddy can be obtained from the biogas plant.

3. Compared to conventional plants, the energy requirement is limited to the last 10% of BOD removal in the aeration tank.

4. By matching the source and demand profile of the water streams from various units, entire effluent generated by the plant can be reused and zero discharge.

5. There is no sludge handling problem as all the sludge generated in the clarifiers can be fed to the bio-gas plant for digestion

Report on Visit of Amrita Team to KRMC

Dr. Meera Balachandran, Professor of chemical engineering and Dr. Nithya K., Faculty in chemical engineering visited the rice processing facility of Pavizham Healthier Diet Pvt. Ltd. at Koovappady PO, Perumbavoor on 18th December 2021. Pavizham Healthier Diet Pvt. Ltd. , constituent unit of KRMC, is one of the largest rice mills in Kerala with fully mechanised milling and processing, co-gen power plant and waste water treatment plant. The team visited the parboiled rice manufacturing plant, the flattened rice (poha or aval) manufacturing unit and the utility plant to understand the processes and the nature of the effluent. The team also visited the effluent treatment plant (ETP) and studied the various processes in the ETP. The technology for the waste treatment plant was partly provided by CSIR aimed at zero discharge operation and partly indigenous. The treated water is conforming to the statutory standard and is currently being used for irrigation and sludge is being disposed of into their agricultural land and vacant facility. Samples from various units of ETP and preliminary analysis have been initiated. The company has also provided the ETP layout and few test reports.

By collaborating with Amrita, KRMC aims to bring down the water treatment cost and develop a suitable technology / method to dispose of the sludge that is generated in the ETP plant. This initiative by KRMC is supported by both Kerala and the Central government.

Discussions were held with the Managing Director of Pavizham, Mr. N. P. Antony, the Technical coordinator Mr. Advin Mathew and ETP in-charge Mr. Joy. The Amrita team identified some sections where optimization and modifications are required which will bring down the cost of treatment. A detailed study and analysis of the existing plant design and waste water parameters are required to give a complete solution.

Performance evaluation study of ETP Facility at KRMC-

Analysis of raw Effluent generated and its variations in various sections of ETP

During site visit, raw effluent and waste water samples from various treatment stages were collected from KRMC's effluent treatment facility. The physicochemical analysis based on APHA of the same is presented below.

Table 1 Physicochemical Analysis of Rice Mill Effluent

	pH	MLSS mg/L	BOD mg/L	BOD Reduction	COD mg/L	COD Reduction
Raw Effluent	5.1	NA	3360		5520	

USAB Outlet	7.3	NA	2380	30%	3910	29%
Aeration Tank outlet	7.0	800*	2020	10%	3312	15%
After chlorination & Filtration	6.7	NA	1860	5%	2760	17%
			TOTAL	45%		50%

* Required MLSS in Aeration tank is >4000

Preliminary findings of Rice mill waste water

The waste water collected from the rice mill effluent is analysed and the following findings were documented. Based on the results, the team also suggests several options to upgrade the effluent quality and to make the whole system cost effective. Various options are proposed and based on the interest from the company and upon further discussions the final proposal shall be made for producing higher quality effluent.

Key findings

1. Based on the analysis of the UASB outlet it has been observed that only 30% of BOD and COD load is removed in the UASB reactor. See Table 1. The reason for this could be the poor degradation kinetics of the UASB reactor.
2. BOD reduction in activated sludge process is also very low. Only around 10% of BOD is removed after activated sludge process. Typical MLSS concentrations for conventional activated sludge plants range from 2,000 to 4,000 mg/L. However, we found that only 800 mg/L is the MLSS concentration. This may not remove sufficient BOD from the wastewater.
3. The presence of inhibitory compounds (phenol and lignin) that interfere with, or hinder, the performance of, the activated sludge system in the oxidation (degradation) of the incoming organic load, again leading to high COD concentrations in the effluent.
4. Phenol causes complex COD and cannot be sufficiently oxidised in the UASB or ASP, leading to high COD concentrations in the effluent. Phenols can be degraded but only if the right microbes are present and functioning. The plant's microbial community determines whether you get full, partial or no degradation. Phenols are

good and well controlled in aerobic biological purification as long as the compounds are fed in at a relatively constant rate and there are no coexisting inhibiting agents such as S^{2-} in overly strong concentrations.

5. Even after post treatment such as chlorination and filtration the contaminants are seen to be still on the higher end. More specifically, the TDS value is still found to be 800 – 900 mg/L
6. It has also been observed from our visit that the majority of the contaminants are removed mainly with the use of chemical coagulation units rather than the UASB and ASP processes. This is because a coagulation unit is suitable to remove both Natural Organic Matter (NOM) and Dissolved Organic Carbon (DOC). Alternatively, these question the purpose of having a UASB and ASP reactor in the effluent treatment plant. This adds huge cost to the entire treatment unit and further generates unwanted sludges at undesirable points.

Proposed strategies for the existing treatment

1. An extensive analysis of physical and chemical wastewater characterization is to be carried out to identify the appropriate treatment system for the removal of specific contaminants.
2. Cost analysis of the existing effluent treatment plant and identifying the scope for improvement and reducing unit cost
3. Lab scale coagulation and flocculation studies and in-depth investigations of studies related to chemical dosing requirements in dosing tanks and cutting down cost with respect to quantity and selection of coagulants.
4. Studying the acclimatisation process of activated sludge and UASB towards increasing BOD and COD in a Batch reactor and assessing the biodegradation kinetics.
5. Generating activated carbon from the ash produced from the industry and the same can be used in the activated carbon filter to reduce COD and TDS

Proposed strategies for upgrading the treatment plant

1. Pilot studies on Integrated MBBR (Moving Bed Biofilm Reactor) FBBR (Fixed bed Bioreactor)- Advanced Chemical oxidation process for recalcitrant phenolic, and lignocellulosic compounds and TDS.
2. Studies on the Combination of Coagulation-flocculation and ultrafiltration Processes for COD and TDS removal.
3. Optimising process conditions for the growth of microbial consortia in biological reactors for simultaneous BOD and COD removal.
4. Pilot studies on setting up the Batch Electro coagulator set up for simultaneous BOD and COD removal

A follow-up visit to KRMC was made by the Amrita team on 23 April, 2022 to assess the performance of the effluent treatment plant based on the suggestion given by the Amrita team. The performance was found to be satisfactory. Processes and units that can be optimised further were identified and samples collected for the study.

In the meeting with KRMC officials, they expressed their interest in Industry – Academia joint venture projects and to collaborate with Amrita Vishwa Vidyapeetham, Coimbatore, India to upgrade the existing facility to a better and more efficient technology to generate biomethane gas from the effluent treatment plant. KRMC is interested in exploring carbon credit trading options and reducing the environmental pollution as well as water footprint through total recycling of the treated wastewater. Amrita and KRC will work on a collaborative research project proposal to develop a Biomethane Production Facility from Rice Mill Effluent with Power-to-X integration.

Outcomes

1. Expression of interest from KRMC for collaborative project proposal.

2. Joint collaborative project proposal titled "Green Fuels from Rice Mill Industry using Power-to-X by Integrating Wastewater treatment, Biomethanation, and Solar Power" submitted in response to the Indo Danish Joint call on Green Fuels including Green Hydrogen to the Department of Science and Technology (DST).

XVI. Cashew Nut Industry Needs Assessment

The Cashew (Anacardium Occidentale) was introduced in India by the Portuguese in the 16th Century. Over the years, cashew became a crop with high economic value and attained the status of an export–oriented commodity, earning considerable foreign exchange for the country. India exports cashew kernels to over 60 countries. Its major markets are US, Japan, Spain, France, Germany, UK as well as Middle East countries such as UAE and Saudi Arabia. In India, cashew is cultivated across 1.2 million hectares of land, with a productivity of 706 kg per hectare, according to 2020 government data. Maharashtra, Andhra Pradesh, Orissa, Kerala, Karnataka and West Bengal are among the major producers. India has around 1600 cashew nut processing industries out of which 840 cashew industries are situated in Kerala and are mainly concentrated in Kollam district.

List of Governing bodies and Associations

Directorate of Cashewnut and Cocoa Development, Ministry of Agriculture and Farmers Welfare, Kera Bhavan, Kochi
Kerala Cashew Board Limited, Thiruvananthapuram, Kerala, India.

Demand & Supply

Export of Cashew Kernel, CNSL and Import of Raw Cashewnut in India for the past 20 years

Year	Cashew Kernel Export from India		CNSL Export from India		RCN import into India	
	Quantity (MT)	Value (Rs. Cr.)	Quantity (MT)	Value (Rs. Cr.)	Quantity (MT)	Value (Rs. Cr.)
1998-1999	77,076	1630.00	1912	4.21	2,41,161	958.00
1999-2000	96,805	2569.00	1930	3.74	2,53,577	1186.00
2000-2001	89,155	2049.00	2246	3.89	2,49,318	961.00
2001-2002	98,203	1789.00	4178	5.93	3,55,556	950.00
2002-2003	1,04,137	1933.00	7215	9.26	4,00,659	1237.00
2003-2004	1,00,828	1804.00	6926	7.03	4,52,399	1401.00
2004-2005	1,26,667	2709.00	7474	7.91	5,78,884	2191.00
2005-2006	1,14,143	2515.00	6405	7.09	5,65,400	2163.00
2006-2007	1,18,540	2455.15	6139	10.29	5,92,604	1811.62
2007-2008	1,14,340	2289.02	7813	11.98	6,05,970	1746.80
2008-2009	1,09,522	2988.40	9099	26.06	6,0,5850	2632.41
2009-2010	1,17,991	2801.60	11227	27.62	7,52806	3037.09
2010-2011	1,05,755	2819.39	12051	33.77	5,29,730	2649.56
2011-2012	1,31,760	4390.68	13575	59.46	8,09,825	5338.64
2012-2013	1,00,105	4067.21	9192	29.84	8,92,365	5331.74
2013-2014	1,14,791	5058.73	9480	38.61	7,71,356	4563.99
2014-2015	1,18,952	5432.85	10938	55.81	9,39,912	6570.93
2015-2016	96,346	4952.12	11677	57.59	9,58,339	8561.01
2016-2017	82,302	5168.78	11422	44.00	7,70,446	8839.42
2017-2018	84,353	5870.97	8325	32.63	6,49,050	8850.03
2018-2019	66,693	4433.99	5300	26.85	8,35,463	10929.00
2019-2020	67,647	3867.165	4605	23.093	9,38,038	8861.58

Source: CEPCI

India started importing raw cashew nut kernels in the 1960s to meet its growing processing demands. India's raw cashew production in the 20 years—between 1995 and 2015—grew at a compound annual growth rate (CAGR) of 3.1 per cent, while its domestic demand grew at a CAGR 5.3 per cent, according to the Cashew Export Promotion Council of India (CEPCI). To bridge the gap, India imports from over 15 African and Asian countries.

The problem started in 2006 when the Centre introduced a 9.4 per cent import duty on raw cashew. It intensified in 2016 when the price of raw cashew increased from US$800 to US$1,800 per tonne in the international market primarily due to the growth of cashew processing industries in Vietnam and China, which are more mechanised and efficient than India. India's import of raw cashew declined from 0.96 million tonnes (MT) in 2015-16 to 0.65 MT in 2017-18, according to the Directorate General of Commercial Intelligence and Statistics, Kolkata. Several African countries are now planning to process about 50 per cent of their cashew in-house and enter the world market in a big way. Cashew industry in our country is facing stiff competition from countries like Vietnam, Brazil, Mozambique and Tanzania. India stands 2nd in the export of cashew kernels in the world. Kerala state stood 1st in the extent of area under cashew during 1970s. But with the expansion of area under rubber, major areas under cashew of the state were converted to rubber plantation. At present Kerala stands 6th position in area and 5th position in production among other states viz Maharashtra, Andhra Pradesh, Odisha, Tamil Nadu and Karnataka. Kerala's contribution to the Indian cashew industry is remarkable in the processing and exporting sectors Kerala has 840 registered cashew factories, almost all of them in Kollam. And over 80 per cent have shut shop in the past

few years due to huge operational costs that eventually led to accrued loss of these firms. The closures have rendered many people jobless; mainly women.

Strength	Weakness
· A large pool of experienced and skilled labourers is available. · Favourable climatic conditions give high quality cashew kernels. · Higher output per hectare of cultivation compared to other countries.	· High processing cost. · Lack of process mechanisation and automation. · Dependence of Raw Cashew Nuts (RCN).
Opportunities	**Threats**
· Favourable Government policies can revive the industry. · The industry is having a global growth rate of 4.8% CAGR.	· Heavy dependence on RCN which may attract duty. · The RCN exporters may start processing units in their home country.

Problem statement

Amrita TEC and the seven member faculty team from mechanical, Computer Science departments, visited various cashew nut units in Kollam to understand the process and the issues faced by the Cashew Nut processing cluster.

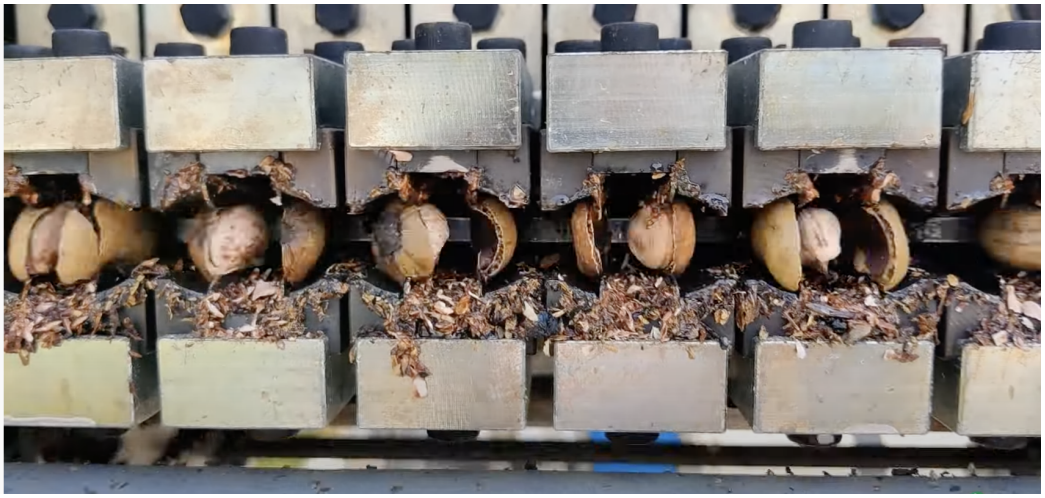
Attendees included:

Sl No.	Name	Background
1	Dr. Jeetu S Babu	Mechanical Engineering
2	Dr. R. Ajith Kumar	Mechanical Engineering

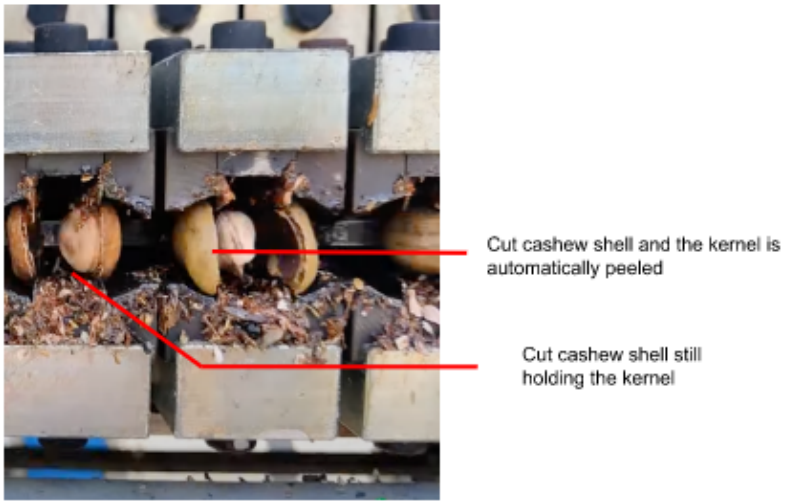
3	Dr. Gopakumar G	Computer Science and Engineering
4	Dr. Sarath S	Computer Science and Engineering
5	Dr.Usha Devi Amma C	ECE
6	Dr. Suma H	ECE
7	Surendran K. N	Mechanical Engineering

Manual hand operated cashew peeling machine

Manual Peeling of the Kernel from the cashew.



Automatic Cashew Shelling Machine.



The team studied the entire manufacturing process to get a holistic view of the problem.

Features	Traditional Hand Cutting	Automatic Shelling Machine	Improve Automatic Shelling Machine
Man Power for Cutting	Yes	No	No
Shelling Efficiency	Low	Moderate	100%
Manual Peeling of Kernels required	Yes	Yes	No
Untouched by Human hand	No	No	Yes

- High operating cost is involved in processing due to manual operations.
- A huge volume of standard quality at standard price is the need rather of the global market.
- A processed food product that is untouched by hand is required for the global market and perceived to be hygienic.
- Automation and novel processes are required for reducing the processing cost of the Industry.
- Shelling is the process where more manual operations are involved which is to be automated with high efficiency to bring the manual operations to nil.

Expected Outcomes

- An automatic shelling machine with 100% efficiency that requires no manual peeling of the kernels will be developed.
- Significantly lower processing cost of production.
- A processed food product that is untouched by hand is required for the global market and perceived to be hygienic.

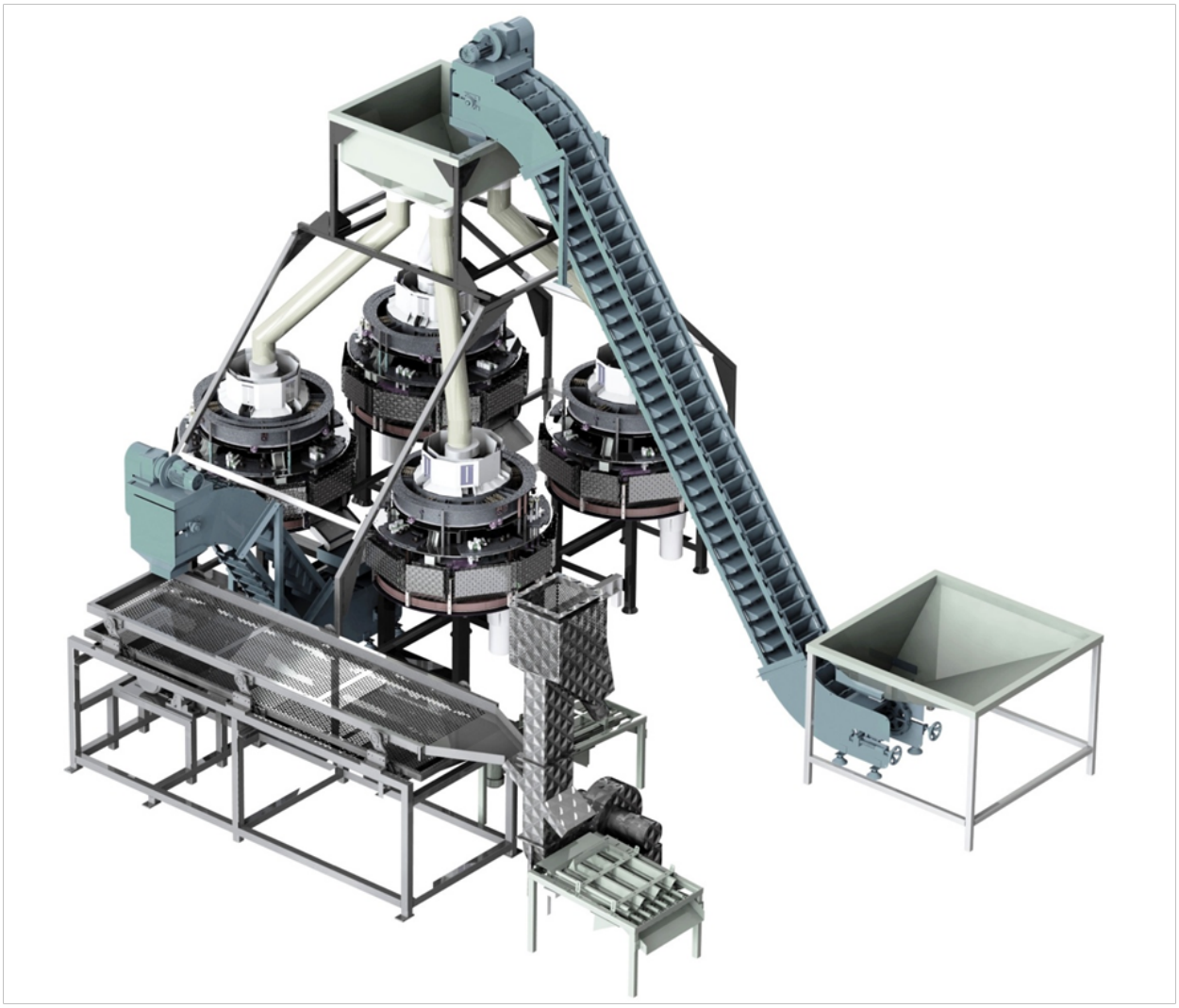
List of Cashew Industries Visited:

1. Latha Cashews, Vallikummam, Kayamkulam., Kerala
2. Sainel Cashews, Padayanivattom, Kayamkulam.

The technology is being developed with **Libra Innovations Pvt. Ltd., Chennai**

Circular Shelling Machine

Multi-Grade shelling machine



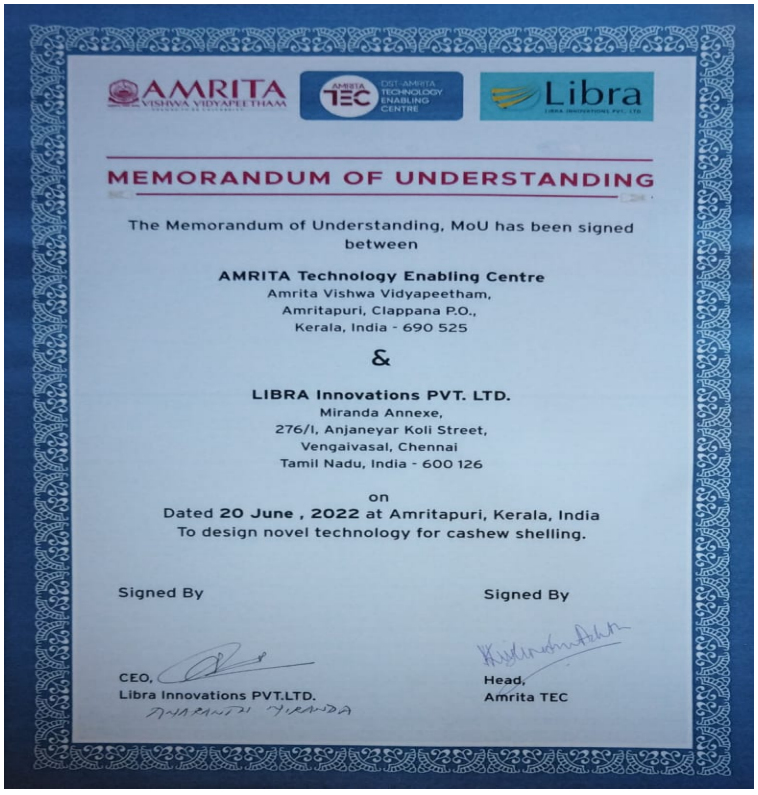
A seven member faculty team from Amrita along with Mr. Surendran K.N. visited two factories in Kayamkulam, Kerala to understand the process and the issues in the Cashew Nut Factory.

The entire process involves Roasting, Shelling, Drying, Peeling, Grading, Quality Controls, Fumigation and Packaging, which is a very labour-intensive process and takes about 10 days to complete. Industry has mechanised some of the process to reduce the cost incurred and increase productivity.

Further, to the discussion with the consortium of the cashew nut Industry in Kollam and Libra Industries Pvt. Ltd. Chennai, the Amrita team was entrusted with the task of solving the technical issue to increase productivity, thereby lowering the cost incurred. An EOI was signed between Amrita TEC and Libra Industries Pvt. Ltd for Research and Development on 20 June 2022.

After multiple interactions with the stakeholders involved - Libra Industries Pvt. Ltd., Cashew Nut Industry Consortium and Amrita Team,, it was agreed that the Amrita will take up the issue for research and development and fine tuning of the technology to achieve the desired results. An EOI was signed by the Amrita TEC team and Libra Industries Pvt. Ltd to take it ahead. Mr. Surendran K N from Amrita TEC played a major role in this and Dr. Pramod R. from Mechanical Engg Dept. will be leading the research efforts to resolve the issues.

Discussion of MOU with Amrita TEC and M/S Libra Innovations Pvt. Ltd, Chennai At Amritapuri



AMRITA VISHWA VIDYAPEETHAM | AMRITA TEC DST-AMRITA TECHNOLOGY ENABLING CENTRE | Libra

MEMORANDUM OF UNDERSTANDING

The Memorandum of Understanding, MoU has been signed between

AMRITA Technology Enabling Centre
Amrita Vishwa Vidyapeetham,
Amritapuri, Clappana P.O.,
Kerala, India - 690 525

&

LIBRA Innovations PVT. LTD.
Miranda Annexe,
276/I, Anjaneyar Koli Street,
Vengaivasal, Chennai
Tamil Nadu, India - 600 126

on
Dated **20 June , 2022** at Amritapuri, Kerala, India
To design novel technology for cashew shelling.

Signed By

CEO,
Libra Innovations PVT.LTD.

Signed By

Head,
Amrita TEC

Signing of MOU with Amrita TEC and M/S Libra Innovations Pvt. Ltd, Chennai At Amritapuri

XVII. Collaboration with Plywood Consortium

Plywood is made of three or more thin layers of wood bonded together with an adhesive. Each layer of wood, or ply, is usually oriented with its grain running at right angles to the adjacent layer in order to reduce the shrinkage and improve the strength of the finished piece. Most plywood is pressed into large, flat sheets used in building construction. Other plywood pieces may be formed into simple or compound curves for use in furniture, boats, and aircraft.

In 1797, Englishman Sir Samuel Bentham applied for patents covering several machines to produce veneers. In his patent applications, he described the concept of laminating several layers of veneer with glue to form a thicker piece—the first description of what we now call plywood.In about 1890, laminated woods were first used to build doors. As the demand grew, several companies began producing sheets of multiple-ply laminated wood, not only for doors, but also for use in railroad cars, buses, and aeroplanes.

In 1928, the first standard-sized 4 ft by 8 ft (1.2 m by 2.4 m) plywood sheets were introduced in the United States for use as a general building material. In the following decades, improved adhesives and new methods of production allowed plywood to be used for a wide variety of applications.

Today, plywood has replaced cut lumber for many construction purposes, and plywood manufacturing has become a multi-billion dollar, worldwide industry.

Indian Plywood Industry

The India plywood market reached a value of INR 195.8 Billion in FY 2021-22. Looking forward, the industry is expected to reach INR 297.2 Billion by 2027-28, exhibiting a CAGR of 7.4% during 2022-23 to 2027-28.

The India plywood market is primarily driven by the growing demand for plywood from the residential sector in the country. This is facilitated by the increasing population, shifting lifestyle patterns and the increasing number of nuclear families across India. In line with this, there has been a considerable increase in the refurbishment and renovation of existing residential areas, supported by rapid urbanisation, inflating disposable incomes and improving living standards of the working population. A majority of the population prefers apartments that are semi-furnished or fully furnished, owing to the associated convenience, which, in turn, is propelling the demand for plywood in the Indian market.

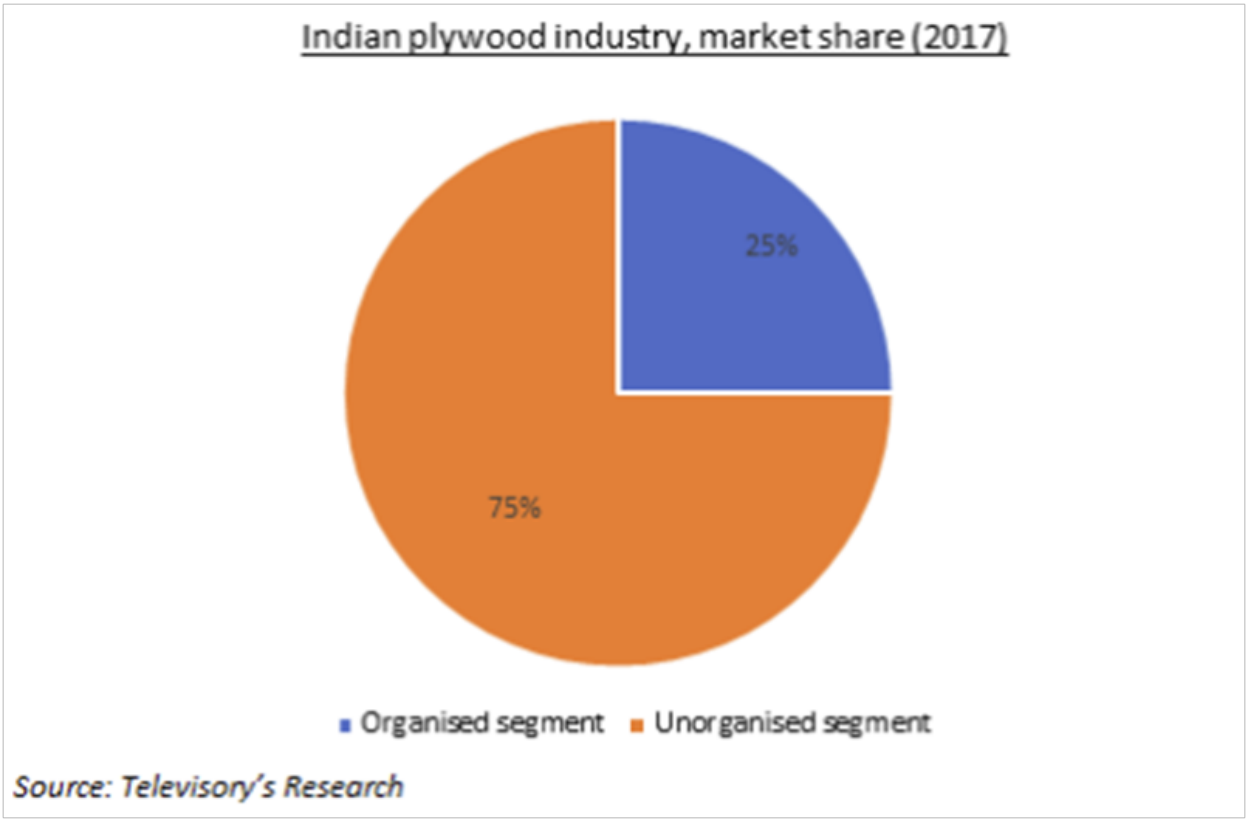
Key players are collaborating and entering into joint ventures with regional plywood manufacturers based across India. The majority of these manufacturers are based out of areas that have an abundance of raw material supply, which ensures an assured supply of finished products at competitive prices.

Plywood Industry in Kerala

Plywood industry is one of the most promising and developing industries in Kerala. The industry makes an enormous contribution to the economy of the state.

According to Sawmill owner and Plywood Manufacturers Association (SOPMA), Kerala has 600 plywood manufacturers and around 450 of them are based out in Perumbavoor and nearby villages. Most of the units started out as Sawmill and moved into the Plywood 20 years ago.

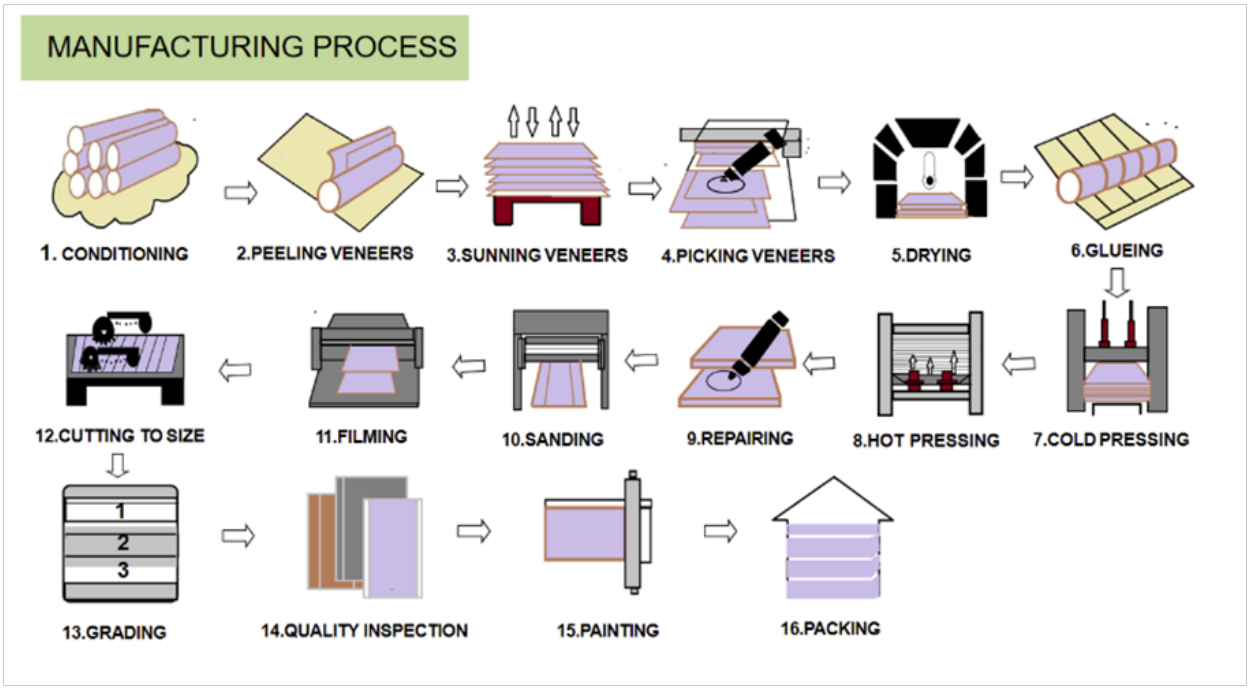
Currently the industry is dominated by the unorganised segment; however there is a shift for unorganised segment to semi-organised and organised segment. Hence there is a need for affordable technology for these companies to upgrade to the need of the market to produce a higher quality product with lesser production cost.



The Approach:

The manufacturing process was studied by visiting the industries to give suitable technology for overcoming their problems.

An Overview of the Manufacturing Process



List of Problems Identified

Major Problem:

Upon studying the manufacturing process, the hot pressing stage plays a critical role in bringing out a quality product. Hence standardisation, automation with control and monitoring has to be employed at this stage of the manufacturing process. The Perumbavoor Plywood Consortium has agreed to have technology transfer for the automation of the hot pressing process through TEC. The parameters that are to be controlled and monitored are:

- Curing temperature maintained in the process.
- Thickness of the veneer.
- Curing time per lot of the production.

Latest sensors and IoT devices are being deployed and a dashboard to monitor these parameters is being developed. This is to be transferred to the industry through AMRITA Technology Enabling Center (AMRITA TEC).

Other problems includes the following:

- Air pollution from the industry due to chemicals involved.
- Deforestation and soil degradation as the raw materials are the trees that have to be cut down.

A strategic alliance is being established with AMRITA TEC to provide a long-term solution for the above stated problems.

Expected Outcome of Technology Transfer

- A consistent quality product at an affordable cost can be produced.
- As the industry becomes more organised, the government's tax collections from the industry will increase.
- The work environment improves for the manpower involved and the manpower challenges faced by the industry facing will get addressed..
- This will provide an opportunity towards solving the air pollution caused due to the industry.

Amrita TEC team is visiting the Plywood Cluster Consortium, Angamaly, Kerala

XVIII. MSME Interactions

The Amrita TEC team is visiting the MSME clusters in Ernakulam, Kottayam, Thiruvananthapuram and other locations in Kerala to identify and understand their products, processes and issues. Mr. Surendran K.N. has visited more than 30 units so far to assess their needs and their Technology Readiness Levels (TRL). Amrita TEC is offering services like technology development, prototyping, testing and commercialization. Amrita TEC also organises training programs and skill development workshops for the benefit of the MSMEs.

Amrita TEC team is visiting the Special Economic Processing Zone, Kakkanad, Kochi

XIX. Problem Statements from Recycling Industries Along Themes Offered by DST

S.No.	Areas of Focus
1	Technologies for Resource Efficiency & Circular Economy, utilisation of industrial wastes & by-products, carbon capture utilisation and storage (CCUS) technologies, skill upgradation
2	Technologies for large utilisation of Red Mud and recovery of Iron, Titanium, Vanadium etc.
3	Technologies for large utilisation of tailing, recovery of quartz and other precious metal from tailing as well as from slag

Amrita TEC team and a faculty team from AMRITA Coimbatore campus, visited about 35 MSMEs in Coimbatore and Kerala for defining the problem statements as required by DST. Some of the industries

visited were Barani Ferrocast Pvt. Ltd., Bright Castings Pvt. Ltd., RSM Autokast PVt. LtdUniversal Iron Traders, Gokul Metals & Alloys etc. The problem statements were arrived at based on the guidance received from DST and the same has been submitted to DST for further action. The problem statements are listed below:

XX. Recycling and Reuse of Waste Sand from Foundries

An effective and scalable technology for recycling, re-using of the waste sand coming out of the foundries and disposal of the carbon wastes to reduce the pollution it is causing.

Abstract

Foundries are one of the oldest industries surviving in the world today. Though newer technologies have come, there is still the problem of adapting to the changes and disposal or reusing of the industrial waste. One of the main ingredients required for foundry is the silica sand. After its use, the sand is dumped laced with chemicals in the old wells or near to the water bodies or open lands. This is causing groundwater poisoning and depletion of soil fertility. Approximately 3000 tons of waste is being dumped in the Coimbatore region alone. Thus, prompting to find a solution for recycling and reusing the waste sand coming out of the foundries. As of now, the sand cannot be reused as it would not give desired results.

The aim of the project is to find a technology solution to recycle and reuse the sand, thereby reducing the pollution caused by the waste sand from the foundries.

1) Recycling and reusing of the Waste Foundry Sand (WFS) in foundry industry
2) Treating and using the WFS in construction materials when it is not fit to be reused in the casting industry;
3) Using the WFS in construction materials applying nanotechnology to arrest the toxic content leaching away on interaction with water.

Expected Outcome

- Reusing of the waste sand in the foundries thereby reducing the excavation of sand from the sea shores
- Silica sand is a natural resource and with the reuse of the sand in the foundries, this natural resource can be conserved
- Reduction in water / soil contamination
- Reduction in fuel consumption since the sand is transported from far-off places

- Reduction in air pollution
- Reuse of the sand means reduction on the quantity of the material required and thereby savings to the company.
- Improvement of health of the people as the groundwater contamination can be reduced or stopped.
- Moving towards environmental sustainability both at local level and global level.

XXI. Process Automation for Effective Recycling of Scraps

Automation of fettling with AI and machine vision to be developed with a focus of reclaiming the material, protecting workmen from occupational hazards and eliminating environmental degradation.

Abstract

After the casting is completed the fettling process is done to remove the unwanted metals from the casting which are currently being dumped as the waste. The excess parts such as die's parting lines, runners, risers, sprue, chills etc are unavoidable in the casting process, but needs to be cut and removed when the final product is to be made ready. The process is currently manual and labour intensive, which is an occupational hazard for the people and is also time-consuming. Even after this process, the unwanted materials will still be on the castings due to human error. Another problem which is imminent is these wastes are collected by the scrap dealers and dumped indiscriminately all over the place, after removing the metal parts from the waste. The same metal is being mixed with other scrap material and resold to the foundries for processing and this is causing a lot of wastage as the castings are developing during the process and large quantities of fine dust is produced, which causes health hazards.

Hence, the need of the hour is to find a solution to reclaim the metal parts completely before dumping the waste. The industry is looking for an AI solution with machine vision which can reclaim the material completely before dumping the waste. A filing process can be adopted which can eliminate the dust produced as a by-product of the process.

Expected Outcome

- Recovery of the material upto 95% - 98%
- Safe working environment for the workmen – which is dust and pollution free
- Recycling of the waste material upto 90%
- Reduction /elimination of the occupation hazards

- Protecting the earth from pollution and contamination thereby reducing the imminent health issues
- Elimination of dust resulting clean working environment

XXII. Effective and Scalable Technology for Capturing, Storing and Reusing Carbon (CCUS) Emitted by Industries and Vehicles.

Abstract

There is a lot of carbon emission from the industries and emission from vehicles. This is causing air pollution and the quality of breathable air has worsened in the cities. While there is immediate need to reduce the carbon emission from the industries and vehicles, another way is to capture the emitted carbon, storing and reusing the same to produce carbon-related products. As of now the technology to capture, store and reuse the carbon is very expensive. As of now, very few and big industries are using this technology in developed countries and this is yet to catch up in India.

There is a huge and immediate need to find a cost effective and scalable solution to capture, store and use the carbon emission from the industries and vehicles.

Expected Outcome

- Reduction in the pollution levels in the country
- Increased air quality
- Improved health and living conditions
- Increased productivity

XXIII. Effective Recycling of Non-Ferrous Scrap Materials

An effective and efficient scalable technology for reusing the Aluminium scrap and reducing the pollution and contamination in the environment

Project Summary

Aluminium is one of the most recycled metals, but the metallurgical difficulty is significantly higher than the steel recycling. This difficulty arises due to a complicated sorting procedure of the collected scrap. 9 different alloys make the composition control and extraction of pure aluminium very difficult. There are a lot of hazardous emissions and metal oxides which need to be effectively disposed of or captured for

reusage. The challenges are metal oxides during the melting process, evaporation of hazardous emissions such as carbon monoxide, lead etc, sorting of aluminium scrap, separation of ferrous scrap from aluminium scrap are most crucial.

But, aluminium and aluminium alloys being low melting metallic materials, has enormous scope for MSMEs to establish local recycling units if the following issues are sorted out.

- An innovative simplified method for sorting of aluminium scrap
- An innovative simplified method for separation if ferrous scrap and impurities from aluminium scrap
- Metallurgy for real-time composition control
- Metallurgy for property enhancement of recycled aluminium alloys
- Control of emissions and solid contaminants

Expected Outcome

- Increased yield and productivity
- Better and safe working conditions
- Capturing, storing, re-usage of emitted carbon emitted during the melting process
- Eliminating indiscriminate dumping and pollution of environment

6. Amrita TEC Initiated Industry Engagements Towards Product Co-Creation.

XXIV. Non-Disclosure Agreement with BPL- Pharmaceuticals

Amrita TEC signed a Non-Disclosure Agreement with BPL for exchange of knowledge, information and co-creation and development of products and processes related to medical devices.
Amrita TEC signed a Non-Disclosure Agreement with BPL for exchange of knowledge, information and co-creation and development of products and processes related to medical devices

Agreement Signing with BPL and Amrita at ASE Coimbatore

XXV. Prototyping and Commercialisation discussion with Holmarc Opto Mechatronics, Kalamassery, Kerala.

AMRITA-TEC team had discussions with Holmarc Opto Mechatronics Pvt Ltd to prototype and commercialise manufacturing of Universal Measuring Machine. Mr.K.N.Surendran, Liaison Executive, MSME Technology Enabling Centre explained the distinctive advantages of the Universal Measuring Machine such as the fact that it has a high accuracy of 0.0001 mm. The patency of the product will be with Amrita School of Engineering and the manufacturing and marketing will be done by Holmarc Opto Mechatronics Pvt Ltd. A one-time technology transfer fee and a royalty on sales is to be paid by Holmarc Mechatronics Pvt Ltd.

Presentation of advantages of Universal Measuring Machine to M/S Holmarc by Mr.K.N.Surendran, TEC Amrita.

Universal Measuring Machine (UMM), Developed by Amrita School of Engineering Amritapuri, CMTI Bangalore and Holmarc Opto-Mechatronics Ltd,Kerala

XXVI. Agreement with Traboda

Amrita TEC signed an agreement with Traboda for framing of process for Cyber Security and Development. Bond on a portal which focuses on the preparedness for Cyber Security.

XXVII. WE SHOULD DO MORE HERE?

7. Events and Visits

XXVIII. Amrita TEC Participation in Government of Tamil Nadu's Naan Mudhalvan initiative meeting

Naan Mudhalvan meeting was held at government secretariat complex at Chennai on 18 June, 2022 presided by Mr. Udhayachandran T, IAS, Principal Secretary to the Chief Minister of Tamil Nadu. This is a pet initiative of the Tamil Nadu government and is in collaboration with NASSCOM & Tamil Nadu Skill Development Corporation. Amrita TEC has got representation in its committee for:

- Evolving a comprehensive plan of action to address employability and skill gaps existing in the state of Tamil Nadu
- White paper on above-mentioned area and fostering innovation in academia
- Structured program for capacity building of manpower for industry and MSME clusters
- Support in solving the problems faced by industry and MSME clusters through technology enablement in universities and colleges
- Strengthen the enabling eco-system with active participation of higher educational institutions with special programs and incentives
- Thrust sectors of the Tamil Nadu government announced as:
    - Semiconductor
    - Fintech & BFSI
    - Electric Vehicles (EV)
- Priority for thrust sectors in technology development support such as patenting, assessment, mining and market study from the government

XXIX. Machinery Expo Expo 2022 Kerala

The Machinery Expo 2022 Kerala was organised by Department of Industries & Commerce, Govt. of Kerala between 24th to 27th January 2022 at JLN International Stadium Ground, Ernakulam

Shri. Prakash (DIrector, MSME Kerala) visits Amrita TEC at Machinery Expo 2022

Amrita TEC participated under the technical Institutions category. Amrita showcased the products developed in-house such as N96 masks, PAPR kit, E-Wheel Chair, UV Sanitzer, Solar driven vehicle and IIOT Sensor products and the visuals were displayed in the stall.

Stall attracted a good number of visitors and there were few genuine queries regarding the Armita TEC from those who wanted to take their technology to the next level and to the market. The following brochure was distributed to the visitors.

XXX. Technology Mining at Central Coir Research Institute, Alappuzha, Kerala.

Amrita TEC team is visiting the Central Coir Research Institute,Alappuzha, Kerala

Amrita TEC team is visiting the Central Coir Research Institute,Alappuzha, Kerala

AMRITA TEC team Mr. K.N.Surendran, Mr. R.Venkatesh and Mr .C.Rathina Balaji visited Coir Research Institute and Enterprise India National Coir Conclave at Coimbatore to identify the opportunities in the coir industry. Following insights and opportunities were identified.

Amrita TEC team at "Enterprise India National Coir Conclave "at Coimbatore

The global coco coir market stood at a value of around USD 304.8 million in 2020. The market is expected to grow at a CAGR of 8.1% in the forecast period of 2022-2027 to attain a value of around USD 485.9 million by 2026. An optimistic growth rate of 13.35% CAGR is also possible and to reach USD 948.69 million by 2027. However, new technology and innovative products have to be developed to achieve this growth. Globally over 30 countries in Asia, East Africa and America grow coconut. Only India and Sri Lanka do value addition to this natural fibre. India commands monopoly with 80% world trade in coir yarn and coir products. Though more than 30 countries spread over the tropical belt in the regions of Asia, East Africa, and America grow coconut, the economic utilisation of coconut husk, which otherwise is a waste material, is made only in Asian countries that too on a significant commercial scale in India and Sri Lanka. In India, coir industry is concentrated in Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Odisha, Puducherry, Maharashtra, West Bengal, Gujarat, Assam, Tripura, Lakshadweep, and Andaman and Nicobar Islands. The needs of the coir industry were identified as follows:

- To identify and transfer existing technologies and promote the use of coir fibre products currently on the market to compete with substitutes
- To mine new technologies and identify innovative products in which natural fibres have advantages over synthetics.

XXXI. Technology Mining at MECON Engineering Consortium Centre, Manjeri, Kerala

Amrita TEC team visit to the MECON Fabrication common Facility Centre,Manjeri,Kerala

Amrita TEC team is visiting the MECON Fabrication Common Facility Centre, Manjeri, Kerala

As a part of technology mining exploration visits, Amrita TEC team visited the common facility centre of steel fabrication cluster, MECON Common Facility Centre (CFC)' at Manjeri. This CFC is equipped with machines like lathe, milling, drilling, grinding, welding, bending, painting and powder coating. The facility also hosts a classroom. Currently the CFC is servicing more than 100 fabrication units in Manjeri and nearby areas.

XXXII. Participation in TINTEX 2022, Handicrafts Exhibition , Thrissur, Kerala

Amrita TEC team is visiting the MECON Fabrication common Facility Centre,Manjeri,Kerala

https://youtu.be/lVchLZXbYDo

AMRITA TEC team team visited Tindex 2022 -Thrissur Industrial Exhibition. This is an exhibition of products of Micro, Small and Medium Scale Enterprises (MSME). 60 MSME showcased their products primarily from the handicrafts sector. This visit was beneficial in identify needs of cottage industries in Kerala.

XXXIII. Technology Mining at Agri Implements Consortium, Shornur , Kerala

Amrita TEC Team Visited The Agri Implements Consortium at Shoranur, Kerala.

The Consortium Chairman, Mr. Purushothaman discussed various problems, challenges and opportunities facing the industry. The TEC team visited the following units.

1. PARASAKTHI Tools and Implements, Shoranur.
2. Gayathri Tools, Shoranur.
3. Universal Agrico, Shoranur

The issues face by this cluster were identified as:

- Availability of quality raw material
- Upgradation of process for Zero defect

- Marketing strategies

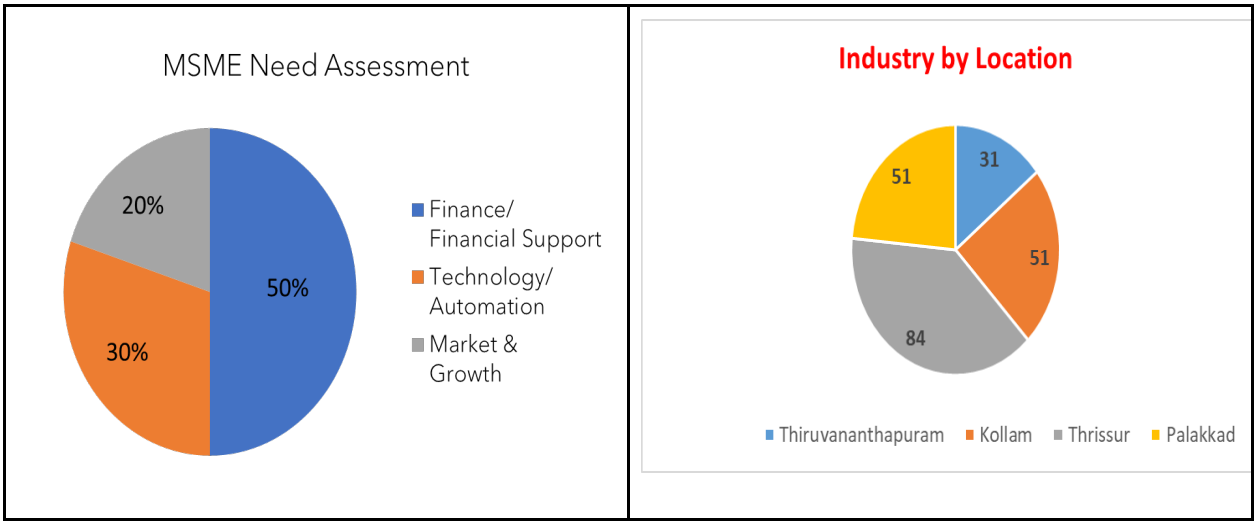
XXXIV. Technology Mining at Kerala Pottery, Thrissur, Kerala

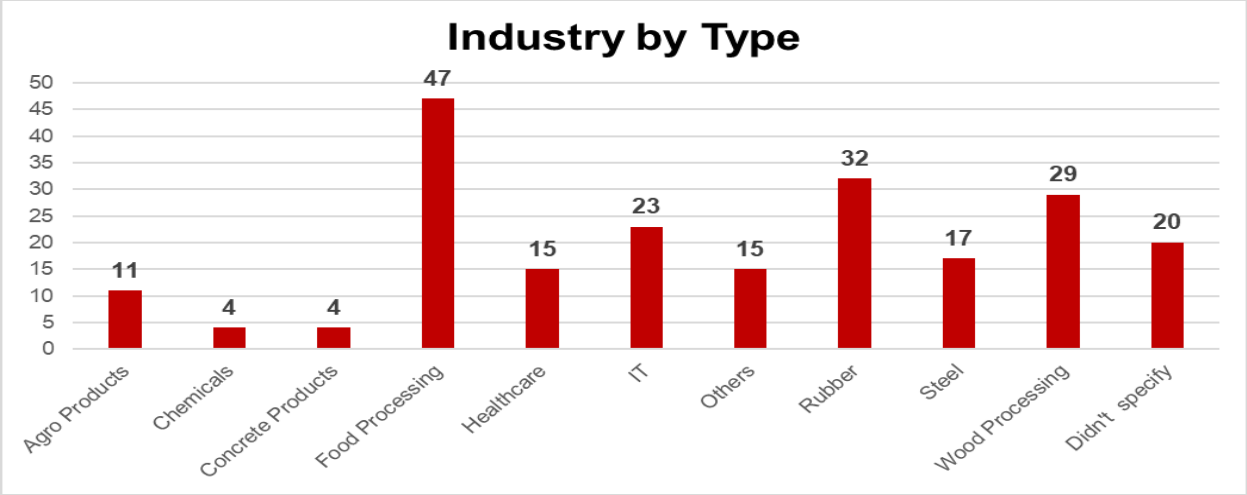
Amrita TEC team visited Kerala Pottery, Thrissur, Kerala to assess the needs of the industry. The end-to-end cycle of the industry from raw materials, process and marketing efforts taken were studied. This is a skill oriented sector and the products do have a high perceived value. However the industry is facing significant manpower challenges as the newer generation is not taking up this vocation due to poor wages and working environment. Although the perceived value of the products are high, the market has not yet discovered a clear market structure to tap the price potential from the buyers as the industry is unorganized and there is no foundational structure for transactions between the manufacturer and buyer.

8. Training Sessions, Seminars and Webinars

XXXV. Needs Assessment for Training For MSMEs

Amrita TEC's surveys to understand what MSMEs needed revealed that primarily finance and financial support, technology and automation as well as a lack of understanding on how to expand the market were the most common issues faced by the industry. India's MSME sector losing competitive edge to other international markets comes as no surprise based on these findings. There is a huge need and opportunity to empower MSMEs in the process.





XXXVI. Development of MSME Specific Training Programs by Amrita TEC

Training of 5S implementation for Productivity Improvement.

- 5s Concept
- Steps in Implementation
- 5S Gamification
- 5s Training
- 5s Performance Auditing
- 5s Culture building.

Sales Training

- Building rapport and customer relationship

- Starting a sales conversation
- Selling strategies
- Sales pitch
- Handling objections and rejections
- Negotiation
- Closing a deal

Digital Marketing

- Introduction to Digital Marketing
- Importance of Digital Marketing
- Digital Marketing Strategies
- Digital Marketing Planning
- Digital Engagement of customer
- Social Media Marketing

ERP Implementation

- Importance of ERP
- Various Modules available in ERP
- Steps in successful implementation of ERP
- Demo of cloud based ERP.

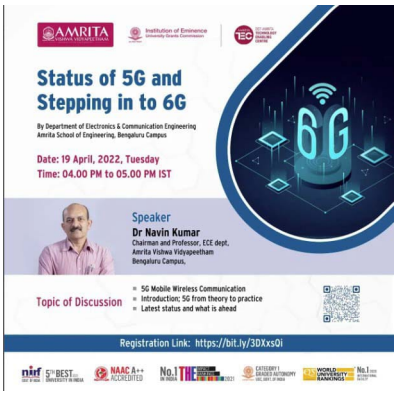
Automation

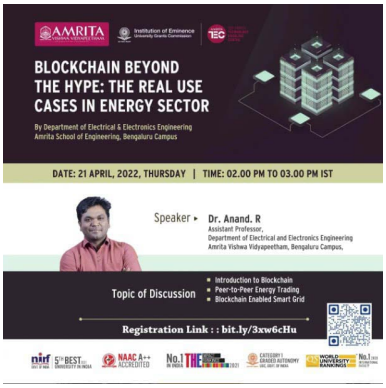
- How Automation is Changing Manufacturing Today
- Automation systems in the age of Industry 4.0
- Intelligent sensors
- Control and Regulation Technology
- Industrial Robots and Humans

XXXVII. List of Seminars and Webinars For Amrita TEC Connected Institutes

Sl No	Title	Number of Attendees
1.	Status of 5G and Stepping in to 6G	165
2.	Blockchain Beyond the Hype: The Real Use Cases in Energy Sector	116
3.	Supply Chain Management	17
4.	The New Age Robotics - A multidisciplinary outlook	28
5.	Energy Storage Devices	21
6.	Camera Captured Document Processing	69

7.	Integrated Machine Health Monitoring	40
8.	Impact of Attitude, Values and Beliefs on Human Behaviour	16
9.	Industry 4.0 – An overview and challenges	46
10.	Biotechnology: The Future is Now	30
11.	AI for Natural Language Processing (NLP)	29
12.	Nudge Marketing and GenZ customers	36
13.	Applications of IoT with Sensor Fusion and Machine Learning	53
14.	Advanced Materials for the removal of Inorganic Contaminants from Wastewater	20
15.	Autonomous Vehicles: The Roles of Communication, Networking and Computing	54
16.	Big Data Analytics and AI in Clinical Trials-An overview	39


Status of 5G and Stepping in to 6G
By Department of Electronics & Communication Engineering
Amrita School of Engineering, Bengaluru Campus
Date: 19 April, 2022, Tuesday
Time: 04.00 PM to 05.00 PM IST
6G
Speaker
Dr Navin Kumar
Chairman and Professor, ECE dept,
Amrita Vishwa Vidyapeetham
Bengaluru Campus,
Topic of Discussion
5G Mobile Wireless Communication
Introduction: 5G from theory to practice
Latest status and what is ahead
Registration Link: https://bit.ly/3DXxs0i

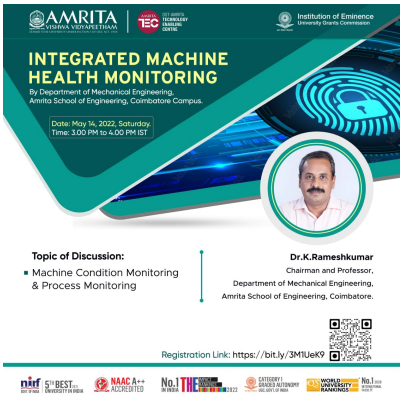

BLOCKCHAIN BEYOND THE HYPE: THE REAL USE CASES IN ENERGY SECTOR
By Department of Electrical & Electronics Engineering
Amrita School of Engineering, Bengaluru Campus
DATE: 21 APRIL, 2022, THURSDAY | TIME: 02.00 PM TO 03.00 PM IST
Speaker
Dr. Anand. R
Assistant Professor,
Department of Electrical and Electronics Engineering
Amrita Vishwa Vidyapeetham, Bengaluru Campus,
Topic of Discussion
Introduction to Blockchain
Peer-to-Peer Energy Trading
Blockchain Enabled Smart Grid
Registration Link : : bit.ly/3xw6cHu


SUPPLY CHAIN MANAGEMENT
By Department of Mechanical Engineering,
Amrita School of Engineering, Bengaluru Campus
25 April 2022, Monday
03:30 pm to 04.30 pm IST
Speaker
Dr. T. Srinivas Rao
Associate Professor
Department of Mechanical Engineering,
Amrita School of Engineering, Bengaluru
Topic of Discussion
Solving Supply Chain issues through evolutionary algorithms
Registration Link : bit.ly/3KR1uYt


THE NEW AGE ROBOTICS - A MULTIDISCIPLINARY OUTLOOK
By Department of Electronics and Communication Engineering,
Amrita School of Engineering, Bengaluru Campus
27 April 2022, Wednesday | 03:30 pm to 04.30 pm IST
Speaker
Dr. Sreeja Kochuvila
Topic of Discussion
The current/emerging trends in robotics research
Registration Link: https://bit.ly/3u0Krtir

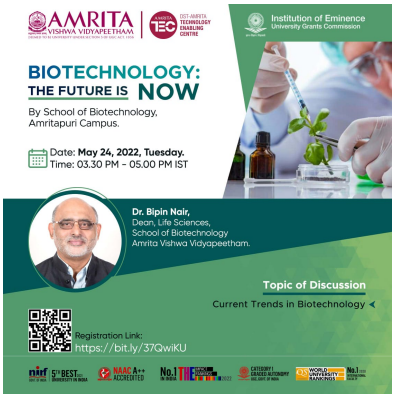

Webinar
Energy Storage Devices
by Department of Science and Humanities
Amrita School of Engineering, Chennai Campus.
April 29 2022 (Friday)
04:30 PM to 05:30 PM IST
Topic of Discussion
Energy storage devices
REGISTER NOW
bit.ly/3xFYhqX
SPEAKER
Dr Sarathchandran C
Asst. Professor
Department of Science and Humanities,
School of Engineering, Amrita Vishwa
Vidyapeetham, Chennai Campus.


WEBINAR
CAMERA CAPTURED DOCUMENT PROCESSING
By Department of Computer Science and Engineering,
Amrita School of Engineering, Bangalore Campus.
On 30 April 2022(Saturday) At 02.00 PM to 03.00 PM IST
SPEAKER
Dr. Peeta Basa Pati
Professor, Department of Computer Science and Engineering,
School of Engineering, Amrita Vishwa Vidyapeetham, Bengaluru.
Topic of Discussion
Introduction into processing document images
Challenges associated with camera captured document images
Progress in technology development of camera captured documents
REGISTER NOW
bit.ly/3Mbj6i1


INTEGRATED MACHINE HEALTH MONITORING
By Department of Mechanical Engineering,
Amrita School of Engineering, Coimbatore Campus.
Date: May 14, 2022, Saturday
Time: 3.00 PM to 4.00 PM IST
Topic of Discussion:
Machine Condition Monitoring & Process Monitoring
Dr.K.Rameshkumar
Chairman and Professor,
Department of Mechanical Engineering,
Amrita School of Engineering, Coimbatore.
Registration Link: https://bit.ly/3M1UeK9

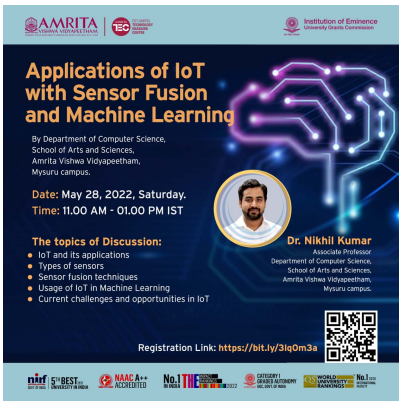

IMPACT OF ATTITUDE, VALUES AND BELIEFS ON HUMAN BEHAVIOUR
By Department of Management and Commerce,
Amrita School of Arts and Sciences,
Mysore Campus.
Date: May 18, 2022, Wednesday
Time: 11.00 AM to 12.00 PM IST
Topics of Discussions:
Basic aspects of human behaviour and how a person's attitudes, values, and beliefs influence his behaviour.
What type of human being is needed for the organization, and whowill be left behind in the race.
Speaker: Dr. Sriranjini.S
Assistant Professor,
Department of Management and Commerce,
Amrita School of Arts and Sciences,
Mysuru Campus.
Registration Link: https://bit.ly/3vVuSqi


INDUSTRY 4.0
AN OVERVIEW AND SOME CHALLENGES
By Department of Computer Science and Engineering,
Amrita School of Engineering,
Bangalore Campus.
Topic of Discussion
A brief overview of Industry 4.0
Associated research challenges in Computing, Communication, and Control/Monitoring.
Dr. B. Hariram Satheesh
R&D manager,
ABB Technology, Bangalore
Registration Link:
https://bit.ly/3Mhefwv
Date: May 21, 2022, Saturday
Time: 10.00 AM to 11.00 AM IST


BIOTECHNOLOGY:
THE FUTURE IS NOW
By School of Biotechnology,
Amritapuri Campus.
Date: May 24, 2022, Tuesday.
Time: 03.30 PM - 05.00 PM IST
Dr. Bipin Nair,
Dean, Life Sciences,
School of Biotechnology
Amrita Vishwa Vidyapeetham.
Topic of Discussion
Current Trends in Biotechnology
Registration Link:
https://bit.ly/37QwiKU


AI for Natural Language Processing (NLP)
By Center for Computational Engineering and Networking (CEN)
Amrita School of Computing,
Amrita Vishwa Vidyapeetham,
Coimbatore Campus.
Date: May 27, 2022, Friday.
Time: 05.00 PM - 06.00 PM IST
Dr. Premjith B,
Assistant Professor,
Center for Computational Engineering and Networking (CEN)
Amrita School of Computing,
Amrita Vishwa Vidyapeetham,
Coimbatore Campus.
The topics of Discussion:
Introduction to NLP
Recent Trends in NLP, Important Algorithms in NLP
Research problems in NLP
Registration Link: https://bit.ly/3LmZ1Vq


Nudge Marketing and GenZ customers
By Department of Commerce and Management,
Amrita School of Arts & Science,
Amritapuri Campus
Date: May 27, 2022, Friday.
Time: 07.00 PM - 08.00 PM IST
The topics of Discussion:
How small attractions give great results in the market.
How to communicate with your customers when they are focused
Dr. SHEEJA.R
Assistant Professor,
Commerce and Management,
Amrita School of Arts & Science,
Amritapuri Campus
Registration Link: bit.ly/39sBXqW


Applications of IoT with Sensor Fusion and Machine Learning
By Department of Computer Science,
School of Arts and Sciences,
Amrita Vishwa Vidyapeetham,
Mysuru campus.
Date: May 28, 2022, Saturday.
Time: 11.00 AM - 01.00 PM IST
The topics of Discussion:
IoT and its applications
Types of sensors
Sensor fusion techniques
Usage of IoT in Machine Learning
Current challenges and opportunities in IoT
Dr. Nikhil Kumar
Associate Professor
Department of Computer Science,
School of Arts and Sciences,
Amrita Vishwa Vidyapeetham,
Mysuru campus.
Registration Link: https://bit.ly/3lq0m3a


Advanced Materials for the removal of Inorganic Contaminants from Wastewater
By Department of Chemical Engineering and Materials Science,
Amrita School of Engineering,
Coimbatore Campus
Date: Jun 04, 2022, Saturday
Time: 10.00 AM - 11.00 AM IST
The topic of Discussion:
Water and Wastewater treatment using nanomaterials and biochar
Dr. Nithya K.
Assistant Professor
Department of Chemical Engineering and Material Sciences,
Amrita School of Engineering,
Coimbatore Campus.
Registration Link: bit.ly/3IYQ4aw


AUTONOMOUS VEHICLES:
THE ROLES OF COMMUNICATION, NETWORKING AND COMPUTING
By Department of Electronics and Communication Engineering,
Amrita School of Engineering,
Bengaluru Campus.
Date: June 08, 2022, Wednesday
Time: 04.00 PM - 05.00 PM IST
The topic of Discussion:
Technologies that pave the way for autonomous vehicles, emphasizing the roles of communication, networking and computing.
Dr. Manoj Kumar Panda
Associate Professor,
Department of Electronics and Communication Engineering,
Amrita School of Engineering,
Bengaluru Campus.
Registration Link:
bit.ly/3Q4QxWy


BIGDATA ANALYTICS AND AI IN CLINICAL TRIALS-AN OVERVIEW
By Department of Computer Science and Engineering,
Amrita School of Engineering,
Bengaluru Campus.
DATE: JUNE 09, 2022, THURSDAY
TIME: 03.00 PM- 04.00 PM IST
Ms. Uma Kattil Sadasivan,
Senior Bigdata engineer,
IQVIA Research and Development India Pvt Ltd,
Bangalore.
Topics of Discussion:
What is Clinical Trial?
How does BigData Analytics make clinical trials simpler?
Importance of AI in Clinical Trial
Registration Link:
bit.ly/3m2V5Pe