



विज्ञान एवं  
प्रौद्योगिकी मंत्रालय  
MINISTRY OF  
SCIENCE AND  
TECHNOLOGY

सत्यमेव जयते

# 2023 **DST - AMRITA TECHNOLOGY ENABLING CENTRE**

## HALF YEARLY REPORT - JAN - JUN 2023

---

Dr. Krishnashree Achuthan  
Amrita Vishwa Vidyapeetham, Amritapuri,  
Kollam, Kerala - 690546

# Table of Contents

<b>Table of Contents.....</b>	<b>2</b>
<b>Technologies Mined, Developed, Commercialized and Transferred .....</b>	<b>4</b>
Technologies Mined.....	4
TRL Assessment.....	4
<b>Technologies Commercialized .....</b>	<b>11</b>
India's First Low-Cost Hybrid Solar-Electric Car .....	11
Hybrid Distribution System with Survat Industries .....	12
Product Commercialization of Cheapest Powered Wheelchair .....	13
<b>Technologies Developed.....</b>	<b>14</b>
Cashew Grading Machine development with MAKS Automation, Kottarakara.....	14
Development of Healthcare Robots with material handling capability. ....	15
<b>Consultancy for Shoranur Agricultural Implements Consortium Pvt. Ltd. (SAICO) .....</b>	<b>17</b>
About the Industry .....	18
Preliminary Industry Study .....	18
Questionnaire.....	19
Detailed Industry Study .....	19
Welding Cluster (20-25 companies).....	20
Scissors Cluster (15-20 companies) .....	20
Cutlery Cluster (20-25 companies) .....	20
Implements Cluster (25-30 companies) .....	20
Findings from Study .....	21
Demand Management .....	21
Market Survey .....	21
Forecasting Techniques.....	21
Aggregate Planning .....	22
Process Flow Analysis ~ Current State VSM.....	24
Findings from the VSM ~ Implements Cluster .....	24
Chart, pie chartDescription automatically generated .....	25
Cutlery Cluster .....	25
Findings from VSM .....	26
Suggestions .....	27
Development of a Lean Framework.....	27
Our Plan for the Consortium .....	30
Productivity enhancement of agricultural equipment manufacturing consortium- An investigative study.....	30
Department-wise sequence of questions.....	30
About the Consortium .....	31



<b>Industry &amp; Government Bodies Tie-Ups for Technology Enablement through TEC.....</b>	<b>32</b>
Interactions with MADITSSIA, Madurai.....	32
Interaction with NIFT-TEA.....	33
Interaction with ZAR Partners .....	33
Interaction with Spirex Food .....	34
Janatics India Pvt. Ltd.....	35
Kalki Automations Visit to Coimbatore Campus .....	35
Collaboration with Scomode Technologies.....	36
Bangalore Chamber of Industry and Commerce, BCIC.....	36
Ecosystem Collaboration Interaction with MeitY Startup Hub.....	39
Collaboration with CODISSIA Defence Innovation and Atal Incubation Centre (CDIIC) .....	40
Amrita - CII Collaboration.....	41
MSME Intellectual Property Facilitation Center .....	42
MSME, DI tie up for Entrepreneurship Awareness Camp.....	42
Rural Impact Innovation in Coir Industry .....	43
<b>Academic Partnerships with various institutions.....</b>	<b>45</b>
SNS College of Engineering (Autonomous), Coimbatore .....	45
Kalaingar Karunanidhi Institute of Technology, Coimbatore.....	46
RVS Arts & Science, Coimbatore. ....	47
Dr. NGP Institute of Technology (Autonomous), Coimbatore. ....	48
<b>Events .....</b>	<b>49</b>
Amrita TEC Participation in the 108th IndianScience Congress (ISC) 2023 .....	49
Participation in IMTEX, 2023 .....	50
DST Amrita TEC Participation in Global Tech Summit.....	51
DST Amrita Technology Enablement Meet & Exhibition at KPRIET, Coimbatore .....	53
DST-Amrita TEC is the Event Partner for Uimage Catalyst'23 roadshow of StartupTN. ....	55
DST-Amrita Technology Enabling Center (TEC) Anokha Techfair (April 2023) .....	56
TEC Conclave, University of Hyderabad .....	58
Training program & Webinars Organized .....	58
<b>Industry-Academic interaction facilitated by TEC Anokha.....</b>	<b>61</b>
Industry Academia Meet (May 2023) .....	62
<b>Civil20: Summit on Technology, Security and Transparency, coimbatore.....</b>	<b>64</b>
<b>Awards &amp; Acheivements .....</b>	<b>66</b>
Elected as Sectional Committee Member of the ICT .....	66
Consolation Prize at IMTEX, 2023 .....	66
<b>Patents &amp; Designs Granted through TEC.....</b>	<b>67</b>
US Patent 11,618,625 Protective Packaging and Delivery.....	67
US Patent 11,610,466 Multilevel Rapid Warning System for Landslide Detection .....	69
Indian Patent 422918 A Progressive Computer Simulated Haptic Training System for Bar	



Bending Skills .....	69
----------------------	----

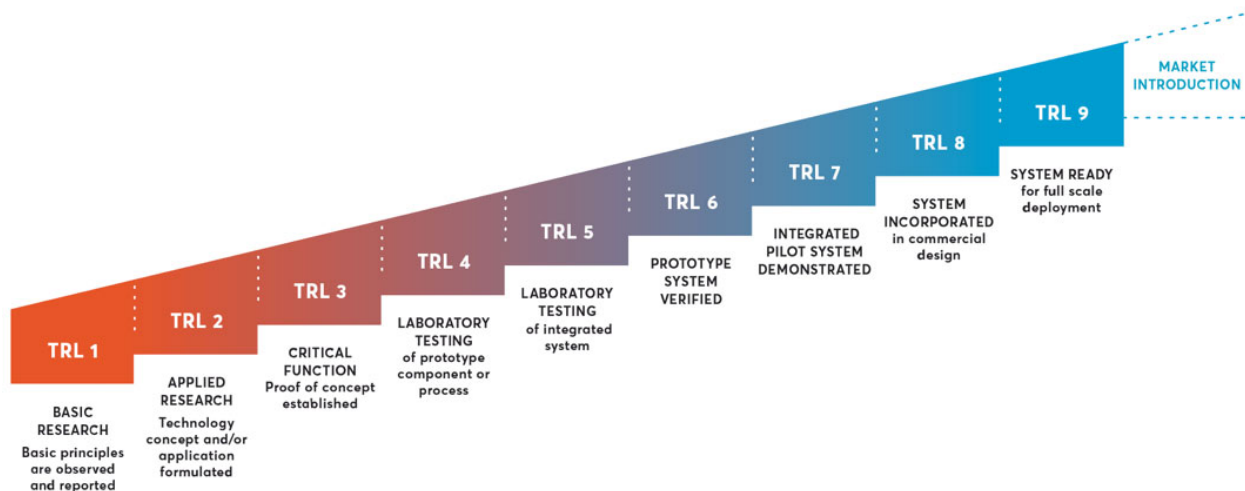
# Technologies Mined, Developed, Commercialized and Transferred

## Technologies Mined

One of the focus areas of activity of DST-Amrita TEC is the mining of technologies. The technologies were mined from Amrita Vishwa Vidyapeetham's IP portfolio, DST recommended projects, and the technologies developed in other academic institutions where the Amrita-TEC acts as a hub or nodal center for developing technologies and inculcating the innovative mindset amongst the young minds

## TRL Assessment

TRL assessment is a systematic method used to evaluate the maturity and readiness of the technology for practical application or implementation. The TRL scale is a standard tool used by researchers, engineers, and decision-makers to assess the development stage of a technology, ranging from its conceptualization to its full-scale deployment and commercialization.



Title of the Project	TRL	Field
Smart Shopping Using Metaverse	3	AR / VR
Smart Helmet	4	IOT



PST Intersecting Platform	3	Software
Electric Cycle With Anti-Theft System	5	IOT
Semi-Automatic String Hopper Machine	2	Food
Sensor Trash Bin	2	IOT
IV Drip Rate Monitoring System	2	Health Care
lot Based Vehicle Pollution Detection	2	IOT
Automatic Cradle System For Infant Care Using lot	2	IOT
Smart Wireless Information Board	2	IOT
Automatic Power Failure Information To EB	2	Power
Energy Harvesting Umbrella	3	Power
Smart Navigation Stick -Blind Person	3	IOT
Middle Benchers	1	Software
Design Virtual Kit	1	Software
Smart Irrigation System	2	IOT
Coffee Roaster Machine Module	2	Food
Health Monitoring Band Using lot	1	Healthcare
Exoskeleton For Paralytic Leg	1	Healthcare
Third Arm	2	Miscellaneous
An Wearable Device To Prevent Covid Led Pneumonia Infection	1	Medical / Healthcare
EyeBall Sensored Automatic Wheelchair For Paralyzed Patients	1	Healthcare
Enhanced Biosorption Of Heavy Metals Using Fungal Biomass	1	Water Treatment
Synthesis Of Carbon Quantum Dots From Shrimp Shells And Using It For Heavy Metal Detection	1	Water Treatment
Bio Contactor For Dye Decolourization Using Isolated Bacterium -Ddb-6	2	Water Treatment
Solar PV Array Based Multifunctional Smart EV Charger	1	Power
Highway Wind Power Generation Using Vertical Axis Turbine	1	Power
Road Accident Management System	2	Software
lot Based Smart Parking System	1	IOT

Vertical Axis Wind Turbine	1	Power
Hospital And Pharmacy Management	1	Healthcare
Autonomous Underwater Vehicle	1	UAV
Hand Operating Shock Tube	2	Instrument
Mini Stealth Drone	2	UAV
Three Way Drone	2	UAV
Design Of Electric Meter Box Opener Using Rfid	1	Power
Automated Speed Optimizer	1	Automobile
Predator Free Agriculture Farm	1	Agriculture
SOS Bangle For Women Safety	1	IOT
Automated Accident Intimation And Rescue System Using AI	2	IOT
Indoor Navigation System	1	Health Care
Household Cleanser To New World For Hygienic Food Consumption	5	Food
Smart Waste Management And Segregation	1	Waste Management
Fruit Flavoured Tea Powder With Enhancing Nutrients	3	Food
Subsurface Drainage Cum Irrigation	1	Agriculture
Underwater ROV	5	UAV
Self Regulated Trash Segregating Bin	5	Waste Management
lot Thermal And Mask Entry System	2	IOT
Control Of Devices By Eyeball Tracking For Paralyzed Patients	1	Health Care
Warm Bed Mattress	2	Health Care
Capsule Based Gastric Rhythm Analyzer	4	Health Care
Crop Growth Monitoring And Pest Control By Organic Pesticide Using Drones	2	Agriculture
An Oracle For Crop Selection And Networked Merchandise Hub	3	Agriculture
Advanced Irrigation Control Systems Based On Iot	1	Agriculture
Mobile Application For Mental Health Issues And Rehabilitation	1	Healthcare
An Android Application For Reliable Production Of Textile Merchandises	1	Software
A Website For Renting Farm Equipment And Soil	1	Software

Replenishment		
3- Tier Safety	1	Software
Women Safety Using Automatic Drone Technology	1	Drone
Landmine Detection Using Drones.	1	Drone
Sign Language Detection And Translation	2	Software
Vision Glass For Visually Impaired Using Yolo V3	2	AR/VR
Livestock Farming Management Using Android Application	1	Software
Usage Of Modern Technologies In A Rescue Squad Wagon	1	Software
Analysis Of Stock Values On Stock Market	1	Software
Internet Of Things Based Traffic Management For Emergency Vehicles	1	IOT
Fertilizers Composition With Plant Growth Analysis And Implementation Of Smart Agro System	3	Agriculture
Iot Based Smart Band	1	IOT
Crop Growth Monitoring System And Network Merchandize App For Smart Agriculture	3	Agriculture
IOT Based Smart Dustbin	1	IOT
Smart Solution For Railways	1	Logistics
Gas Leakage Monitoring & Alerting System For Industries	1	IOT
Smartfarmer - IOT Enabled Smart Farming Application	1	Agriculture
Signs With Smart Connectivity For Better Road Safety	1	IOT
Smart Hand Wash Monitoring Device	1	HealthCare
IOT Enabled Forecasting And Warning System For Flash Floods And River Floods	1	Disaster Management
Smart Charging On E-Vehicle Using Grid Connection And Solar Power	2	Electric Vehicle
Detection Of Mask And Human Body Temperature Sensed Automatic Door Opening System	2	Software
Design Of Three Port DC-DC Cuk Converter	3	Power Electronics
Smart And Automated Irrigation System Using IOT	2	Agriculture
Multi Use Power Grid Using Bidirectional Converter	2	Power Electronics
Bidirectional DC-DC Converter for	3	Electric Vehicle

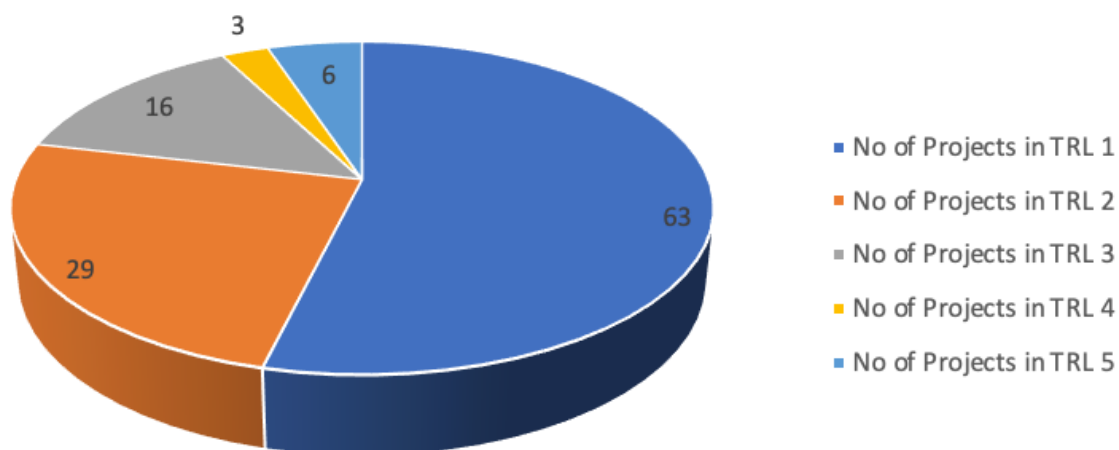


Plug-In Electric Vehicle Charger		
IOT Based Home Security System And Theft Identification System	3	IOT
Modified Mechanical Structure Electric Bike Design Computation And Prototype Model Implementation	3	Electric Vehicle
Efficient Luo Converter Based On Sheppard Taylor Topology For DC Micro-Grid Applications	1	Power Electronics
Prototype Development Of Iot Based Cotton Crop Health Monitoring System And Smart Irrigation With Field Protection Using Autonomous Rover	4	Agriculture
AI Based Two Way Sign Language Recognition System	1	Software
Touch Free Restroom Restoration Machine	5	Health & Hygiene
Electric Mini Mobility Vehicle	5	Electric Vehicle
Smart OTP Based Wireless Locking System	1	Software
Art From Waste - Waste Management	3	Waste Management
Connect To Serve	1	Software
Women Safety	1	Software
Career Guidance App	1	Software
AJ Arts	2	Waste Management
Easy Tech	1	Software
Shilp	2	Waste Management
Hands In Future	1	Software
Grow Your Career	1	Software
Betel Leaf Ladoo	3	Food
Integration Of AI With Artificial Intelligence	1	AI / ML
Hypoglycemic Food Products Using Flowers	1	Food
Butterfly Pea Flower Cookies	1	Food
Microbial Sunscreen	1	Bio Technology
Biodegradable Sanitary Napkins	1	Bio Technology
Carbofuran Pesticide Detection Kit	3	Bio Technology
Nutrient Bottles	3	Bio Technology

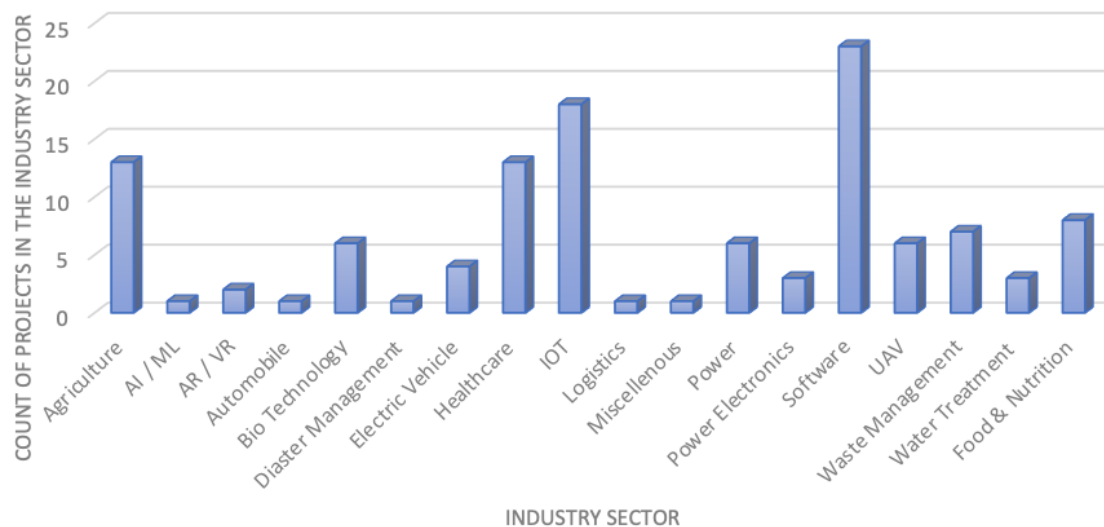
Save Indian Economy	1	Software
Mybookstore	1	Software
College Sports Management System	1	Software
Whole Indian Handicrafts Products	1	Waste Management
Fish Amino Acid, Organic Fertilizers	2	Agriculture
Organic Lipstick	2	Bio Technology
Organic Fertilizers	1	Agriculture
Organic Beauty Products	1	Bio Technology
Valued Added Products From Sugarcane Bagasse	1	Waste Management
Millet Biscuits	1	Food

Amrita TEC has so far assessed about 117 technologies in the past 6 months enabling the innovators to fine tune and take their ideas to the next level. The technology mining process involves approaching the innovators, MSMEs, and R&D in academia to share their ideas/innovations/prototypes in a prescribed format. An NDA agreement is signed with them to make them feel comfortable to share their ideas/innovations. A presentation is made by the innovator to explain their ideas in detail during the TRL assessment. Questions are asked to fine-tune their ideas/innovations so that the products gain acceptance in the market.

### Technology Readiness Level of the Projects




### Industry Sector of the Projects



117 technologies were mined during the period Jan to June 2023. Out of the total number of the technologies mined, about 8% of the technologies were above the TRL level of 4. Suggestions and ideas were shared with the innovators to improve or modify their ideas according to the





needs of the market. Ideas on market-driven innovation and how to inculcate the ideas that would benefit society at large are shared with the innovators.

# Technologies Commercialized

## India's First Low-Cost Hybrid Solar-Electric Car



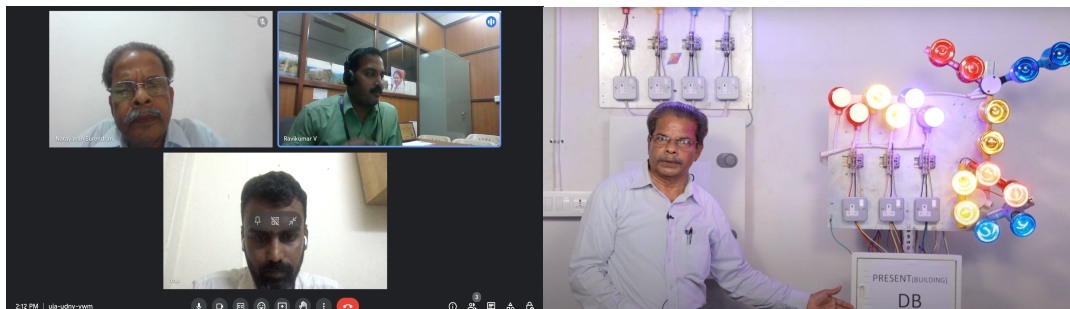
The Technology Enabling Centre (TEC) has been at the forefront of supporting the development and advancement of eco-friendly transportation. As part of the mission to benefit society and combat climate change, TEC has supported the innovation of India's first low-cost hybrid solar-electric car. With a solid commitment to reducing carbon emissions and promoting sustainable practices, TEC has supported filing of patent for this groundbreaking hybrid car that can be fitted to the existing IC Engine vehicle. TEC is now exploring the commercialization of this revolutionary vehicle. By harnessing the power of solar and electric energy, the low-cost hybrid car offers an environmentally friendly transportation solution that significantly cuts down on carbon emissions. The initiative supports the vision of our country and Chancellor Amma in that "We should indigenously develop and build eco-friendly and electric transportation vehicles that not only

benefit society but also reduce climate change or global warming by cutting down carbon emissions. “

The activities and support extended by the TEC include the following

- Support for Development of Hybrid car
- Patent Filed and Granted
- Exploring Commercialization

## Hybrid Distribution System with Survat Industries



Amrita Technology enabling center has supported Survat Industry for validating their innovation through the support of Technology Enabling Center. The interaction with the innovator and the expert review was facilitated by TEC. The innovation was primarily a distribution board with enhanced safety than the conventional three-phase distribution board. The Hybrid Distribution Board has the following features.

- The new model called hybrid DB (HDB) developed for three-phase systems will isolate the fault in each phase individually or the fault between phases.
- The accuracy is high, and the operating time of the HDB is kept minimum for ground fault as well as earth fault to avoid any further damage to the equipment connected.
- When a fault occurs in any one phase, that particular phase is only isolated, keeping healthy phases energized continuously, which is not possible with the currently available three-phase DB in the market.

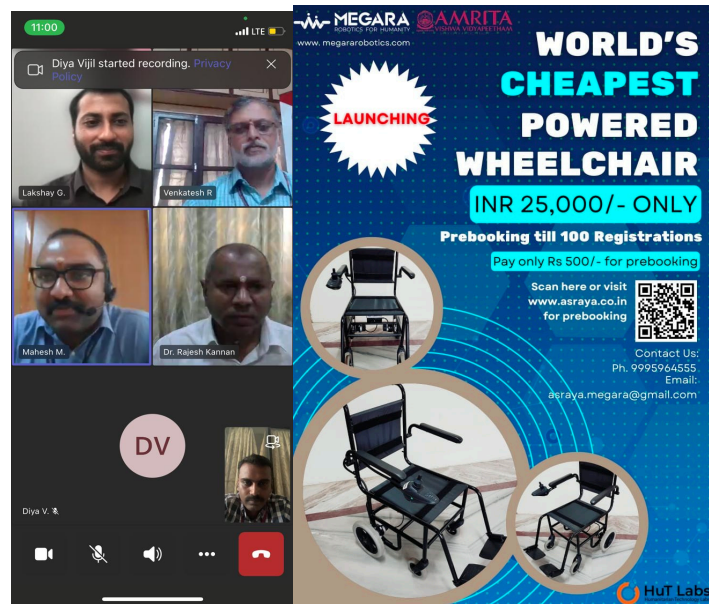


- The HDB brings individual neutral wires for all the phases; hence improper wiring by an electrician could be avoided. Hence the load circuit will act as an individual phase.
- This HDB panel will be useful to residential and commercial customers where the EB supply is three-phase because the connected load is high, but the customer is using all single-phase loads.
- The robust design of the HDB panel brings unique and robust operation for the fullest safety to the end customer.

## Product Commercialization of Cheapest Powered Wheelchair

Amrita Technology Enabling Center has supported Humanitarian Labs in bringing out the product from its initial stage of a lab-scale prototype, testing, validation, and commercialization of the product. Megara Robotics is one of the leading companies in innovative robots for humanitarian causes. Its main objective is to act as designers, developers, buyers, sellers, and dealers in all kinds of Robot and Automation Systems, Robot and Automation technology, and Information Technology products and act as manufacturer of Robot and Automation components, Robot and Automation control components and Providing Robot Control Services, Automation projects and Service and Advanced Powered Wheelchairs and expansion programs. Amrita TEC has inked a partnership for third-party manufacturing to gain access to the broader markets. The various product that is considered for outsourced manufacturing is

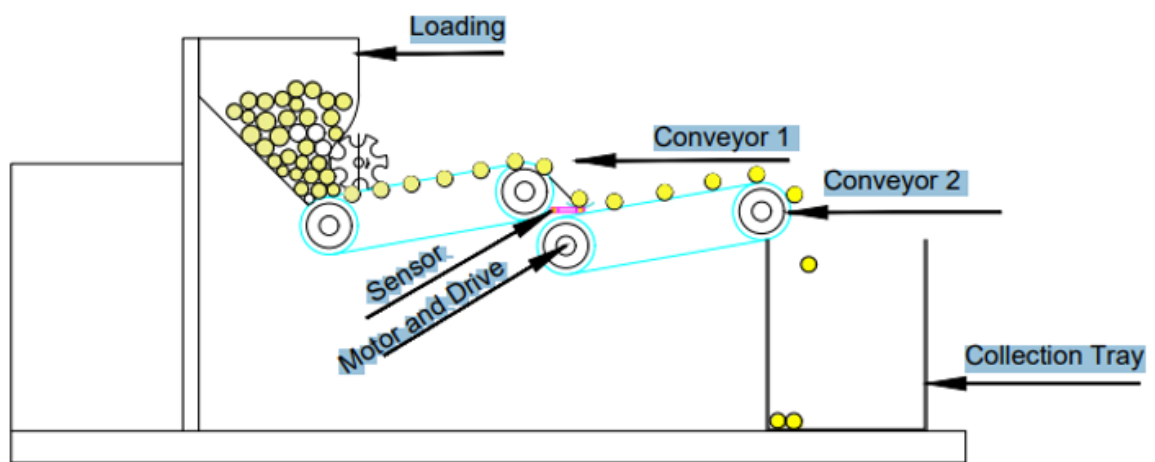
- Self-E Wheelchair
- Hooded Wheelchair
- MUDRA- Foldable Wheelchair.



## Technologies Developed

### Cashew Grading Machine development with MAKS Automation, Kottarakara.

Amrita TEC has been extending its support to various MSME clusters to develop and implement innovative technology into its business. Cashew Industries is one of the prominent industries of Kerala but is facing stiff competition from international players in terms of price. The industry is facing a lack of technology for automation and high manpower cost. Amrita TEC has made a careful study of the manufacturing process and the level of automation of each of these processes and is in the process of developing an automation process for a labor-intensive process. Amrita TEC, in partnership with MAKS Automation, Kottarakara, is developing a unique machine that automates the cashew nut grading process.



Cashew Kernel Sorting Machine Design

## Development of Healthcare Robots with material handling capability.

Amrita TEC has identified the following problems and facts related to the healthcare of the elderly.

- The elderly population is expected to grow significantly in the coming decades.
- Robots can play an essential role in providing healthcare support and independent living for the elderly.
- The World Health Organization has developed a global strategy and action plan on aging.
- Nurse Robot is a type of robot that can deliver food and medicine to patients and provide elderly care at homes.

- Robots can help to reduce the burden on healthcare workers and provide more personalized care for the elderly.
- Robots can also help to reduce social isolation and loneliness among the elderly.
- The development of robots for elderly care is still in its early stages, but there is great potential for this technology to improve the lives of millions of people.

Considering the above, Amrita TEC is actively involved in developing the following proposed robot for commercial availability. The features are

- 4 Wheeled autonomous Robot can be controlled from anywhere
- Robot can move autonomously inside the hospital/Home
- Connectivity with Alexa, a voice assistant
- Lidar and Depth camera is used for navigation
- Face-mask detection using OpenCV to recognize and track face and facemask using a normal RGB camera.
- Thermal imaging to measure body temperature using a FLIR Lepton thermal camera without contact.
- Total Weight: 10Kg and Battery life : 1hr (using 10Ah Battery) Weight carrying capacity: 2Kg (by Tray), 1Kg (Both arms).



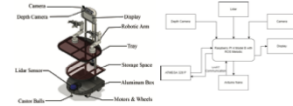
## Design & Manufacturing of Autonomous Mobile Robot for Material Handling

### Motivation

- The predicted worldwide growth in the elderly population is from 702 million in 2019 to over 1.5 billion by 2050.
- Robots can play an essential role concerning healthcare support and independent life, especially when problems related to ageing start to appear.
- The World Health Organization (WHO, Geneva, Switzerland) developed a global strategy and action plan on ageing, improving measurement, monitoring, and research on healthy ageing.
- Nurse Robot is essential to deliver food and medicine to patients & for elderly care at homes.



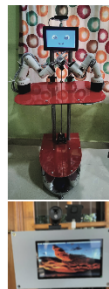
### Design Structure of Nurse Robot



- 4 Wheeled autonomous Robot can be controlled from anywhere
- Robot can move autonomously inside hospital/Home
- Connectivity with Alexa, a voice assistant
- Lidar and Depth camera is used for navigation
- Face-mask detection using OpenCV to recognize and track face and facemask
- using a normal RGB camera.
- Thermal imaging to measure body temperature using a FLIR Lepton thermal camera without contact.
- Total Weight: 10Kg and Battery life : 1hr (using 10Ah Battery)
- Weight carrying capacity: 2Kg (by Tray), 1Kg (Both arms)

### Manufacturing of the Nurse Robot

- MS and Aluminum are used in robot body fabrication
- Robotic arms are made by 3D printing
- Head of the robot consists of Touch Display( 8 inch), Depth Camera for 3D Mapping and Monitoring and Raspberry Pi processor.
- Two 6 DOF Robotic Arm
- Arduino nano microcontroller & 12 Servo Motors are used for the arm movement
- MoveIt Package in ROS is used for the controlling the ARMS



### Steps For Robot Navigation

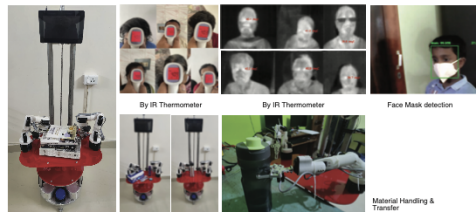


GMapping - Process of creating the map of the environment by Lidar sensor  
Path planning -To get an optimised path for the navigation using the above map.  
AMCL (Adaptive Monte Carlo Localization)- To find the location and orientation of the robot.  
Alexa Integration - To control the robot using Alexa, a voice assistant



### Commercial Impact & Applications

- Important to Medical Hospitals, Homes, office and Hotels
- Healthcare assistance in public health emergencies such as the SARS-CoV-2 virus (COVID-19)
- These robots assists in transporting goods, providing patients information, patrolling the facilities, and sending an alert when any unexpected patient behavior is detected.
- Handling chemically hazardous materials, highly infectious samples, Radioactive materials, laboratory samples, hot objects etc
- Waste management and cleaning inaccessible surfaces
- Supports service Robots and healthcare Industries



Publications : Vidhun V Warriar and Ganesha Udupa "An Autonomous home assistant robot for elderly care", International conference on Robotics, control, Automation and Artificial Intelligence, Manipal, Nov 24-26, 2022 .

## Consultancy for Shoranur Agricultural Implements Consortium Pvt. Ltd. (SAICO)

Amrita TEC team visited the Shoranur Agri Implements Consortium (SAICO) with the faculty experts from the Department of Mechanical Engineering - Coimbatore. The report on the strategies and technologies to be implemented for SAICO was compiled by Mr.Balakrishnan Anand (CB.EN.U4MEE19206), Mr.Muthukrishnan M (CB.EN.U4MEE19226), Naren Karthikeyan S (CB.EN.U4MEE19227) and Mr.Shyam Sundar J G(CB.EN.U4MEE19240) under the guidance



of Dr. P.G Saleeshya, Professor, Dept of Mechanical Engineering & Dr. M. Thenarasu, Asst. Professor, Dept of Mechanical Engineering

## About the Industry

Shoranur Agricultural Implements Consortium Pvt. Ltd. (SAICO) is a manufacturer of agricultural equipment operating out of Shoranur, Palakkad, Kerala. They fall under the umbrella of The Ministry of Micro, Small and Medium Enterprises (MSME). 160 units fell under the consortium, but nearly 60 of them had to shut their operations due to failing business.




Consortium Logo



## Preliminary Industry Study

Companies in the consortium are facing the risk of being put out of business owing to tough competition offered by the cheaper and better-quality Chinese products and in some cases, even products from North India. They argue that the unwavering support from the Chinese government towards the Chinese agricultural equipment manufacturers means that they are able to combine technology with lean and agile manufacturing to reduce the overall production cost, thus enabling





them to sell at lower prices and still generate huge profits. The employees we spoke to insist that most places they have gone to for help have turned a blind eye towards their struggles. Even after repeated requests, there seems to be no signs of help. Another problem they face with products apart from scissors is the involvement of Tata steel in using a grade of steel different to MS steel that helps them cater to the areas with soft soil, which is roughly 80% of the total share. There is a lack of standardization in the production processes, and there are absolutely no safety measures in place. However, the biggest issue the consortium faces is the internal competition between the companies in the consortium, that leads to a shrinkage and division of market share and profits. From the findings of the preliminary industry study, it was decided to prepare a questionnaire to conduct a detailed industry study.

## Questionnaire

The purpose of designing a questionnaire was to provide a structured way to gather data and information from the consortium. This allows us to collect required data to understand the current situation of the consortium and accordingly identify areas that require addressing. Before preparation of the questionnaire, functional areas were identified from the preliminary study. These functional areas are integral to the functioning of the companies in the consortium. The functional areas are Production & Planning, Inventory & Maintenance, Procurement & Logistics, Cost Management, People Management, Ergonomics, Quality Management & Sales and Customer Relations. A total of 276 questions were framed.

## Detailed Industry Study

The questionnaire was administered over multiple visits. For ease of study, the consortium was divided into four clusters, based on the products manufactured: welding, implements, cutlery and scissors. Each cluster contains a few industries operating under it. From the survey-based research, critical areas were identified at each cluster, and it was decided it would be best suited to base our approach around the 10 wastes of lean manufacturing, 14 principles of lean manufacturing and the 6S methodology. It was noticed that all four clusters experience almost similar problems.

## Welding Cluster (20–25 companies)

There is an overproduction of coconut de-husker. No proper demand exists from the customer and there are no proper pricing policies. There is a scope for commodity bundling, among household products. Unhealthy competition between companies hinders business. No incentive schemes are provided for employees, which may result in a lack of motivation. There is scope to implement 6S methodology, and Heijunka.

## Scissors Cluster (15–20 companies)

There is a difference in quality of raw materials received causing issues in production. A shortage of labor exists which can be solved by scope for labor pooling. Only partial 6S methodology practices are in place. No quality measures are in place.

## Cutlery Cluster (20–25 companies)


No proper raw material inventory. There is no documented quality system. 6S methodology not being followed. Over-processing occurs regularly. Internal competition exists between companies inside the cluster. There are no proper pricing policies in place. The attitude of the workforce shown towards the management is poor.

## Implements Cluster (25–30 companies)

Unnecessary motion taking place, which is a waste. No proper demand exists. Overproduction takes place. No quality systems in place. There is no proper inventory management and a severe lack of standardization. No safety measures in place. A severe lack of rapport between companies in the cluster.

## Findings from Study

The consortium is unaware of customer demand, causing overproduction. This can be solved by incorporating proper demand management practices. Lots of delay and inventory build-up occurs in production activities. Creating a current state VSM would give the existing process flow. The current state VSM will reveal a mismatch in the production output and customer demand. Demand



Forecasting techniques can help overcome the mismatch. Companies compete with one another shrinking customer base and market. An understanding must be reached between companies.

## Demand Management

### Market Survey

The first step in demand management was for us to conduct a market survey. This was to help us identify the general trend of agricultural implements (hand tools) in the market. We began by identifying markets in and around Coimbatore and simultaneously pursued markets in Kerala. Conversations were also held with professors at Tamil Nadu Agricultural University (TNAU) and we also gained insights from the Deputy Director at Ministry of Small, Micro and Medium Enterprises (MSME), Thrissur, Kerala. Agriculture hand tools are being used more often in hilly regions. Mechanized implements are more often used on flat lands. Lack of labour availability is forcing farmers to adopt mechanized implements. Exciting schemes to adopt lean manufacturing are being rolled out by MSME. However, the consortium chose not to participate in those schemes. Common sharing facility was suggested by MSME. Product diversification was discussed an increased focus on horticulture tools was proposed. Collaboration with other consortiums was suggested to address demand at rural areas. Scope for aggregation of demand was also explored.

## Forecasting Techniques

Production activities take place without prior knowledge of customer demand, causing them to overproduce. Hence it is vital the consortium incorporates forecasting techniques. Exponential Smoothing is a time series method that is effectively used for demand forecasting widely. This method makes use of the available data and calculates the forecast for the next time series. The smoothing constant ( $\alpha$ ) can be varied according to smooth the graph along with the forecast and actual data.

### Jaiju Implements- Sickle

Daily Demand- 150

Monthly- 3600 (approx)

Time	Actual Demand	Forecast Demand
1	3000	3300
2	3212	3195
3	3700	3200.95
4	3900	3375.6175
5	3850	3559.151375
6	3300	3660.948394
7	3100	3534.616456
8	3300	3382.500696
9	3400	3353.625453
10	3250	3369.856544
11	2450	3327.906754
12	3500	3020.63939
		3188.415603

$\alpha$	0.35
Initial Forecast	3300

### *Demand Forecasting ~ Exponential Smoothing Model*

The survey-based research revealed a severe lack of any sort of customer demand data across the years. Hence, the demand forecasting model in figure 2 was done by taking input data that would approximately resemble the customer demand data at the consortium. This is a test implementation.

## Aggregate Planning

The VSM's revealed severe WIP inventory buildup. They also highlighted a broken process flow, right from procuring raw materials to performing manufacturing activities. Aggregate Planning specifies what materials and other resources are needed and when they should be procured to minimize cost. This will help manage production in advance and reduce inventory as corroborated with the critical areas identified with the questionnaire.

Unit Costs	
Normal	10
Overtime	12
Sub-Contract	15
Holding Cost	1

Period	1	2	3	4	5	6
Forecast	3300	3195	3200	3375	3559	3660
<b>Output</b>						
Regular	3600	3600	3600	3600	3600	3600
Overtime	0	0	0	0	0	0
Sub-contract	0	0	0	0	0	0
Output- Forecast	300	405	400	225	41	-60
<b>Inventory</b>						
Beginning	1000	1300	1705	2105	2330	2371
Ending	1300	1705	2105	2330	2371	2311
<b>Backlog</b>						
<b>Cost</b>						
Regular	36000	36000	36000	36000	36000	36000
Overtime	0	0	0	0	0	0
Sub-contract	0	0	0	0	0	0
Hire						
Backorder						

Unit Costs	
Normal	10
Overtime	12
Sub-Contract	15
Holding Cost	1

Period	1
Forecast	3300
<b>Output</b>	
Regular	3600
Overtime	0
Sub-contract	0
Output- Forecast	300
<b>Inventory</b>	
Beginning	1000
Ending	1300
<b>Backlog</b>	
<b>Cost</b>	
Regular	36000
Overtime	0
Sub-contract	0
Hire	
Backorder	

Forecast for the following time period

Considering the company produces 150 products for 24 working days in a month

Excess of 300 products is produced in the following month which is a waste

Excess inventory held up due to overproduction in the previous month

In addition to the manufacturing costs the idle inventory also carries holding costs as well as man, machine, materials costs

Here considering unit costs the manufacturing comes around the above price but it is not inclusive of the inventory that is held up

## Process Flow Analysis ~ Current State VSM

The market survey results stated that the demand for agricultural hand tools is diminishing. Market survey results that the production activities are outdated. This also ties in with the results from the questionnaire clearly that reveal all clusters accumulate a lot of WIP inventory. Survey results also reveal that machines spend a lot of time in idle state. An effective way to tackle this problem would be to examine the process flow at clusters to streamline the production. A Current State Value Stream Map serves as the best technique. It highlights bottlenecks in the production process. Data was collected from different industries across clusters. The VSM as expected, revealed unusually excessive amounts of non-value-added-time and WIP inventory across industries. A current state VSM would also show how their production activities are out of sync with the customer demand. The market survey results stated that the demand for agricultural hand tools is diminishing. This context would make overproduction a bigger problem.

## Findings from the VSM ~ Implements Cluster

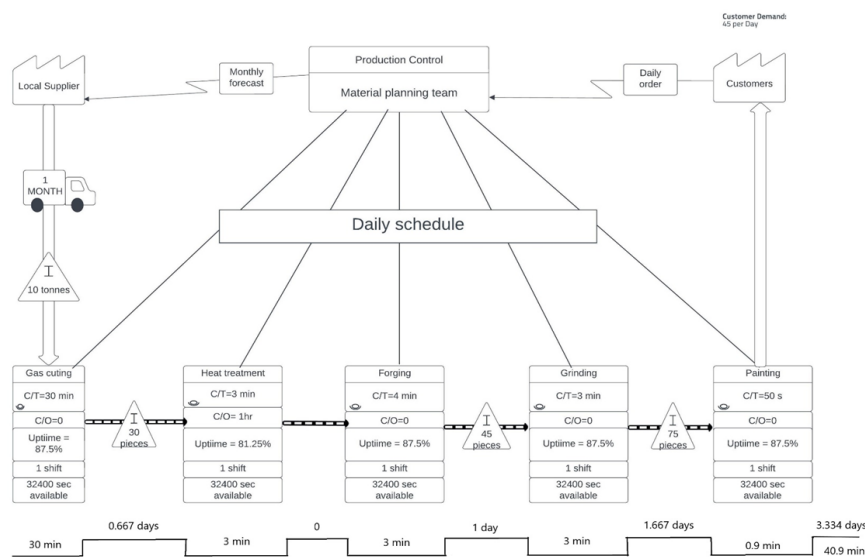


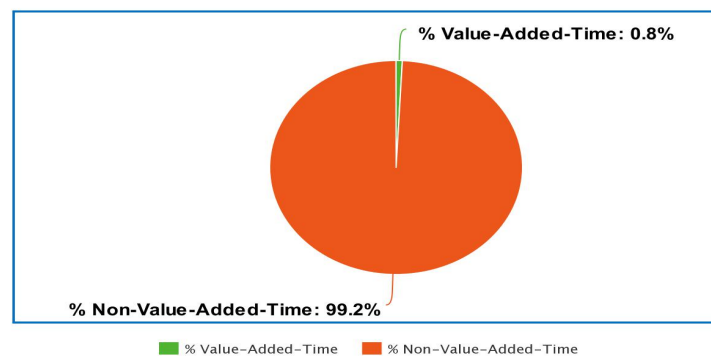
Figure 3: Current State VSM ~ Implements Cluster



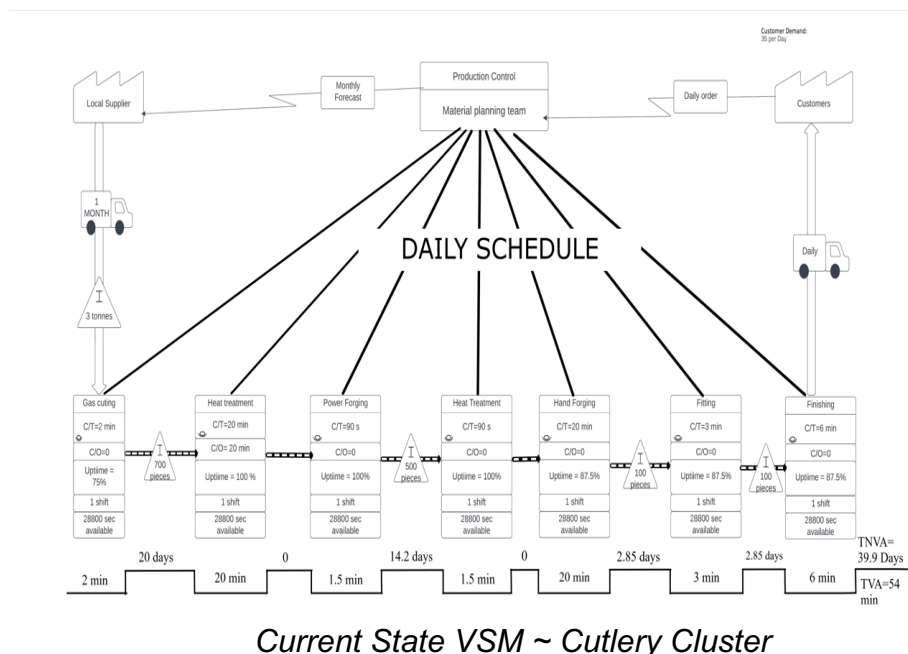
Rails cut in batch of 2 tonnes only when previous batch is completely exhausted. This causes delay, which is a waste. As figure 3 shows, lot of WIP inventory and time between forging, grinding, and painting. This is due to grinding and painting operations not taking place daily. Demand is 40 pickaxes a day, however the company is overproducing. Total value-added-time is 40 minutes and 50 seconds. Total non-value-added-time is 3.334 days. % VAT is 0.85% and % NVAT is 99.15%

Figure VA, NVA Distribution

Universal Implements ~ VA & NVA Distribution



## Cutlery Cluster



## Findings from VSM

Monthly order of 3 Tonnes given to supplier. These are gas cut in large batches. The WIP inventory between gas cutting and heat treatment is 700 pieces. The large inventory means that the inventory stays there for 20 days (about 3 weeks). The cut rails are then taken for heat treatment, where they are heated to a high temperature, to make it easier to perform the forging operation. Since the forging process must be done when the rails come out of the oven, there is no WIP inventory. After the forging process, the pieces undergo heat treatment once again before performing hand forging. There is a WIP inventory of 500 pieces, and this inventory stays there for 14.2 days (about 2 weeks) before it goes for the hand forging. Hand forging is done to bring out superior finishing, as cutlery products all require good finishing. The WIP inventory between hand forging and fitting and operations is 100 pieces. The inventory stays there for 2.85 days. The WIP inventory between fitting and finishing is 100 pieces and this causes it to be there for 2.85 days. The total VAT is 54 min and the total NVAT is 39.9 days (about 1 and a half months). The percentage value added time is 0.09% and the percentage non-value-added time is 99.91%.

Manikanda Implements ~ VA & NVA Distribution

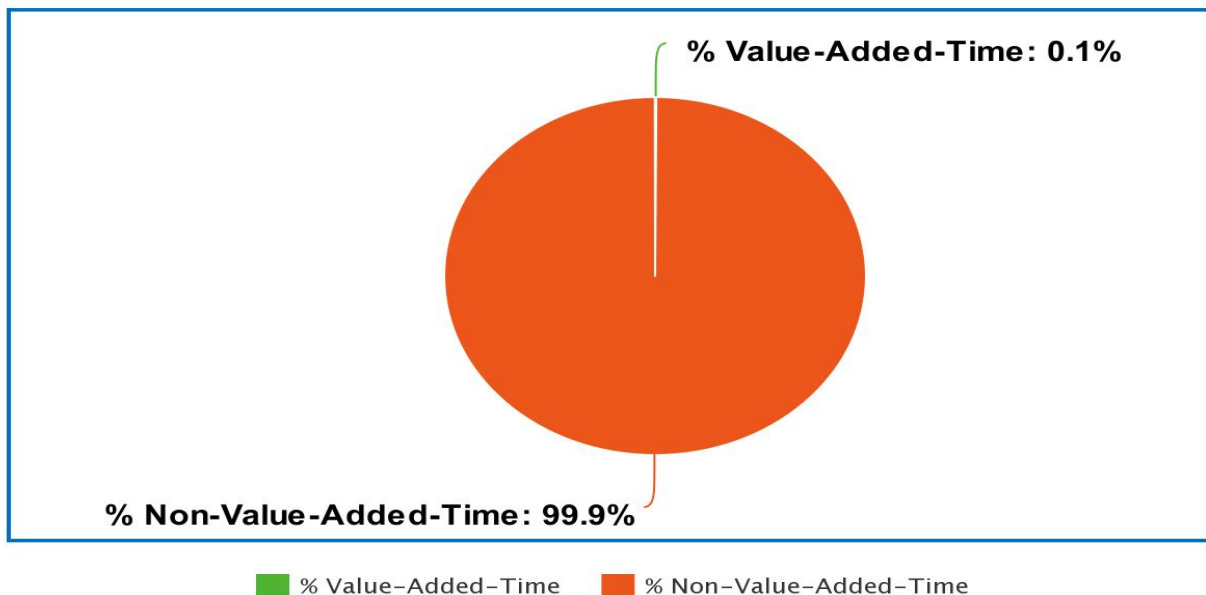



Figure 6: VA, NVA Distribution ~ Implements Cluster

## Suggestions

Shoranur Agricultural Implements Consortium Limited (SAICO), is a trading company and acts as a raw material bank for the companies in the consortium. They claim to be operating for the companies' welfare by providing raw materials, machine components and essentials at a reduced price. They offer cut rails and spring leaf to companies. One suggestion would be to encourage companies in the cluster to buy cut rails from the consortium directly thereby avoiding the gas cutting operation, which not only consumes a lot of time and money, but also workforce. This will reduce the wait time for cut rails, which the company often experiences. Another suggestion would be to adopt rotary forging, an alternative to power forging. Only a small area of the die is in contact with the work piece at any given time, rotary forging requires as little as one-tenth the force required by conventional forging techniques. The average cycle time for this operation is 10 to 15 seconds. Because of the lower forging loads, die manufacture is easier, and the required die strength is much lower. Because impact is not used in rotary forging, there are fewer environmental hazards than in conventional forging techniques. Complications such as noise, vibrations, fumes, and dirt are nonexistent. Performing the grinding and painting operations daily would reduce WIP inventory in the implements cluster. In the cutlery cluster, an alternative to hand forging is induction hardening. Induction hardening is a form of heat treatment in which a metal part is heated by induction heating and then quenched. The quenched metal undergoes a martensitic transformation, increasing the hardness and brittleness of the part. Induction hardening is used to selectively harden areas of a part or assembly without affecting the properties of the part. This is followed by induction tempering, where the induction coil is heated to 450 degrees Celsius. The combined cycle time for induction hardening and tempering is 5 seconds, as opposed to the heat treatment process which requires 20 minutes.

## Development of a Lean Framework

A multi-level lean framework has been developed for the consortium. This will act as a roadmap for the consortium to adopt lean manufacturing. Since implementing lean is not a quick process, a phase wise implementation has been proposed. The 5 phases are set-up, smooth, standardize, streamline, and sustain. The work to be done in each phase has been carefully drafted based on the consortium's current situation, and resources required to evolve and willingness to evolve. For



the work to be done in each phase, the lean tools that will assist in performing in the work have been included another level. The 14 principles of lean manufacturing are the bedrock of any lean implementation process. A connection has been made with the work to be done in each phase and all the 14 lean principles. Hence once this framework has been followed and implemented, it would mean that the consortium has incorporated the 14 principles of lean manufacturing, meaning they well and truly have implemented lean manufacturing at the consortium.

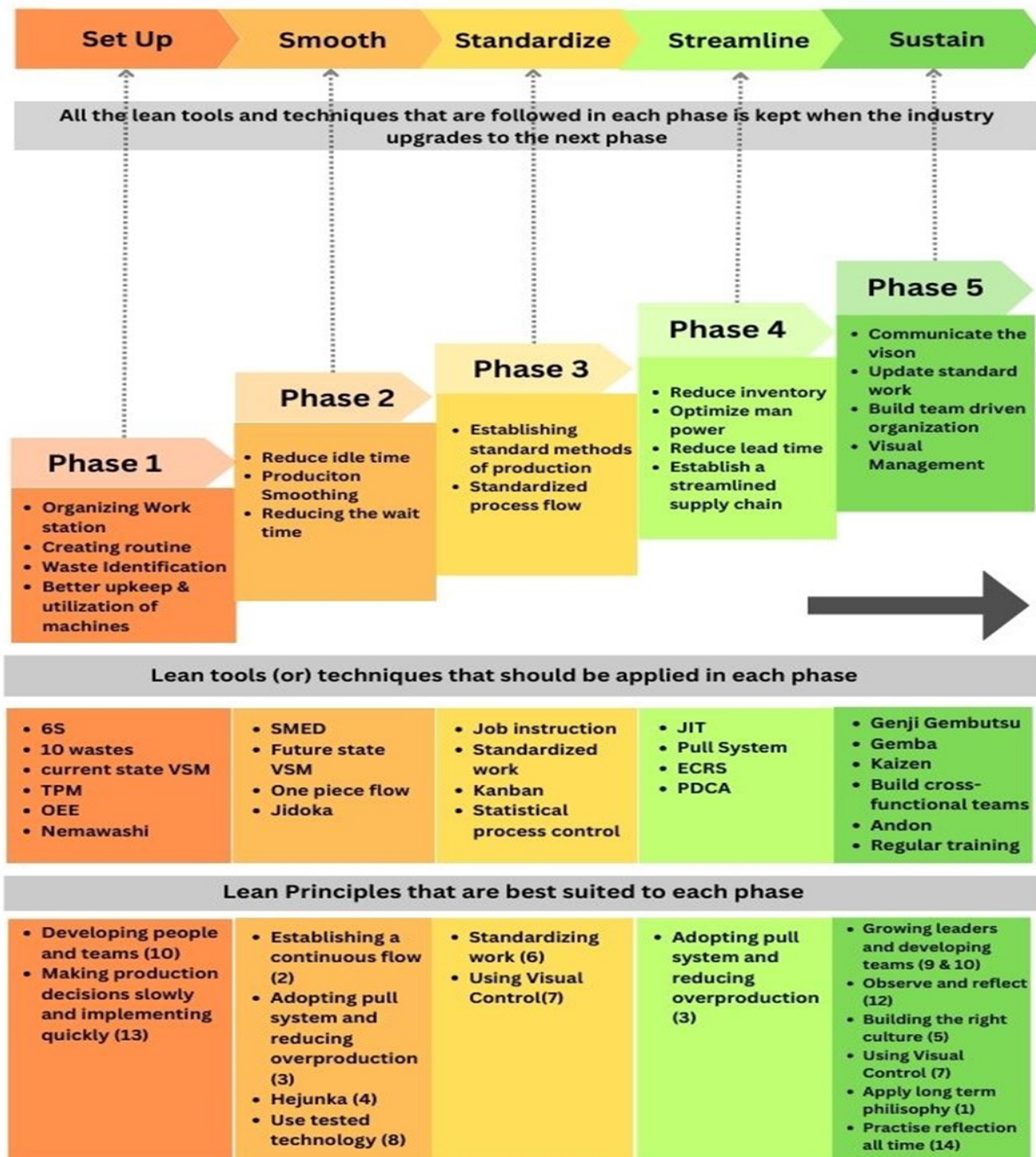


Figure A Lean Framework

## Our Plan for the Consortium

From the results of the survey-based results, it was clear that all functional areas need addressing. Once all the areas have been addressed, it is important that a standardized system is created. Standardized systems across companies in the consortium promote efficiency, quality, consistency, and cost-effectiveness in manufacturing industries. They create a stable foundation for continuous improvement, facilitate interoperability, and enable manufacturers to meet regulatory requirements while achieving operational excellence. Once a standardized system is introduced, the supply chain must be streamlined. A streamlined supply chain enables companies in the consortium to achieve operational excellence, reduce costs, improve customer service, enhance collaboration, and effectively manage risks. It allows companies to respond quickly to changing market dynamics, gain a competitive edge, and deliver value to customers while maximizing efficiency and profitability. The consortium also expressed interest in expanding their market to parts of North India and even abroad, the feasibility of this will be studied. Automation is another area the consortium requested assistance in, hence groundwork will be laid for that. Finally, the internal competition between the companies in the consortium must be removed and an understanding must be brought between them.

## Productivity enhancement of agricultural equipment manufacturing consortium- An investigative study

### Department-wise sequence of questions

1. General – About the consortium
2. Production and Planning Department
3. Inventory and Maintenance
4. Sales and Customer Relations
5. Procurement and Logistics
6. Cost Management
7. People Management



- 8. Ergonomics
- 9. Quality Management

## About the Consortium

- 1) What is the size of your consortium?
  - a. Micro Enterprise                      b. Small Enterprise
  - c. Medium Enterprise                      d. Large Enterprise
- 2) How many industries are there in your consortium presently?
- 3) What is the largest & smallest industries in your consortium?
- 4) What is the area of your consortium?
- 5) How many employees do you have?
- 6) What are your short-term goals?
- 7) What are your long-term goals?
- 8) Are there any specific funding schemes from the MSME?
  - a. Yes                      b. No
- 9) If yes, did you participate in them?
  - a. Yes                      b. No
- 10) What was the impact of those schemes on your company?
- 11) Are there any specific funding schemes from the Kerala Government?
  - a. Yes                      b. No
- 12) If yes, did you participate in them?
  - a. Yes                      b. No
- 13) What was the impact of those schemes on your company?

## Industry & Government Bodies Tie-Ups for Technology Enablement through TEC

Interactions with MADITSSIA, Madurai.



Madurai District Tiny & Small Scale Industries Association, popularly known as “MADITSSIA,” has been serving for the development of Micro and Small Enterprises for the past 46 years in the Southern Districts of Tamilnadu. MADITSSIA Association is Registered under the Societies Act., and is a Democratic organization run by an elected body with around 1500 direct members and 7500 indirect members, along with 35 affiliated Industrial Associations as an Institutional Members. Mr.C.Rathina Balaji, Commercial Associate, Amrita TEC, met the president Mr.Sampath on January 31, 2023 and discussed the various activities of Technology Enabling Center and the support that it provides for MSME. Discussions were made for organizing Seminars, Training Programs, Workshops and Exhibitions in various sectors highlighting the Technology, Development and Innovations in their respective fields.

## Interaction with NIFT-TEA

National Institute of Fashion Technology promoted by Tiruppur Exporters Association, is interested in collaborating with Armita for the technology development for the textile industry. Met with Dr. Senthil and Mr. Periyasamy, CEO of NIFT-TEA. The team is exploring the possibilities of signing an MOU and in the process of areas where we can collaborate for the technology development, transfer or commercialization.



## Interaction with ZAR Partners



ZAR Partners is an India based micro VC firm with a mission to support early stage start-up founders by transforming their ideas into impactful business organisations. ZAR Partners is driven and led by the founders with an intent to help fellow founders by sharing our expertise , experience, and network that can be leveraged to Build , Scale, and Grow faster. Amrita TEC team members Mr.R.Venkatesh and Mr.C.Rathina Balaji intracted with Mr.R.Rajesh Kumar, Co-Founder, and Partner. The possible avenues for collaboration, commercialization of technologies, and working together with the Amrita ecosystem were discussed.

## Interaction with Spirex Food



The International Year of Millets 2023 is a UN-declared year to raise awareness of the nutritional and environmental benefits of millets. Millets are a group of small-seeded grasses that are grown in dryland areas around the world. They are a good source of protein, fiber, and minerals, and they are also gluten-free. The International Year of Millets is an opportunity to promote the production and consumption of millets and to support the efforts to make millets a more mainstream food crop. Mr.C.Rathina Balaji, commercial associate, Amrita TEC is visited Spirex Food Pvt Ltd to understand the technology requirements of the industry. A discussion on the current market opportunities in the millet was discussed with Mr.Shanmuga Sundaram, Managing Director of the company.

## Janatics India Pvt. Ltd.





Exploring to collaborate with the industries for TEC activities we had visited Janatics India Pvt. Ltd., Coimbatore and meeting with their team - Mr. Balu, Manager - Business Development, Mr. K ganapathy Subramaniam, Head - Applications and Training and Mr. R Ramesh, Executive Director. Janatics team showed interest in collaborating with Amrita for development of technologies and technology transfer. Discussion are on for signing the MOU with the Janatics team.

## Kalki Automations Visit to Coimbatore Campus



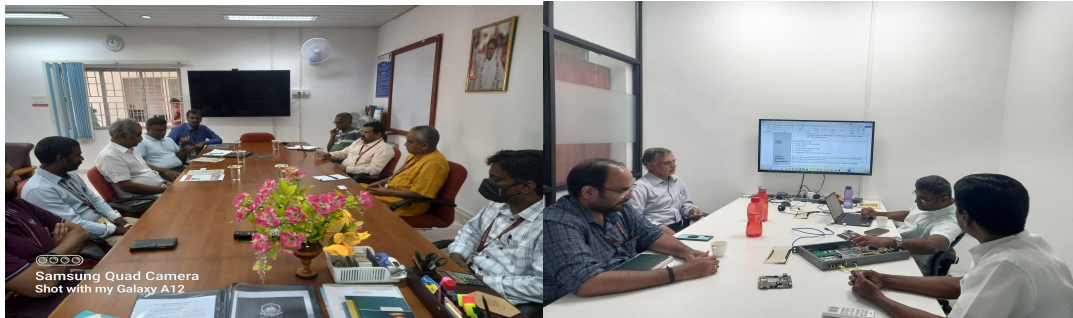
Team from Kalki Automations visited Coimbatore campus for exploring the possibilities of collaboration with Amrita Vishwa Vidyapeetham through TEC. Kalki Automations develop and manufacture different types of sensors for industrial usage. Their HO is in Thailand and their Indian facility is at Coimbatore. Currently they are collaborating with different educational institutions for R&D and prototype development. Kalki is ready to provide the technical know how and train our students and will provide finance to procure the raw material for the prototype development. Discussions are underway to sign an MOU with Kalki Automations.

## Collaboration with Scomode Technologies

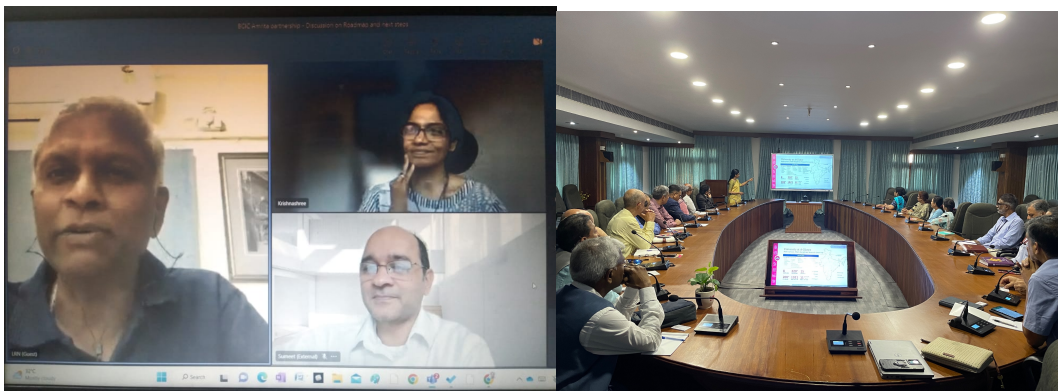
Amrita TEC signed an MOU with Scomode Technologies, a Coimbatore based company. Scomode is a IOT based technology solution provider in network, communications areas. having




presence in India, Malaysia, UAE & USA. The MOU focuses on Research & Development, prototype and product development and effective utilisation of resources in Amrita. The negotiations are on for signing contractual agreement for a project.



## Bangalore Chamber of Industry and Commerce, BCIC





A team of delegates from BCIC, Bangalore, headed by Dr.L.Ravindran, President, BCIC visited Amrita TEC, and interactions were arranged between various centers of excellence at Amrita. The following areas of for engagement were discussed and the summary of the discussion are as follows

- BCIC recognized the potential of start-ups funded by AMRTIA TBI in solving industry problems faced by BCICI. Collaboration with these start-ups could offer innovative solutions.
- BCIC expressed keenness in providing industry access and market access to companies incubated by Amrita-TBI, facilitating their growth and market penetration.
- BCIC displayed interest in participating in the pitch fest organized by Amrita-TBI, aiming to connect with and support promising start-ups.
- BCIC acknowledged the recognition of Amrita University and proposed its involvement in the board or committee to benefit from its expertise.
- BCIC committed to assisting Amrita in connecting with other academic institutions within BCIC, fostering collaboration and knowledge exchange.
- BCIC expressed interest in partnering with Amrita for C20 events, emphasizing their commitment to collaboration.
- BCIC showed interest in utilizing the skill development services provided by Ammachi Labs. They also expressed a desire to leverage advanced technologies from Ammachi Labs for other science and skill development modules.
- BCIC requested an exclusive session related to the IOT products in Amrita TEC, including a product display, before committee members to explore potential partnerships.
- BCIC expressed interest in mutually engaging in mentoring start-ups and recommended that mentors have investable interest in the start-ups they guide.
- BCIC proposed collaborating with academia and start-ups to work on corporate problem statements and use cases, fostering innovation and real-world solutions.
- BCIC extended support to Amrita-TBI for working with Amrita AHEAD (Amrita for Holistic Education and Development) in offering Family Business Management courses, including a short-term Women Entrepreneurs course.
- BCIC expressed interest in collaborating on projects related to Ambulance Emergency & Traffic Signal management, aiming to improve emergency response and traffic management systems.

## Ecosystem Collaboration Interaction with MeitY Startup Hub



Dr. Prashant R. Nair, DST-Amrita Technology Enabling Center (TEC) fellow, represented Amrita TEC in an ecosystem collaboration interaction with Mr. Jeet Vijay, CEO, MeitY Startup Hub (MSH) under the Ministry of Electronics & IT, Government of India on the sidelines of the G20 Digital Economy Working Group (DEWG) meeting held at Lucknow from 13 to 15 February, 2023. MSH has been set up as a national coordination, facilitation, and monitoring center that will integrate startups, incubation centers, centers of excellence, and all stakeholders with all innovation-related activities of the ministry. Potential collaboration opportunities identified for Amrita TEC were:

- Handholding and mentoring the startups for whom Amrita TEC has supported in technology commercialization towards participation in the grand challenges of MSH.
- Participation in the upcoming roadshow events of the MSH, some of which are being planned at various universities across India.
- Participation in G20 Digital Innovation Alliance (DIA), which includes tracks for students, faculty, researchers, and startup founder.



## Collaboration with CODISSIA Defence Innovation and Atal Incubation Centre (CDIIC)



DST-AMRITA TEC has been in detailed collaboration discussions with CODISSIA Defence Innovation and Atal Incubation Centre (CDIIC), Coimbatore. As a culmination of these discussions, Dr. Prashant R. Nair, DST-Amrita TEC fellow & Vice-Chairman, IQAC, Amrita Vishwa Vidyapeetham, Coimbatore campus, met with Dr. Vinodhkumar B., GM of CDIIC on 10<sup>th</sup> February, 2023 primarily to fix a date for signing the MoU. Areas of potential collaboration identified include joint research & technology development, working papers, and technology enablement.

## Amrita – CII Collaboration



The Confederation of Indian Industry (CII) is an industry-led organization dedicated to fostering India's development. With over 9,000 members from various sectors and an extensive network of enterprises, CII has actively influenced India's growth for over a century. CII collaborates with the government, industry leaders, and civil society to drive policy changes, enhance competitiveness, and promote inclusive and sustainable development. With a focus on areas like corporate citizenship, skill development, and women's empowerment, CII plays a crucial role in shaping India's future. With a strong presence and partnerships worldwide, CII serves as a trusted reference point for Indian industry and the global business community. Amrita has registered as a National Membership. Amrita TEC team headed by Dr. Krishnashree Achuthan discussed the areas of collaboration with Mr. P. Ganesh, Past President CII and Mr. Saji Mathew, Deputy Director & Head, CII Kerala South Zone. The following activities and avenues were discussed for collaboration and networking

- Amrita Technology Enabling Centre to extend the outreach activities with MSME through CII.
- To help start-up in the ecosystem to enable market access through CII.
- To leverage the Amrita's academic excellence to work for the common goals of Amrita and CII.
- Collaboration with CII Center of Excellence for working together
  - CII Institute of Logistics, Chennai
  - CII Institute of Quality, Bangalore
  - CII - ITC Centre of Excellence for Sustainable Development, Delhi
  - CII-Centre of Excellence for Competitiveness for SMEs



- CII - Naoroji Godrej Centre of Manufacturing Excellence, Mumbai
- CII - Sohrabji Godrej Centre of Excellence, Hyderabad
- CII - Suresh Neotia Centre of Excellence, Kolkata
- CII - Triveni Water Institute, Gurugram
- CII - FACE, New Delhi
- CII Centre of Excellence for Innovation, Entrepreneurship, and Start-ups

## MSME Intellectual Property Facilitation Center



The executive team from the MSME DFO, comprising visited Amrita Vishwa Vidyapeetham to conduct a comprehensive evaluation of the MSME IPFC proposal. The team had a detailed presentation by Dr. Krishnashree Achuthan, Director of the Technology Enabling Center, who highlighted the academic excellence and strengths of Amrita Vishwa Vidyapeetham, supported by facts, statistics, and relevant data. During the presentation, the challenges involved in commercializing patents were discussed, along with strategies for success in this area. The vision of developing an ecosystem that fosters the generation of high-quality patents and increases awareness to enhance the number of patents was outlined. The meeting was coordinated by Mr.Mahesh Mohan, Mr.K.N.Surendran, and Mr.C.Rathina Balaji from Technology Enabling Center.

## MSME, DI tie up for Entrepreneurship Awareness Camp.



The Technology Enabling Center (TEC), facilitated a tie-up between Ammachi Labs and the MSME for the implementation of an Entrepreneurship Awareness Program and Leadership Development Program. These programs are for the beneficiaries of the SANKALP project by Ammachi Lab. Ms. Ananya Gaur, Ammachi Lab and Mr. Harikumar, Ammachi Lab and other TEC members actively participated in the discussion and the following training programs were proposed to be conducted.

## Rural Impact Innovation in Coir Industry





Amrita TEC collaborates with Coir Board and Central Coir Research Institute to foster impactful innovation in the coir industry, empowering rural areas with entrepreneurship and job opportunities. Through this partnership, Amrita TEC aims to create a positive impact on the coir sector by developing cutting-edge solutions and technologies. By leveraging research and expertise, the initiative seeks to enhance the coir industry's productivity and sustainability while promoting economic growth in rural communities. Together, they strive to unlock the potential of the coir sector, uplifting livelihoods and contributing to the overall socio-economic development of the region. As part of their efforts, they have conducted industry visits to analyze the potential of various coir businesses.



## Academic Partnerships with various institutions.

### SNS College of Engineering (Autonomous), Coimbatore



Amrita Technology Enabling Center (TEC), funded by Government of India's Department of Science & Technology (DST) and headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham has signed an MoU for academic partnership with SNS College of Engineering (Autonomous), Coimbatore. MoU exchange by Dr. S. Charles, Principal on behalf of SNS and Dr. Prashant R. Nair, Head, IQAC, Amrita Vishwa Vidyapeetham on behalf of AMRITA in the presence of Dr. Gnanasundari P., HOD-ECE, SNS and other HODs. As part of the MoU, Amrita TEC would work with the college for technology enablement of its ideas, prototypes, products and innovations developed by its students, researchers and faculty through technology mining, co-creation, development, transfer and commercialization as is the state of the technology. 17 innovations of SNS College of Engineering were evaluated for Technology Readiness Levels (TRL) by Amrita TEC liaison manager, Mr. Venkatesh R. These innovations developed by students include a smart cycle with anti-theft system, semi-automated string hooper, energy harvesting umbrella, smart helmet using IoT, coffee roaster machining module, IV Driprate monitoring system and VR system for architects.

## Kalaignar Karunanidhi Institute of Technology, Coimbatore



Amrita Technology Enabling Center (TEC) funded by Government of India's Department of Science & Technology (DST) and headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham has signed an MoU for academic partnership with Kalaignar Karunanidhi Institute of Technology, Coimbatore. MoU exchange by Dr. N. Mohandas Gandhi, Principal on behalf of Kalaignar college and Dr. Prashant R. Nair, Head, IQAC, Amrita Vishwa Vidyapeetham on behalf of AMRITA in the presence of Dr. M. Ramesh, Vice-Principal; Dr. K. Ramasamy, Dean and Dr. S. Santhi, Head, Center for Research of the Kalaignar Karunanidhi college. As part of the MoU, Amrita TEC would work with the college for technology enablement of its ideas, prototypes, products and innovations developed by its students, researchers and faculty through technology mining, co-creation, development, transfer and commercialization as is the state of the technology. 33 innovations of Kalaignar Karunanidhi college were evaluated for Technology Readiness Levels (TRL) by Amrita TEC staff, Mr. Venkatesh R. & Mr. Rathina Balaji C. These innovations developed by college researchers and students included underwater ROV, self-regulated trash segregating bin, 3rd arm, household cleanser for hygienic food consumption, eye ball sensor-based automatic intelligent wheel chair etc.



## RVS Arts & Science, Coimbatore.



Amrita Technology Enabling Center (TEC) MoU with RathnaVel Subramaniam (RVS) College of Arts & Science (Autonomous), Coimbatore . Amrita Technology Enabling Center (TEC) funded by Government of India's Department of Science & Technology (DST) and headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham has signed an MoU for academic partnership with RVS College of Arts & Science (Autonomous), Coimbatore. MoU exchange was by Dr. T. Sivakumar, Principal, RVS College of Arts & Science and Dr. Prashant R. Nair, Head, IQAC, Amrita Vishwa Vidyapeetham in the presence of Dr. Ayyappa Das MP, Vice-Principal; Dr. Preethi Samson, HOD, Department of Food & Nutrition, Dr. Parimala GS, Scientific Research officer of the college on 16 December 2022. As part of the MoU, Amrita TEC would work with the college for technology enablement of its ideas, prototypes, products and innovations developed by its students, researchers and faculty through technology mining, co-creation, development, transfer and commercialization as is the state of the technology.

## Dr. NGP Institute of Technology (Autonomous), Coimbatore.



Amrita Technology Enabling Center (TEC) funded by Government of India's Department of Science & Technology (DST) and headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham has signed an MoU for academic partnership with Dr. NGP Institute of Technology (Autonomous), Coimbatore. MoU exchange was by Dr. Thavamani D. Palaniswami, Secretary & Trustee of Dr. NGP Institute of Technology and Dr. Prashant R. Nair, Head, IQAC, Amrita Vishwa Vidyapeetham in the presence of Dr. S.U. Prabha, Principal and Dr. Palanikumar D., HOD-CSE of the college. As part of the MoU, Amrita TEC would work with the college for technology enablement of its ideas, prototypes, products and innovations developed by its students, researchers and faculty through technology mining, co-creation, development, transfer and commercialization as is the state of the technology.

## Events

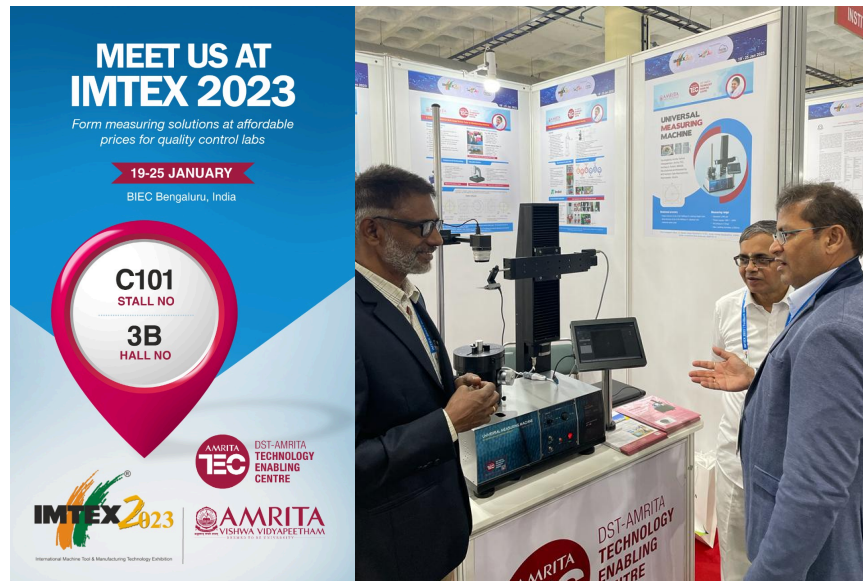
### Amrita TEC Participation in the 108th Indian Science Congress (ISC) 2023



Dr. Prashant R. Nair, DST-Amrita Technology Enabling Center (TEC) fellow, represented Amrita TEC in the 108<sup>th</sup> Indian Science Congress (ISC) 2023, held at Rashtrasant Tukadoji Maharaj University, Nagpur, from 3 to 7 January, 2023. ISC is the largest and oldest scientific gathering in India. It is an annual event organized by the Indian Science Congress Association (ISCA) and the Government of India's Department of Science & Technology (DST). ISC 2023 was virtually inaugurated by the Hon'ble Prime Minister of India, Shri Narendra Modi, on 3<sup>rd</sup> January 2023. The event featured the pride of India exhibition showcasing India's advances in science and technology; farmer, tribal, women, and children's congresses; plenary talks; invited talks; and research papers in 14 sections.

Dr. Prashant R. Nair visited various exhibition stalls of DST, DRDO, DAE, and CSIR during the visit and extensively interacted with various representatives of these national labs to explore ecosystem collaboration for Amrita TEC. This included a brief meeting with Dr. Srivari Chandrasekhar, Secretary, DST, on 4<sup>th</sup> January, 2023.

## Participation in IMTEX, 2023



Amrita TEC participated in the IMTEX 2023 exhibition at BIEC, Bengaluru, between January 19 and 25, 2023. The exhibition focused on metal cutting machine tools and advanced manufacturing technologies, such as digital manufacturing, additive manufacturing, and Industry 4.0.

Amrita TEC exhibited the technology developed by the university in collaboration with Holmarc Opto-Mechantronics through TEC. Amrita TEC is connecting with and negotiating deals for commercialization.

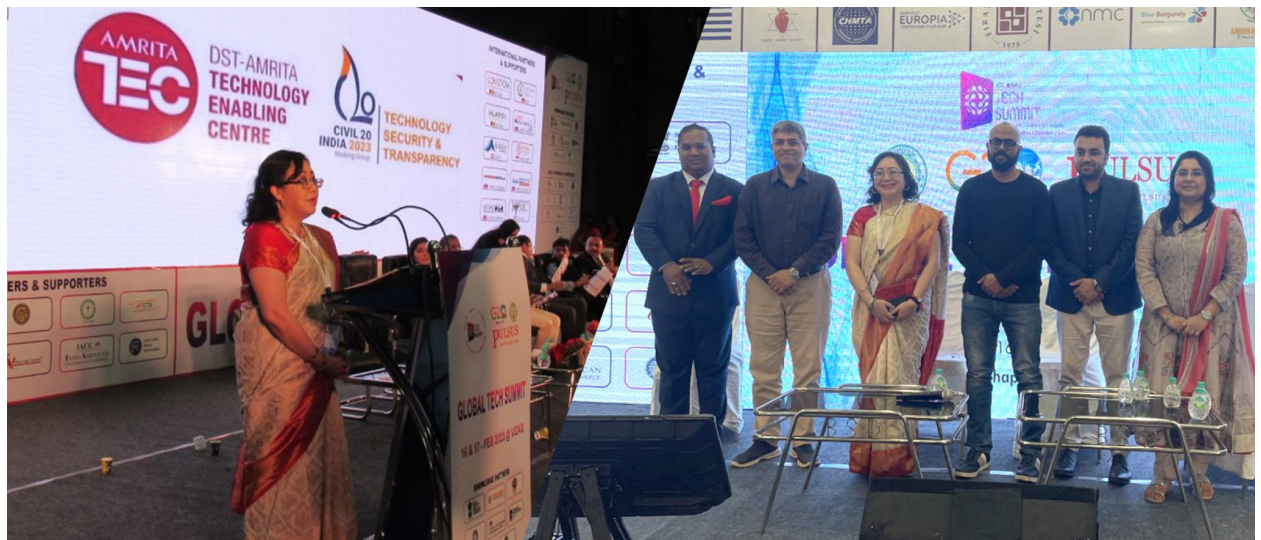
The various industries that expressed interest for collaboration with Amrita TEC are

- Fracktal works, Bengaluru
- Pneumatics India, Kochi
- ASKIB Engineers Pvt Ltd, Kolkata
- Maruti Instruments, Rajkot
- Mitutoyo, Bengaluru
- Omega Metrology Products, Bengaluru.
- Precision Sales, Kolhapur.



- QMARZ CNC & Metrology, Chennai.
- Steer Engineering, Bengaluru.
- KC Precision, Aurangabad
- Krupa Tech Pvt Ltd, Rajkot.
- Top Gear Transmissions, Maharashtra
- Vaska Tech, New Delhi
- Xtreme Engineering Equipment Pvt Ltd, Maharashtra
- Knorr- Bremse, Pune
- JK Techx, Chennai.
- Hommel - Etamic, Bengaluru.
- Genau Extrusions Pvt Ltd, Hosur
- Future Innovation Technology, Pune

## DST Amrita TEC Participation in Global Tech Summit







Amrita TEC was invited for the inaugural address at India's largest Global Tech Summit 2023, which took place in Visakhapatnam on February 16 and 17, 2023. The summit focused on exploring emerging technologies and solutions to counter challenges in various sectors. This was the first of its kind in India, with a major focus on the application of Technology to Health, Tech, Finance, Pharma, Science, and other Industrial Sectors. The summit was attended by participants from Asia, Europe, North America, South America, and Africa. The event attracted 400 tech leaders and 1000 delegations from 25 countries; among the highlights was the signing of a MoU between the National Development and Reforms Commission (NRDC) and the European Business and Technology Center (EBTC). Additionally, approximately 100 startups showcased their innovative ideas at the summit. Dr. Nava Subramaniam, the Coordinator for the Civil20 Working Group on Technology, Security, and Transparency at Amrita Vishwa Vidyapeetham, delivered the inaugural address. The activities of the TEC were exhibited in the stall.

## DST Amrita Technology Enablement Meet & Exhibition at KPRIET, Coimbatore



DST-Amrita Technology Enabling Center (TEC), headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham, organized a Technology Enablement Meet & Exhibition at the premises of its academic partner, KPR Institute of Engineering & Technology (KPRIET), Coimbatore on 11<sup>th</sup> March 2023. With the focal theme of Technology for Societal Empowerment, this meet was organized in association with the Technology, Security & Transparency (TST) Working Group of Civil20 (C20) official engagement group of G20. 30 innovations with a societal & humanitarian focus from DST-Amrita TEC's academic partners and student startups were showcased at the exhibition. Mr. K.K. Pillai, Authority Member, Agricultural & Processed Food Products Export Development Authority (APEDA) under the Ministry of Commerce & Industry, Government of India, inaugurated the meet & exhibition, and Dr. Sasangan Ramanathan, Dean-Engineering, Amrita Vishwa Vidyapeetham along with Mr. Divyanshu Verma, CEO, Redinent Innovations distributed prizes & awards to the top 10 innovations of the meet. These innovators will be mentored for technology enablement and pre-incubation support by DST-Amrita TEC. All projects on display were evaluated by a jury and presented with a Technology Readiness Level (TRL) certificate by DST-Amrita TEC. Dr. Akila M., Principal, KPR Institute; Dr. Prashant R. Nair, DST-Amrita TEC fellow; Dr. Ravi Kumar K. and Prof. Navaneethakrishnan Ramanathan, heads of centers for Innovation & Entrepreneurship @ KPR, also addressed the participants. Jury members included Dr. Vinodh Kumar, GM, CODISSIA Defense Innovation Hub & Mr. Sriram TRN,

Director, Everstage Technologies, along with DST-Amrita TEC team members, Mr. K.N. Surendran, Mr. Mahesh Mohan, Mr. Venkatesh R., and Mr. Rathina Balaji. The top 10 innovations identified by the jury were:

- IoT Based Smart Agribot, which is available on an app that allows farmers to perform various tasks such as plowing, seeding, water sprinkling, and testing the PH of the soil
- ATHENA - The healthcare assist, which provides remote monitoring daily. supervision of vital parameters using machine learning algorithms for employees in industries to reduce health concerns and to ensure that productivity remains at satisfactory levels.
- SMPS Battery chargers for electric vehicle charging. which are capable of charging batteries faster and more efficiently than traditional chargers with transformers.
- Development of Impinging Jet Solar Air Dryer for Powder Coating Applications in Small-Scale Industries. The designed system produced hot air at a temperature of 96°C with a flow rate of 100 kg/hr. The system efficiency also increased by 21% as it compared with conventional solar air heaters.
- Neural Amp is a non-invasive bio amp to capture the bio signals (EEG, EMG & ECG) from the human body using electrode patches.
- Smart Shoes for the Blind uses IoT & sensors to help the visually impaired communicate with the environment at an affordable cost.
- Leak detection in concealed pipelines using sensors. This is a system that detects cracks or leaks in pipelines, provides a 3D output of the pipeline with XYZ coordinates, and marks the leak area of the pipeline without demolishing the outer area.
- Advanced IoT Kit provides knowledge on creating connected devices known as the Internet of Things (IoT) quickly and easily with applications in Smart Homes, Smart Cities, Smart Industries, Smart Farming, and Smart Irrigation systems.
- Prototype Biomass Gasifier, which can cut fuel costs for cooking by 70%. This gasifier uses a variety of raw materials to create combustible syngas, including wood briquettes, wood pellets, wood chips, and biomass waste.
- Bio-inspired robotic predatory bird to scare crop-eating birds is a 3D printed carbon fiber reinforced robotic bird also called an ornithopter.



## DST-Amrita TEC is the Event Partner for Uimage Catalyst'23 roadshow of StartupTN.




DST-Amrita Technology Enabling Center (TEC), headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham, was an event partner for the Uimage Catalyst'23 roadshow of StartupTN held at KPR Institutions, Coimbatore on 15<sup>th</sup> March 2023. Uimage Catalyst roadshow, an innovation expo for Tech Startups, was inaugurated by the Hon'ble Minister of Information Technology and Digital Services of the Government of Tamil Nadu, Shri Mano Thangaraj. During the event, Shri Mano Thangaraj also released the compendium of the top 10 innovations of the Technology Enablement Meet & Exhibition of DST-Amrita TEC by handing over the first copy to Dr. Akila M., Principal, KPR Institute, and Dr. Prashant R. Nair, DST-Amrita TEC fellow. Some of the innovations of the student startups supported by DST-Amrita TEC, such as IoT Based Smart Agribot and ATHENA - The healthcare assist, were showcased at the roadshow, and they also got an opportunity to interact with the minister. This roadshow is part of a series of events to promote Uimage Chennai 2023, one of the largest annual technology, entrepreneurship, and skill summits in Asia organized by Electronics Corporation of Tamil Nadu Limited (ELCOT) with an objective to showcase the thriving technology and innovation ecosystem in Tamil Nadu.

## DST-Amrita Technology Enabling Center (TEC) Anokha Techfair (April 2023)



DST-Amrita Technology Enabling Center (TEC), headed by Dr. Krishnashree Achuthan, Dean, Amrita Vishwa Vidyapeetham, organized a Technology Enablement Meet & Techfair between 27 to 29 April, 2023. The techfair was organised in partnership with Technology, Security &





Transparency (TST) Working Group of Civil20 (C20) official engagement group of G20 and Institution's Innovation Council (IIC) of the university. This innovation showcase featured over 50 projects aligned to Civil20 (C20) priorities – technology security & transparency, sustainable & resilient communities and education & digital transformation. These projects were drawn from various departments and centres across the university campuses as well as other institutions such as KPR Institute of Engineering & Technology (KPRIET), Coimbatore.

The techfair was inaugurated by Dr. Sasangan Ramanathan, Dean, Faculty of Engineering, Amrita Vishwa Vidyapeetham in the presence of Prof. C. Parameswaran, Principal Director, Corporate & Industry Relations (CIR) & Air Commodore Satish Menon, Campus Director of Amrita Vishwa Vidyapeetham and Anokha techfest conveners, Mr. M. Sreevalsan and Dr. Prashant R. Nair. DST-Amrita TEC fellow. The projects were evaluated by a committee consisting of Dean-Engineering and Mr. Rathina Balaji, Commercial Associate, DST-Amrita TEC. The Techfair event coordinators were Mr. Venkatesh R., Liaison Manager, DST-Amrita TEC and Mr. Pratyush Pant, III B.Tech Mechanical Engineering student & team.

During the inaugural ceremony, Dr. Sasangan Ramanathan, Dean, Faculty of Engineering, Amrita Vishwa Vidyapeetham said. "We are delighted with the overwhelming response we received from students, industry partners, and the general public for the event. This techfair is a platform for students to showcase their technical skills, interact with industry experts, and learn about the latest technological developments. We are very pleased to see such enthusiastic display of innovation from the students, when India holds the G20 presidency."

A composite for bulletproof jacket for Indian army developed by the department of aerospace engineering @ AMRITA, AI hand wash monitoring system for industry and hospital, from KPRIET and Drishti – A Smart Attendance capturing system for educational institutions from the department of computer science & engineering @AMRITA were recognised as top 3 innovations. The top projects will be supported for technology enablement and business incubation by AMRITA.

## TEC Conclave, University of Hyderabad



Dr. Krishnashree Achuthan, Director Technology enabling center participated at the TEC Conclave that took place on 17<sup>th</sup> and 18<sup>th</sup> April 2023 at Univ of Hyderabad. The event was an excellent opportunity to network with TEC across the country. The experience, accomplishments, and best practices followed by the TEC were shared by networking with fellow participants. The success stories in the conclave were insightful to gain clarity on the importance of TEC's contribution. Amrita TEC will submit a proposal for developing a platform for TEC to network.

## Training program & Webinars Organized





Department of Science and Technology,  
Ministry of Science and Technology, Government of India, New Delhi

Invites you  
For valedictory Function of Two Weeks online  
**FACULTY DEVELOPMENT PROGRAMME  
ON ENTREPRENEURSHIP (FDP)**  
Batch -II Duration (17<sup>th</sup> – 29<sup>th</sup> Apr 2023)  
@  
**KIT - ENTREPRENEURSHIP DEVELOPMENT CELL**  
of  
**KIT-Kalaigarkarananidhi Institute of Technology**  
(An Autonomous Institution- NBA & NAAC Accredited with 'A' Grade)  
Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai  
Kannampalayam Post, Coimbatore - 641 401 Tamil Nadu, India  
Phone No: 0422 2345678, Mob : 989409789, 9789409245, 9042316837  
www.kitko.com, email : kitedevcell@gmail.com



**Guest of Honour**  
**Dr. Prashant R. Nair**  
DST-Amrita Technology Enabling Center (TEC) Fellow  
Vice-Chairman - IQAC, Amrita Vishwa Vidyapeetham, Coimbatore  
Topic : Guideline to Creation of Incubation and  
its support Technology assistance from R&D labs  
& other institutions

**Presided by**  
Mrs. Indu Murugesan  
Vice-Chairperson  
Dr. S. Ravichandran  
Programme Co-ordinator  
Mr. D. Santosh Kumar  
Programme Co-ordinator

**Dr. N. Mohan Das Gandhi**  
CEO  
Dr. M. Ramesh  
Principal  
Mr. C. Ram Kumar  
Deputy Vice-Chairperson

**Date : 24-04-23 | Time : 9-00 to 11-00 am | Venue : KIT - Conference Hall**  
*All are Welcome*



**KIT-Kalaigarkarananidhi  
Institute of Technology**  
An Autonomous Institution, Coimbatore - 641402

**Centre for Research and Development  
&  
Institution's Innovation Council**  
organizes  
**Workshop on  
"Process Design and Development"**



**Resource Person**  
**C Rathina Balaji**  
Commercial Associate,  
Amrita Technology Enabling Centre, Amritapuri

**Presided by**  
Mrs Indu Murugesan  
Vice Chairperson  
Dr M Ramesh  
Principal  
Dr S Santhi  
CFRD-Head & Professor - CSE

**Dr N Mohan Das Gandhi**  
CEO  
Dr K Ramasamy  
Dean-Academics and Research  
Dr R T Yamuna  
HOD - S&H

**Co-ordinators: Dr A BASKER | Dr B KAJAMAIDEEN**

**Date : 20.05.2023 | Time: 9.00 A.M - 1.00 P.M | Venue : KIT-Auditorium**







**JANSON'S INSTITUTE OF TECHNOLOGY**  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai  
Accredited by NAAC & An ISO 9001 : 2015 Certified Institution  
Coimbatore, Tamil Nadu-641 619; www.jit.in



**JIT ISTE STUDENT CHAPTER**  
in association with  
**JIT-IIC Organizes**  
A Workshop On  
**"Technology Readiness Level"**



**Dr. Prashant R. Nair**  
DST-AMRITA Technology Enabling Center (TEC) Fellow,  
Vice-Chairman - IQAC,  
Amrita Vishwa Vidyapeetham, Coimbatore

**Date : 8.2.2023 Time : 2.30 pm to 4 pm Venue : Seminar Hall**



**SNS  
Innovation  
Hub**  
Saravampatti, Coimbatore



**25<sup>th</sup>  
ANNIVERSARY  
1998-2023**

**FDP ON "IGNITING  
ENTREPRENEURIAL  
EDUCATION THROUGH  
INNOVATION & RESEARCH "**  
Registration link  
<https://forms.gle/5pK2CJ58Xduh8466>  
APRIL 5th & 6th, 2023  
RNG Hall, SNSCT



Dr. R. Prashant  
Senior Associate  
IIT Madras Technology Incubation  
Foundation (ITIF)



Dr. S. Subramanian  
Associate Professor  
National Institute of Technology  
Trichy



Dr. R. Ramesh  
Chief Legal Consultant,  
Manager of Strategy Consulting  
L.P. Bangalore



Dr. M. Ramesh  
Union Manager  
Technology Enabling Center  
Amrita Vishwa Vidyapeetham



Dr. R. Ramesh  
Manager & CEO  
Sanyashana IT

**Organizing Team -  
SNS INNOVATION Hub**

**Nalin S**  
The Nalin Singh Trust

**With the Blessings of  
Dr. S. N. Subramanian  
Chairman**

**Dr. S. Rajalakshmi**  
Co-Chairperson

**FIVE PILLARS OF SNS**





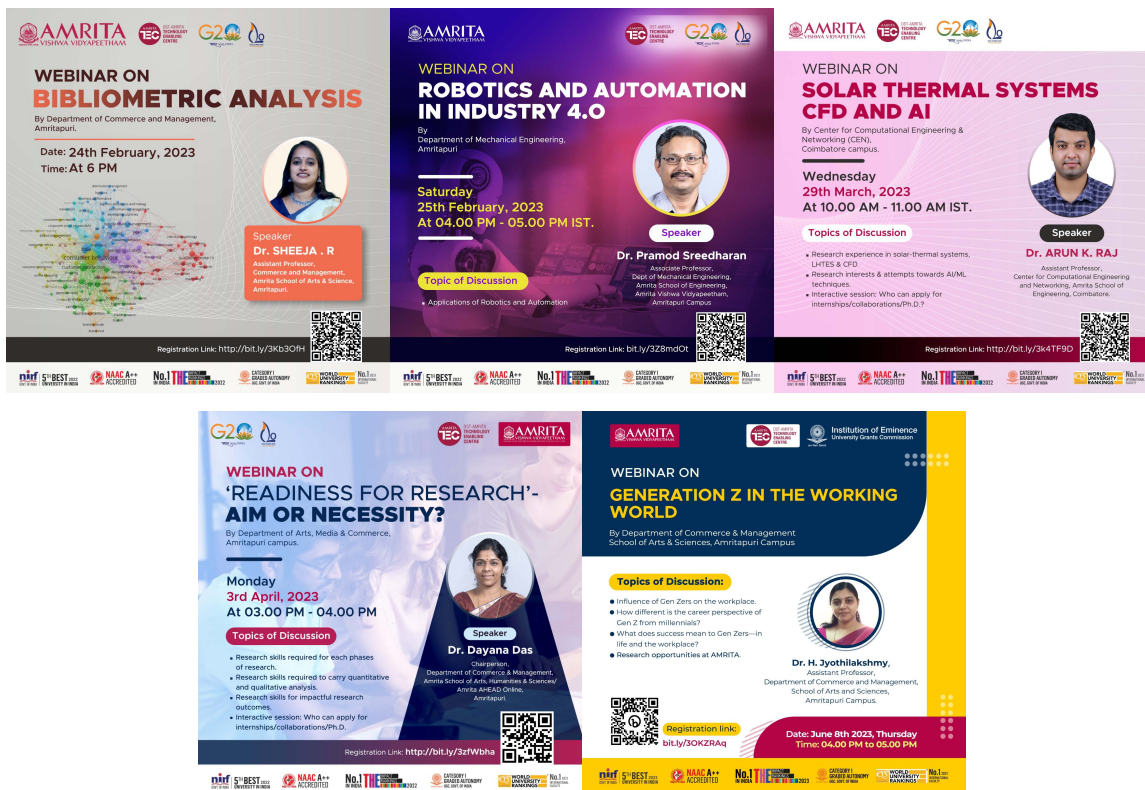


**SPICE**  
The Spice of Life

Amrita TEC has organized diverse training programs aimed at fostering innovation and technology within the ecosystem. These programs cater to students, faculties, researchers, and industrialists, providing them with valuable skill development opportunities and promoting a culture of continuous learning. Moreover, these training programs also create awareness about the Technology Readiness Level (TRL) and the activities of the technology-enabling center. By offering industry-relevant training and TRL insights, the initiative encourages collaboration between academia and industry, nurturing an innovation ecosystem. Participants gain knowledge



of emerging technologies and the maturity levels of different innovations, to enhance their research and entrepreneurial capabilities. These programs not only address industry needs but also facilitate networking, knowledge dissemination, and the transformation of creative ideas into practical applications, contributing to the overall growth and advancement of the community.



Amrita TEC has organized a series of impactful webinars, focusing on the latest trends in technology, to benefit the ecosystem by bridging the gap between academic knowledge and practical application. These webinars serve as a platform for knowledge exchange, bringing together experts, researchers, students, and industry professionals. Participants gain insights into cutting-edge technologies, industry best practices, and real-world challenges, empowering them with valuable information to enhance their skills and stay updated with emerging trends.



## Industry-Academic interaction facilitated by TEC Anokha

Anokha 2023 techfest is proud to be recognized as a supporting event of the prestigious Civil20 (C20), official engagement group of G20. The fest orchestrates a plethora of workshops, innovation showcases and a techfair aligning to the various working groups of C20, which are hosted by Amrita University under the guidance of world-renowned humanitarian leader, Sri Mata Amritanandamayi Devi (AMMA), the Chancellor of the university. DST Amrita Technology Enabling center organised the Techfair that brings students from different universities across the country and gives them an opportunity to showcase their novelty to industrialists and resource persons. One of the best platforms to exhibit talent and innovation, this extravagant showcase brought together under a single roof not only helps students showcase their talent, but also acts as a fantastic opportunity to learn & grow.





## Industry Academia Meet (May 2023)



**Workshop on**  
Autonomous Vehicles (Be EV ready)





Amrita TEC coordinated various training programs to the industry and students on the latest trends in the sectors of Automobile, IoT, NFT, AI, and Biotechnology. Students, researchers, and industrialists from various verticals participated in the workshop with enthusiasm. Industrialists from the MSME sector were highly involved and engaged in the event. The training program was organised in the following topics

- Design, dynamics and brilliance behind the creation of one of the most classic two - wheelers ever built at Harley Davidson Analysis
- "Introduction to LaTeX" - An workshop to attain mastery in efficient management skills and control over formatting documents.
- "Robophone" - An workshop to gain hands-on experience in operating a Bluetooth-controlled pick-and-move robot.
- "Advanced Molecular Toolbox" Discovering about the process of manipulating genes at , as part of Vidyut '23
- "Brain Body Dynamics" Learn about measuring electrical activity in the brain and attain hands-on training in EEG Data
- NFT design competition show off your designing skills and creativity.
- Natural language processing skills to craft your own unique chatbots like ChatGPT and become the next biggest sensation in the field of data processing.



## Civil20: Summit on Technology, Security and Transparency, coimbatore.

Dr. Krishnashree Achuthan, Director Technology Enabling Center and National Coordinator of C20 Summit on Technology, Security & Transparency and Dean of Post Graduate Programs, Amrita Vishwa Vidyapeetham organised an summit on Technology, Security and Transparency. The event was presided by Shri RN Ravi, Hon'ble Governor of Tamil Nadu; Lt. General Dr. Rajesh Pant, National Cyber Security Coordinator, PMO, India; Swami Amritaswarupananda Puri, Vice Chairman, Mata Amritanandamayi Math and Troika Member C20; Vijay Nambiar, Sherpa C20 and Former UN Secretary General's Special Advisor; Bharati Ghosh, National Spokesperson of BJP & Member of National Executive Committee of BJP; Dr. Venkat Rangan, Vice Chancellor, Amrita Vishwa Vidyapeetham.





The summit also provided opportunity for the industries to showcase their latest technological advancement to the other participating industries, researchers, faculties, students and the CSO's. Also various seminars were organised for empowerment of the participants that includes



- Empowering Vulnerable Populations: Challenges and Solutions for Developing Countries.
- Technology for Good: How to Align Ethics, Values, and Human centricity with Technology Goals and Outcomes.
- Child Online Safety, Trafficking & Technology Addiction: Policy Guidelines and Recommendations for a Digital World.
- Technology Financing from the Civil Society Perspective: Civil Society's Take on Financing Technology for Progress.
- From Exclusion to Empowerment: The Role of Technology in Making Health and Education Accessible to All.
- AI Regulation Requirements: How to Avoid Dangers and Achieve Safety and Fairness
- Managing Cross Border Cyber Attacks: Challenges and Opportunities for Cooperation and Coordination.
- Digital Transformation of MSMEs and Digital Economy: Challenges and Opportunities for Growth and Innovation.
- Gender, Vulnerable Populations, and Technology: How to Promote Diversity and Equity.
- Technology and Education: Policy Strategies and Recommendations for Successful Integration.
- Multilingual Internet & Internet Governance: How to Overcome Barriers and Embrace Opportunities for Communication and Cooperation.
- Compassion in the Age of AI: Nurturing Human Flourishing through Ethical Design
- Entrepreneurship: Beyond a Successful Idea.
- From Virtual to Virtuous.

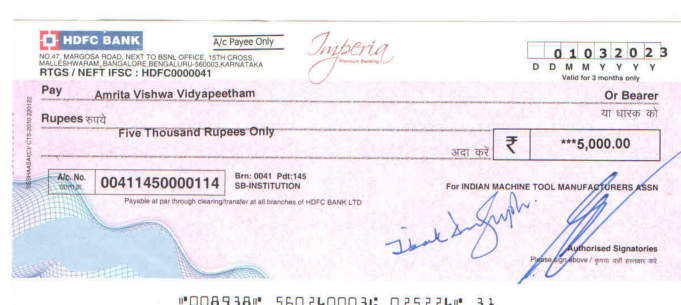
## Awards & Acheivements

### Elected as Sectional Committee Member of the ICT



Dr. Prashant R. Nair, DST-Amrita Technology Enabling Center (TEC) fellow, was elected as a sectional committee member of the ICT section of the ISCA during the congress. This prestigious appointment also puts him on the organizing committee for the next year's science congress.

### Consolation Prize at IMTEX, 2023





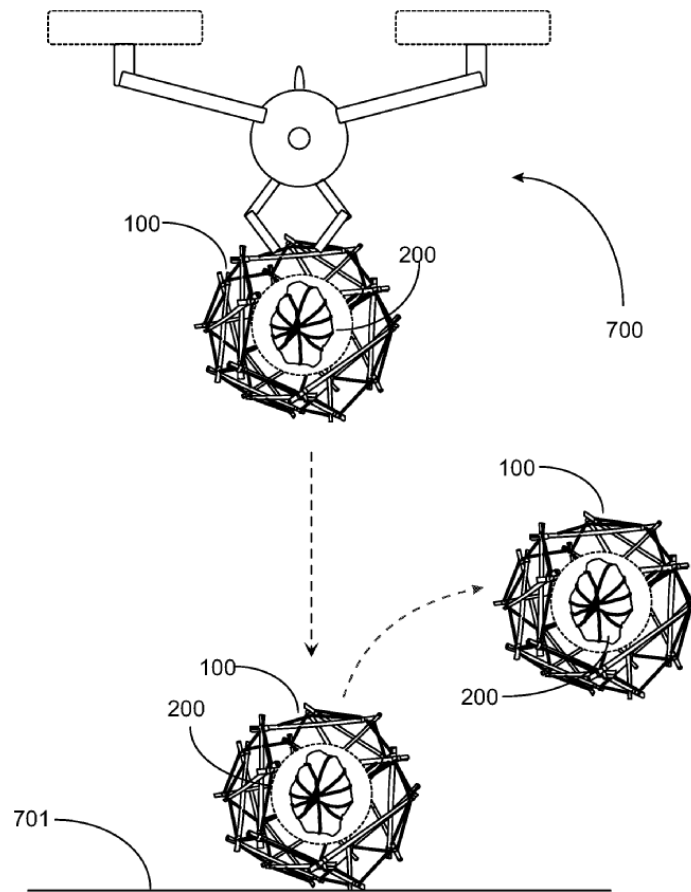
Among various innovation displayed by the academic institution, Amrita product won the consolation prize for its 'Cost effective universal form tester' after various rounds of appraisal. It was also greatly appreciated for building the complex technology with high precession at an affordable prize point.

## Patents & Designs Granted through TEC

### Protective Packaging and Delivery

US Patent 11,618,625

A system for delivery of fragile payloads involves a structure having an approximately spherical aspect composed of rigid struts and flexible tendons joining ends of struts, the flexible tendons in tension placing the struts in compression, the structure having a hollow interior, and one or more fragile items wrapped in a shock-absorbing bio-degradable material such that no fragile item contacts another, forming a payload bundle, the payload bundle joined by fibrous filaments suspending the payload within the structure. The structure carrying the payload bundle is carried to a destination by an aerial vehicle and dropped from a height to the ground, where the structure rebounds and rolls, dissipating kinetic energy gained in falling, preventing the payload bundle from striking ground surface.

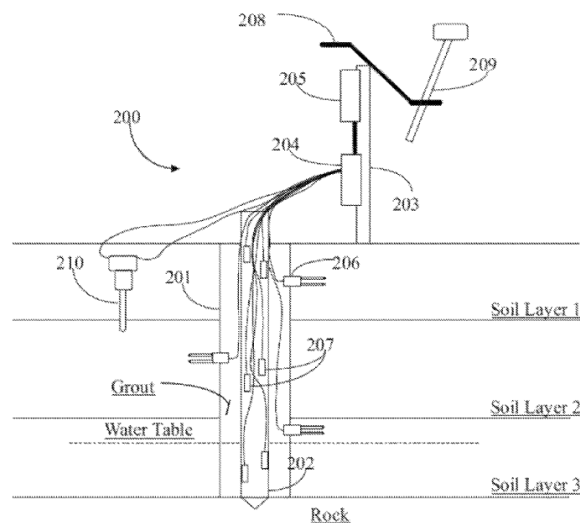




## Multilevel Rapid Warning System for Landslide Detection

US Patent 11,610,466

A hierarchical early-warning system for landslide probability issues a first level warning based on measured rainfall amounts exceeding a determined threshold, a second level warning, after the first level warning, based additionally on measured soil moisture content measured at different levels, and Factor of safety derived from forecasted pore pressure (FPP) each exceeding a determined threshold, a third level warning, after the first and the second level warnings, based additionally on ground movement measurements compared to a determined threshold, and a fourth level warning after the first, second and third level warnings, based additionally on data from movement-based sensors including strain gauge data.

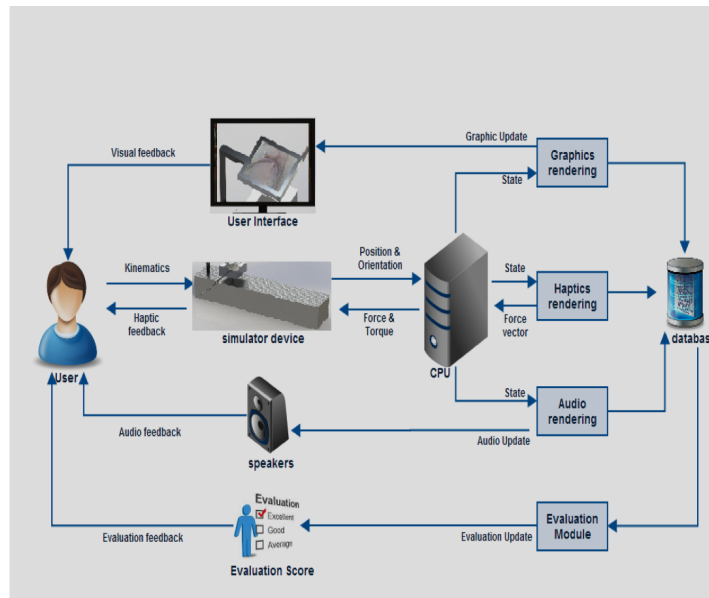


## A Progressive Computer Simulated Haptic Training System for Bar Bending Skills

Indian Patent 422918

All building constructions in India use construction rebars (steel concrete reinforcing bars) to provide structural reinforcement for concrete work. This necessitates experts in bending and cutting rebar to correctly size and bend the long steel rods before they can be installed. This paper presents the design and working of a novel haptic based barbending simulator for providing training to novices in the construction rebar bending skill. The haptic training device is combined

with a virtual environment and is capable of providing manual skill training and evaluation of prior knowledge of the trainees. The proposed system provides a multi modal simulation environment with visual, audio and haptic feedback. A preliminary evaluation of the barbending simulator prototype is also presented which demonstrates that this simulator could be used by the trainers and novices to learn the basic principles of bending a rebar.



TEC has supported to the grant of Indian Design Patent Face Mask 358396-001  
Registered on February 21, 2023