Call for Proposals

Under

TECHNOLOGY DEVELOPMENT PROGRAMME

सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF SCIENCE & TECHNOLOGY

TECHNOLOGY BHAVAN, NEW MEHRAULI ROAD,

NEW DELHI – 110 016

Last Date and Time of Submission: 30.06.2023, 5.00 P.M

(Note: Please complete the online submission of proposal well in advance to avoid last day rush)

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सत्यमेव जयते

Department of Science & Technology (DST)

Technology Development & Transfer (TDT) Division

Project Proposal

under

TECHNOLOGY DEVELOPMENT PROGRAMME (TDP)

DST/TDP/Project_Proposal_Format

Project Title:	Utilization of Pharmaceutical sludge in the making of Eco-friendly bricks
Category	Waste Management Technologies
Research Area	Treatment technology Upgradation
Principal Investigator	Dr.P.SARITHA
Lead Institution	MALLA REDDY ENGINEERING COLLEGE
Date of Submission	30/6/2023

Table of Contents

Section-1. Overview of the Project

1.1. Proposal Submitted for Programme Areas under TDP:

(Please tick √ any of the below)

(**Note:** A PI can submit only one proposal against this DST-TDP Call under only one of the Programme Areas. Submission of more than one proposal from a PI would be liable for disqualification.)

Advanced Manufacturing Technologies (AMT)	
Waste Management Technologies (WMT)	√
Biomedical Device and Technology Development Programme (BDTD)	
Technology Development Programme (TDP)	

1.2. Title: "UTILIZATION OF PHARMACEUTICAL SLUDGE IN THE MAKING OF ECO-FRIENDLY BRICKS"

1.3. **Thrust Area (Refer to Annexure-1):** TOXIC AND HAZARDOUS INDUSTRIAL WASTE

1.4. Category (Please tick √ any of the given category):

Innovation	

(A technological innovation is a new or improved product or process whose technological characteristics are significantly different from before.)

Industrial Application	√

(An invention shall be taken to be capable of industrial application if it can be made or used in any kind of industry, including agriculture/An application capable of being made or used in an industry)

Societal Need	

(An underserved component of society would benefit from the furtherance of this technology)

1.5. TRL (at present) (3-6 scale): 3

1.6. Total Cost: Rs.1,06,74,134-00

1.7. Project Duration: 3 years

1.8. Relevance to:

1) Sustainable Development Goals (SDGs): Goal-11, Sustainable cities and communities
2) National Mission: National Mission on Sustainable habitat

1.9.Lead Investigators

1.9.1. Principal Investigator (PI)

Name	Dr P SARITHA
Designation	Associate Professor
Organization & address	Malla Reddy Engineering College, Maisammaguda, Gundlapochampally, Hyderabad-500100

Telephone(Mobile; Landline)	9849332474
E-mail	poodarisaritha@gmail.com/drpsaritha@mrec.ac.in
Date of birth	23/06/1976

1.9.2. Co-Principal Investigator (Co-PI)

Name	Dr B SUDHARSHAN REDDY
Designation	Professor
Organization & address	Department of Civil Engineering, Malla Reddy Engineering College
Telephones (Mobile; Landline)	9676076033
E-mail	sudharshanreddy@mrec.ac.in
Date of birth	01/03/1982

Name	Dr D BHAGAWAN
Designation	Assistant Professor
Organization & address	Department of Environmental Science, School of Earth Sciences, Central University of Rajasthan
Telephones (Mobile; Landline)	9441184024
E-mail	bhagawan@curaj.ac.in
Date of birth	25/08/1989

1.10.Details of Collaborating Institutes and Industry

1.10.1. Partner-1

Name	Mr. R V TILAK
Designation	Managing Director
Organization & address	Sanray Laboratories Private Limited Plot No 48 & 49 Sy No.302/3, 303/3 EC extension, ECIL, Hyderabad-500062
Telephones (Mobile; Landline)	+91 8885077754
E-mail	tilak@sanraylabs.com
Date of birth	30/05/1980

Section-2. Forwarding Letters

2.1.CERTIFICATE FROM THE INVESTIGATOR(S)

Project Title: **"Utilization of Pharmaceutical sludge in the making of Eco-friendly bricks"**

1. I/We agree to abide by the terms and conditions of the R&D grant.
2. I/We did not submit the project proposal elsewhere for financial support.
3. I/We have explored and ensured that equipment and basic facilities (enumerated in the proposal) will actually be available as and when required for the purpose of the projects. I/We shall not request financial support under this project, for procurement of these items.
4. I/We undertake that space time on permanent equipment (listed in the proposal) will be made available to other users.
5. I/We hereby submitting the Project Proposal complete in all respect, along with (a) Endorsement from the Head of the Organization (on letter head), and (b) Undertakings from the Collaborating Industries/Agencies.
6. I/We shall ensure that the project will be executed as per the General Financial Rules of (GFR) 2017 and the project fund will be kept only in a Zero Balance Subsidiary (ZBS) account of the Host Institute in Union Bank of India. I/We shall also ensure that the above said account will be registered in the Public Funds Management System (PFMS) and the EAT module has been successfully implemented before the submission of the proposal.
7. I/We shall acknowledge DST and the TDT division in all the Papers, Publications and Patents generated out of the proposed research work in every possible platform.

Name & Designation: **Dr. P. SARITHA** Associate Professor, Civil Engineering Department, Coordinator - Entrepreneurship Development Cell, Malla Reddy Engineering College.	Date: 29/06/2023
Signature: 29/6/23	Place: HYDERABAD
Stamp/ Seal: Malla Reddy Engg. College (A) 500 100 Hyderabad	

2.2.Endorsement from Head of Organisation *(On the official letter-head)*

Malla Reddy Engineering College

(An UGC Autonomous Institution approved by AICTE and affiliated to JNTU Hyderabad.
Accredited by NAAC with 'A++' Grade (III - cycle)
NBA Accredited Programmes - UG (CE, EEE, ME, ECE & CSE) PG (CE - Structural Engg., EEE-Electrical Power Systems, ME - Thermal Engg.)

2.2. Endorsement from Head of Organization

Project Title: "UTILIZATION OF PHARMACEUTICAL SLUDGE IN THE MAKING OF ECO-FRIENDLY BRICKS"

Cost: **Rs. 1,06,74,134-00** Duration: **3 years**

1. Affirmed that the Organization welcomes the participation of **Dr. P.Saritha** as the PI and **Dr. B. Sudharshan Reddy & Dr. D Bhagawan** as the Co-PI for the Project and that in the unforeseen and legitimate event of discontinuation by the PI, the Co-PI will assume full responsibility for completion of the Project. Information to this effect, endorsed by me, will be promptly sent to DST
2. Affirmed that the equipment and basic as well as other administrative facilities as per the terms and conditions of the award of the Project will be made available to the Investigator(s) throughout the duration of the Project. All the equipment purchased under the projects will remain the administrative custody of the DST unless any order regarding the same issue by the DST.
3. The Organization shall ensure that as per the rule of GFR 2017, purchase of the equipments may done through the Government e-Marketplace (GEM), to the extent available there as the project involves government funding.
4. The organization shall ensure that under any circumstances, parking of Government Fund will not be done. The Fund will be utilized only for the purpose it was granted.
5. The organization/ institute shall ensure to use Expenditure Advance & Transfer (EAT) module of PFMS.
6. The Organization shall provide timely the Audited Statement of Expenditure and the Utilization Certificate of the Funds under the Grant as required by DST in the prescribed format and all interests and other earnings against released Grant shall be remitted to Consolidated Fund of India (through Non-Tax Receipt Portal (NTRP), i.e. www.bharatkosh.gov.in), immediately after finalization of accounts, as it shall not be adjusted towards future release of Grant.
7. The organization will abide by all the terms and conditions mentioned in the sanction order.

(Head of Organization)

Seal/Stamp

Principal
Malla Reddy Engineering College
Maisammaguda, Dhulapally,
(Post Via Kompally), Secunderabad-500 100.

Date: 29/6/2023

Place: Hyderabad

Malla Reddy Engg. College * 500 100 * Hyderabad

2.3.Undertaking from collaborating Industries/ Agencies

Sanray Laboratories Pvt Ltd.
Plot No. 48 & 49 Sy No.302/3, 303/3,
Ec Extention,ECIL, Hyderabad - 500 062, T.S.
CIN:U73200TG2016PTC109588
Ph: 040-48555855

2.3. Undertaking from collaborating Industries/ Agencies

1. Name of Agency: **SANRAY LABORATORIES PRIVATE LIMITED**

2. I have gone through the Project Proposal entitled **"Utilization of Pharmaceutical sludge in the making of Eco-friendly bricks"** submitted by **Dr. P. Saritha** of **Malla Reddy Engineering College** for DST funding and I hereby affirm that my Organization/ Company is committed to participate in the Project to the full extent as indicated in the Project Proposal including following the technical and financial commitments described in the project proposal.

   a) Technical:

   The study begins with a comprehensive analysis of the chemical composition and physical properties of pharmaceutical sludge. This characterization helps determine the suitability of the sludge as a raw material for brick-making. So in this regard, the industry supports the host institute with the details of the sludge generating steps in the production process, the quantity of sludge generated at each step, the standard protocols, environmental compliance regulations and safety measures followed by the industry.

   b) Financial:

Item	1st Year	2nd Year	3rd Year	Total (Rs)
Equipment	5,00,000-00	3,00,000-00	--	8,00,000-00

Name & Designation: Mr. R.V. Tilak, Managing Director	Date: 28.06.2023
Signature:	Place: Hyderabad
Stamp/ Seal: SANRAY LABORATORIES PVT. LTD. HYDERABAD R.V. TILAK Managing Director SANRAY LABORATIRIES PVT. LTD.,	

2.4 Conflict of Interest

2.4 Conflict of Interest

DEPARTMENT OF SCIENCE AND TECHNOLOGY

POLICY ON CONFLICT OF INTEREST FOR REVIEWER & COMMITTEE MEMBER or APPLICANT or DST OFFICERASSOCIATED/ DEALING WITH THE SCHEME/ PROGRAM OF DST

Issues of Conflicts of Interest and ethics in scientific research and research management have assumed greater prominence, given the larger share of Government funding in the country's R & D scenario. The following policy pertaining to general aspects of Conflicts of Interest and code of ethics, are objective measures that is intended to protect the integrity of the decision making processes and minimize biasness. The policy aims to sustain transparency, increase accountability in funding mechanisms and provide assurance to the general public that processes followed in award of grants are fair and non-discriminatory. The Policy aims to avoid all forms of bias by following a system that is fair, transparent and free from all influence/ unprejudiced dealings, prior to, during and subsequent to the currency of the programme to be entered into with a view to enable public to abstain from bribing or any corrupt practice in order to secure the award by providing assurance to them that their competitors will also refrain from bribing and other corrupt practice and the decision makers will commit to prevent corruption, in any form, by their officials by following transparent procedures. This will also ensure a global acceptance of the decision making process adopted by DST.

Definition of Conflict of Interest:

Conflict of Interest means "any interest which could significantly prejudice an individual's objectivity in the decision making process, thereby creating an unfair competitive advantage for the individual or to the organization which he/she represents". The Conflict of Interest also encompasses situations where an individual, in contravention to the accepted norms and ethics, could exploit his/her obligatory duties for personal benefits.

1. Coverage of the Policy:

a) The provisions of the policy shall be followed by persons applying for and receiving funding from DST, Reviewers of the proposal and Members of Expert Committees and Programme Advisory
Committees. The provisions of the policy will also be applicable on all individuals including Officers of DST connected directly or indirectly or through intermediaries and Committees involved in evaluation of proposals and subsequent decision making process.

b) This policy aims to minimize aspects that may constitute actual Conflict of Interests, apparent Conflict of Interests and potential Conflict of Interests in the funding mechanisms that are presently being operated by DST. The policy also aims to cover, although not limited to, Conflict of interests that are Financial (gains from the outcomes of the proposal or award), Personal (association of relative / Family members) and Institutional (Colleagues, Collaborators, Employer, persons associated in a professional career of an individual such as Ph.D. supervisor etc.)

2. Specifications as to what constitutes Conflict of Interest.

Any of the following specifications (non-exhaustive list) imply Conflict of Interest if,

(i) Due to any reason by which the Reviewer/Committee Member cannot deliver fair and objective assessment of the proposal.

(ii) The applicant is a directly relative# or family member (including but not limited to spouse, child, sibling, parent) or personal friend of the individual involved in the decision making process or alternatively, if any relative of an Officer directly involved in any decision making process / has influenced interest/ stake in the applicant's form etc.

(iii) The applicant for the grant/award is an employee or employer of an individual involved in the process as a Reviewer or Committee Member; or if the applicant to the grant/awardhas had an employer-employee relationship in the past three years with that individual.

(iv) The applicant to the grant/award belongs to the same Department as that of the Reviewer/Committee Member.

(v) The Reviewer/Committee Member is a Head of an Organization from where the applicant is employed.

(vi) The Reviewer /Committee Member is or was, associated in the professional career of the applicant (such as Ph.D. supervisor, Mentor, present Collaborator etc.)

(vii) The Reviewer/Committee Member is involved in the preparation of the research proposal submitted by the applicant.

(viii) The applicant has joint research publications with the Reviewer/Committee Member in the last three years.

(ix) The applicant/Reviewer/Committee Member, in contravention to the accepted norms and ethics followed in scientific research has a direct/indirect financial interest in the outcomes of the proposal.

(x) The Reviewer/Committee Member stands to gain personally should the submitted proposal be accepted or rejected.

The Term "Relative" for this purpose would be referred in section 6 of Companies Act, 1956.

3. Regulation:

The DST shall strive to avoid conflict of interest in its funding mechanisms to the maximum extent possible. Self-regulatory mode is however recommended for stake holders involved in scientific research and research management, on issues pertaining to Conflict of Interest and scientific ethics. Any disclosure pertaining to the same must be made voluntarily by the applicant/Reviewer/Committee Member.

4. Confidentiality:

The Reviewers and the Members of the Committee shall safeguard the confidentiality of all discussions and decisions taken during the process and shall refrain from discussing the same with any applicant or a third party, unless the Committee recommends otherwise and records for doing so.

5. Code of Conduct

5.1 To be followed by Reviewers/Committee Members:

(a) All reviewers shall submit a conflict of interest statement, declaring the presence or absence of any form of conflict of interest.
(b) The reviewers shall refrain from evaluating the proposals if the conflict of interest is established or if it is apparent.
(c) All discussions and decisions pertaining to conflict of interest shall be recorded in the minutes of the meeting.
(d) The Chairman of the Committee shall decide on all aspects pertaining to conflict of interests.
(e) The Chairman of the Committee shall request that all members disclose if they have any conflict of interest in the items of the agenda scheduled for discussion.
(f) The Committee Members shall refrain from participating in the decision making process and leave the room with respect to the specific item where the conflict of interest is established or is apparent.
(g) If the Chairman himself/herself has conflict of interest, the Committee may choose a Chairman from among the remaining members, and the decision shall be made in consultation with Member Secretary of the Committee.
(h) It is expected that a Committee member including the Chair-person will not seek funding from a Committee in which he/she is a member. If any member applies for grant, such proposals will be evaluated separately outside the Committee in which he/she is a member.

5.2 To be followed by the Applicant to the Grant/Award:

(a) The applicant must refrain from suggesting referees with potential Conflict of Interest that may arise due to the factors mentioned in the specifications described above in Point No. 2.
(b) The applicant may mention the names of individuals to whom the submitted proposal should not be sent for refereeing, clearly indicating the reasons for the same.

5.3 To be followed by the Officers dealing with Programs in DST:

While it is mandatory for the program officers to maintain confidentiality as detailed in point no. 6 above, they should declare, in advance, if they are dealing with grant applications of a relative or family member (including but not limited to spouse, child, sibling, parent) or thesis/ post-doctoral mentor or stands to benefit financially if the applicant proposal is funded. In such cases, DST will allot the grant applications to the other program officer.

6. Sanction for violation

6.1 For a) Reviewers / Committee Members and b) Applicant

Any breach of the code of conduct will invite action as decided by the Committee.

6.2 For Officers dealing with Program in DST

Any breach of the code of conduct will invite action under present provision of CCS (conduct Rules),1964.

7. Final Appellate authority:

Secretary, DST shall be the appellate authority in issues pertaining to conflict of interest and issues concerning the decision making process. The decision of Secretary, DST in these issues shall be final and binding.

8. **Declaration**

I have read the above "Policy on Conflict of Interest" of the DST applicable to the Reviewer/ Committee Member/ Applicant/ DST Scheme or Program Officer # and agree to abide by provisions thereof.

I hereby declare that I have no conflict of interest of any form pertaining to the proposed grant *

Name of the ~~Reviewer/ Committee Member or~~ Applicant ~~or DST Officer~~

(Strike out whichever is not applicable)

29/6/2023

(Signature with date)

Section-3. Relevance of Proposed Project

3.1. Current Status of the technology

3.1.1. Internationally

Research on the utilization of pharmaceutical sludge in brick-making is still in its early stages, but there are some promising developments that suggest that this technology could be a viable solution in the future. Several studies have been conducted to evaluate the feasibility of using pharmaceutical sludge as a raw material in brick-making, and the results have been positive. Milica Arsenovic *et al* (2012) Studied the Removal of toxic metals from industrial sludge by fixing in brick structure. Selnur Ucaroglu, *et al* (2012) found that recovery of the waste for construction applications was possible when the waste content of the mortar was < 20%. But solidification for safe disposal was achieved only when higher waste concentrations were added. Shane Donatello, *et al* (2012) carried an assessment of Mercury immobilization in alkali activated fly ash (AAFA) cements. Eisa Hekal, *et al* (2010) Investigated the immobilization of Co (II) in various cement matrices by using the solidification/stabilization (S/S) technique. In this study they used different cement pastes, where ordinary Portland cement while in absence and presence of water reducing- and water repelling-admixtures as well as blended cement with kaolin. J.A. Stegemann, *et al (2009*) Investigated the Stabilization/solidification with cementatious or pozzolanic binders (S/S) is an option for reducing leachability of contaminants from residual, predominantly inorganic, industrial wastes and contaminated soils before disposal or reuse. H. M. A. Mahzuz *et al* (2009) investigated the use of arsenic contaminated sludge in making ornamental bricks. Arsenic contaminated sludge can be substantially found from the treatment of arsenic contaminated ground water. The effectiveness of using this sludge during the process of making ornamental brick has been analyzed and justified. Caijun Shi*, et al* (2006) Studied on the Stabilization/solidification of hazardous and radioactive wastes with alkali-activated cements. Alkali activated cements consist of an alkaline activator and cementing components, Such as blast furnace slag, coal fly ash, phosphorus slag, steel slag, metakaolin, etc. Guangren Qian, *et al* (2006) Explained the utilization of MSWI fly ash for stabilization/solidification of industrial waste sludge. This work investigated the potential for utilization of MSWI incineration fly ash as solidification binder to treat heavy metals-bearing industrial waste sludge. In the study, Municipal Solid Waste Incineration (MSWI) fly ash was used along with ordinary Portland cement to immobilize three different types of industrial sludge while MSWI incineration fly ash was stabilized at the same time. The results showed that the matrixes with heavy metals-bearing sludge and MSWI fly ash have a strong fixing capacity for heavy metals: Zn, Pb, Cu, Ni and Mn. Specimens with only 5–15% cement content was observed to be sufficient to achieve the target compressive strength of 0.3MPa required for landfill disposal. However, there are still some challenges that need to be addressed before this technology can be fully implemented. For example, the composition of pharmaceutical sludge can vary depending on the manufacturing process, which can affect the quality of the bricks produced. Additionally, more research is needed to determine the long-term durability and safety of these bricks in real-world applications. Despite these challenges, researchers and industry experts are optimistic about the potential of this technology and are continuing to explore ways to improve it. As such, it is likely that we will see further developments in the use of pharmaceutical sludge in brick-making in the coming years.

3.1.2. Indian scenario and technological gap

In India, the utilization of pharmaceutical sludge in brick-making is still a relatively new concept, and there are some technological gaps that need to be addressed in order to fully implement this technology. However, some research studies have been conducted in India to explore the feasibility of using pharmaceutical sludge in brick-making. Poornima D K et al (2021) have reviewed extensively the potential use of using waste sludge in the making of bricks. Badar et al. (2012) manufactured a clay brick by replacing sludge, agricultural and industrial waste (such as rise rusk ash and silica fume) at a different temperature brick samples were burnt. Shreekirthi A Mahajan (2017) manufactured a brick using chemical sludge, ordinary Portland cement, stone dust, fly ash, lime and water. Bricks are manufactured at specified proportions of different kind of materials for achieving good strength with adding appropriate water wet homogeneous mixture is done and finally the mortar is allowed to making brick sample. Keerthana et.al (2019): manufactured bricks by partial replacement of clay with sludge (10, 20, 30, 40 percentage). In this paper an attempt is made to reduce pollution by producing ecofriendly bricks. The results obtained showed a crushing strength in range of 3.33 N/mm^2 to 3. 77 N/mm^2. One of the main challenges in India is the lack of awareness and understanding of this technology among brick manufacturers. Many brick manufacturers are not aware of the potential benefits of using pharmaceutical sludge in their production process, and there is a need for more education and awareness-building efforts. Another challenge is the lack of proper infrastructure and facilities for handling and processing pharmaceutical sludge. This can make it difficult for brick manufacturers to source and use this material in their production process. Additionally, there are regulatory issues that need to be addressed. The disposal of pharmaceutical sludge is regulated by the Central Pollution Control Board (CPCB), and there is a need for clearer guidelines on how to use this waste material in brick-making while ensuring compliance with environmental regulations. Despite these challenges, there is a growing interest in the utilization of pharmaceutical sludge in brick-making in India, and some innovative startups and companies are exploring ways to bridge the technological gaps and bring this technology to the mainstream. With the right support and infrastructure, it is possible for India to become a leader in this field and reap the benefits of this sustainable and eco-friendly technology.

3.1.3. Development status at the participating Institutions (Summary of data generated by investigator(s) in their lab)

The immobilization of toxic metals in the pharmaceutical sludge was studied using the solidification/stabilization (S/S) technique. Different mixtures of cement and lime as binders and additives (pulverized fly ash and quarry dust) were used in the present study to reduce the mobility of the metal content of the pharma sludge as well as to strengthen the brick. The strength of the brick is measured using Universal Testing Machine and the toxicity of the brick is done by toxicity characteristics leaching procedure (TCLP) Tests. The results showed that S/S technique had a strong fixing capacity for heavy metals and all the brick specimens prepared were observed to be sufficient in achieving the target compressive strength (5 N/mm^2) and was also found to be economically feasible when compared with a normal brick. The S/S method was observed to be effectively acceptable for solid waste treatment hazardous (Pharma sludge) and Non-Hazardous material (PFA and QD). Bricks were hardened within 2 days from manufacture time. The risk level of toxic metals leaching (Pb, Zn, Ni, Cu, Ni, Co, Cd, and Fe) after bricks (S/S) production was decreased to acceptable levels. Mixed binders (cement and lime) brick is recommended for external use in construction i.e. for pave of pedestrian roads. Negligible concentrations of heavy metals were found in the TCLP leachate. Therefore the sludge from Pharma sludge has a potential to be

reused as construction materials of different applications. As an extension of the work, some more applications of Pharma sludge to be explored by conducting more bench scale studies.

3.2. Significance of the project

3.2.1. Major applications of the proposed technology

The proposed technology of utilizing pharmaceutical sludge in brick-making has several potential applications in various sectors. Here are some major applications of this technology:

1. Construction Industry: Bricks made from pharmaceutical sludge can be used as a sustainable and eco-friendly building material in the construction industry. These bricks have the potential to replace conventional bricks made from clay and sand, which can help to conserve natural resources.

2. Pharmaceutical Industry: Pharmaceutical sludge is a waste material generated during the manufacturing process of pharmaceutical products. By utilizing this waste material in brick-making, the pharmaceutical industry can reduce the amount of waste generated and improve its sustainability.

3. Environmental Management: The utilization of pharmaceutical sludge in brick-making can help to reduce the environmental impact of waste disposal. This technology can help to divert pharmaceutical sludge from landfills and incinerators, which can help to reduce emissions and conserve landfill space.

4. Social Impact: This technology has the potential to create employment opportunities for people in the brick-making industry, particularly in rural areas where brick-making is a common profession. Additionally, the use of sustainable building materials can help to improve the quality of housing and infrastructure in communities.

3.2.2. Target Beneficiaries & Expected Impact

The utilization of pharmaceutical sludge in brick-making has the potential to bring significant environmental, economic, and social benefits, and can be a sustainable and eco-friendly solution for waste management and building material production. It can benefit a range of stakeholders across various sectors.

1. Brick Manufacturers: Brick manufacturers can benefit from the use of pharmaceutical sludge in their production process by reducing their dependence on traditional raw materials such as clay and sand, which can help to conserve natural resources and reduce costs. Additionally, this technology can help to improve the sustainability of their operations and enhance their brand image.

2. Pharmaceutical Industry: The utilization of pharmaceutical sludge in brick-making can help the pharmaceutical industry to reduce the amount of waste generated during the production process, which can improve their environmental sustainability and reduce disposal costs.

3. Environment: The use of pharmaceutical sludge in brick-making can help to reduce the environmental impact of waste disposal by diverting this waste material from landfills, incinerators, and other forms of disposal. This can help to reduce greenhouse gas emissions and conserve landfill space.

4. Society: The use of sustainable building materials can have a positive impact on society by improving the quality of housing and infrastructure, particularly in rural areas where brick-making is a common profession. Additionally, this technology has the potential to create employment opportunities and improve the livelihoods of people working in the brick-making industry.

3.2.3. What further works will require after the project, for commercial exploitation of technology?

After the project, there are several steps that will need to be taken in order to commercialize the technology of utilizing pharmaceutical sludge in brick-making. The commercial exploitation of the technology will require a multi-faceted approach that involves technical, marketing, and regulatory considerations.

1. **Scale-up and Optimization**: The technology will need to be scaled up from the lab scale to the commercial scale in order to produce bricks on a larger scale. Additionally, the production process will need to be optimized to ensure consistent quality and performance.
2. **Standardization and Certification**: The bricks produced using pharmaceutical sludge will need to meet certain standards and certifications in order to be used in construction projects. This will require standardization of the production process and certification of the final product.
3. **Market Research and Development**: Market research and development will be required to identify potential customers and applications for the bricks, and to develop marketing strategies to promote the product.
4. **Infrastructure and Logistics**: Adequate infrastructure and logistics will need to be in place to handle the sourcing, processing, and distribution of pharmaceutical sludge and finished bricks.
5. **Regulatory Compliance**: Compliance with environmental and other regulatory requirements will be required for the commercial exploitation of this technology.
6. **Partnership Development**: Collaboration with key stakeholders, such as the pharmaceutical industry, brick manufacturers, and government agencies, will be important in order to build support for the technology and ensure its successful commercialization.

Section-4. Project Work Summary

4.1. Detailed Objectives

4.1.1. Specific Objectives

1. Assess the chemical composition and physical properties of pharmaceutical sludge to determine its suitability for brick-making.
2. Investigate the potential environmental impact of pharmaceutical sludge disposal and explore the benefits of utilizing it as a raw material in brick production.
3. Evaluate the effects of incorporating pharmaceutical sludge into brick manufacturing processes on the mechanical strength and durability of the resulting bricks.
4. Optimize the formulation and processing parameters for the inclusion of pharmaceutical sludge in brick production to achieve desirable properties and meet regulatory standards.
5. Compare the properties of bricks made with pharmaceutical sludge to conventional bricks to determine their suitability for various construction applications.
6. Conduct a cost-benefit analysis to evaluate the economic feasibility of using pharmaceutical sludge in brick manufacturing, considering factors such as raw material cost, energy consumption, and waste disposal savings.
7. Assess the potential market demand and acceptance of pharmaceutical sludge-based bricks among stakeholders in the construction industry.
8. Explore potential avenues for commercialization and large-scale implementation of pharmaceutical sludge-based brick production.

4.1.2. Scientific Basis and Methodology

Scientific basis:

1. Characterization of Pharmaceutical Sludge: The study begins with a comprehensive analysis of the chemical composition and physical properties of pharmaceutical sludge. This characterization helps determine the suitability of the sludge as a raw material for brick-making. Parameters such as moisture content, organic matter content, heavy metal concentrations, and pH levels are typically evaluated.
2. Environmental Impact Assessment: The proposal aims to investigate the potential environmental impact of pharmaceutical sludge disposal. Pharmaceutical sludge often contains hazardous substances that, if not properly managed, can harm the environment. By utilizing the sludge in brick production, the study aims to reduce the negative environmental impact associated with sludge disposal. This assessment involves analyzing leachate tests, conducting toxicity studies, and evaluating the overall environmental footprint of the process.
3. Mechanical Strength and Durability Analysis: The research focuses on evaluating the effects of incorporating pharmaceutical sludge into brick manufacturing processes on the mechanical strength and durability of the resulting bricks. This involves conducting various tests, such as compressive strength tests, water absorption tests, and freeze-thaw resistance tests. Comparisons are made between bricks made with pharmaceutical sludge and conventional bricks to assess their performance and suitability for construction applications.

Methodology: The proposed methodology provides a systematic approach to address the scientific objectives outlined in the research proposal. It combines laboratory experiments, testing, analysis, and assessments to investigate the viability, performance, and potential benefits of utilizing pharmaceutical sludge in brick production.

1. Collection and Characterization of Pharmaceutical Sludge: Samples of pharmaceutical sludge are collected from wastewater treatment plants or pharmaceutical manufacturing facilities. The sludge is characterized through laboratory tests to determine its chemical composition, physical properties, and any potential contaminants.
2. Formulation Development: Different formulations are developed to incorporate pharmaceutical sludge into the brick-making process. The sludge is mixed with other raw materials such as clay, sand, and additives to optimize the composition and properties of the bricks. The formulation development process involves laboratory-scale experiments and iterative adjustments to achieve desired brick characteristics.
3. Sample Preparation: The formulated mixtures are used to prepare brick samples in the laboratory. The samples are molded using appropriate techniques, such as pressing or extrusion, to obtain bricks of standard size and shape.
4. Testing and Analysis: The prepared brick samples are subjected to a range of tests to evaluate their properties. These tests include compressive strength tests, water absorption tests, dimensional stability tests, durability tests, and other relevant assessments. The properties of the sludge-based bricks are compared with those of conventional bricks to assess their performance.
5. Environmental Impact Assessment: Environmental impact assessment involves analyzing the potential environmental risks associated with pharmaceutical sludge disposal and comparing them to the environmental benefits of utilizing the sludge in brick production. This assessment includes leachate tests, toxicity studies, and life cycle assessments to quantify the environmental impact of the proposed approach.
6. Economic Feasibility Analysis: A cost-benefit analysis is conducted to assess the economic feasibility of utilizing pharmaceutical sludge in brick manufacturing. This analysis takes into account factors such as raw material costs, energy consumption, waste disposal savings, and potential market demand for sludge-based bricks.
7. Market Analysis and Commercialization Strategies: The study explores potential market demand and acceptance of pharmaceutical sludge-based bricks among stakeholders in the construction industry. It also investigates strategies for commercialization and large-scale implementation of the proposed approach.

4.2.Technical Details

4.2.1. Targeted level of development under the project

The pharmaceutical sludge was initially characterized (physic-chemical and trace metal) by following standard methods. The ETP sludge was dried in a hot air oven for 24 h at 105°C. After that it was ground to less than 9.5mm in size to aid workability of the sludge-ash-binder mixture during casting. The PFA and BINDER were mixed in a small container, after 5 min it was blended with water. The dried sludge was added to blended mixer. After fine mix, the industrial by-products silica fume and quarry dust was added to develop the strength of the brick.

This mixture for unfired waste bricks were fabricated in wooden molds with internal of dimensions of 120 mm X 65 mm X 30 mm cubes was used to make the bricks. The bricks were prepared as per the BIS standard (**IS: 40316, 1077-1992)** to achieve compressive

strength. The molds filled with above prepared admixtures and kept in moist conditions for 24h. At the end of this period the bricks were removed from the molds and cured in air at room temperature for 28 days. The samples were cured at ambient temperature and Relative Humidity.

Three typical materials including lime, bentonite and Portland cement are used as binders and pulverized fuel ash, silica fume and quarry dusts are used as add mixers stabilization and solidification. Initially a series of trial bricks are prepared by varying compositions of additives and checked their hardening strength. However the following three series of bricks i.e., B1, B2, B3, B4, B5 are prepared for the laboratory trials. The sludge weight in the all mixtures is varied from 8-10% in the total weight. The composition of the bricks is given below.

COMPOUNDS	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5
Nomenclature of The Bricks	B1	B2	B3	B4	B5
Sludge (%)	10	20	20	20	20
Pulverised fuel ash (%)	45	45	40	40	40
Lime (%)	35	-	20	-	-
Cement (%)	-	30	15	20	35
Quarry dust (%)	10	5	5	20	5
TOTAL (%)	100	100	100	100	100

Table 1. S/S composition

Hardening time of the brick was determined by visual observation and by hand-pressing the specimen for every 6h. Metal leachability test was done by TCLP method and strength of the bricks was measured by Universal Testing Machine.

TCLP Test for S/S Sludge Bricks:

Toxicity Characteristic Leaching Procedure (TCLP) of S/S sludge bricks (waste create bricks) were conducted as per the standard procedures described by USEPA 1996 (4). After 28 days of curing, the samples of cubes were crushed to <9.5 mm in size, according to the requirement of the TCLP procedure. Each crushed sample was treated with an acetic acid solution of pH 2.88 at a liquid-to-solid ratio of 20:1 for a period of 18 h in the bottles. The bottles were tumbled at 28-30 rpm at room temperature for 18 h. At the end of the extraction, the leachate was filtered through a 0.45 μm membrane filter (Whatman glass fiber filter paper) to remove suspended solids.

The filtered leachate was analyzed on atomic absorption spectrometer (AAS) for the heavy metals. After 28 day-long solidificate`s maturing leaching tests were carried out to find out efficiency of investigated S/S formulas.The variable metal concentrations in the leachate of the different unfired bricks(s/s) are reported in Table.4. Results from TCLP method showed insignificant levels of heavy metals and comply with the concentration limits set by United States - Environmental Protection Agency (USEPA) (2005).

	Concentration Level (mg/L)						
Bricks	**Cu**	**Zn**	**Fe**	**Co**	**Pb**	**Ni**	**Cd**
EPA (2005)	800	1200	-	-	4	8	0.8
B1	0.004	0.004	0.028	0.001	0.003	0.002	0.005
B2	0.001	0.005	0.017	0.002	0.003	0.001	0.003
B3	0.003	0.005	0.023	0.001	0.003	0.002	0.005
B4	0.005	0.004	0.019	0.002	0.002	0.002	0.001
B5	0.003	0.006	0.042	0.003	0.003	0.001	0.001

Table 2 Concentration of Heavy Metals in Leachate (TCLP)

Universal Testing Machine: A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. It is named after the fact that it can perform many standard tensile and compression tests on materials, components, and structures. The bricks that were prepared in the present study showed different characteristics with respect to its strength, percentage of water absorption and then the weight of the brick. Finally cost evaluation of the bricks have been done and compared with red brick and fly ash brick.

NAME	**WEIGHT (Kg)**	**STRENGTH (N/mm²)**	**WATER ABSORPTION (%)**	**COST ANALYSIS (Rs)**
B1	**1.76**	**3.36**	**8.38**	**3.92**
B2	**2.19**	**3.28**	**2.91**	**2.56**
B3	**1.87**	**4.66**	**6.6**	**3.30**
B4	**2.05**	**9.00**	**5.9**	**1.8**
B5	**2.00**	**4.56**	**10**	**2.95**
Red brick	**1.66**	**5.00**	**18**	**4.50**
Fly ash	**3.80**	**5.00**	**16**	**4.00**

Table 3: Comparative study of bricks in terms of strength and cost

4.2.2. Proposed target specifications & performance standards

The proposed target specifications and performance standards for bricks made using pharmaceutical sludge as a raw material can be established based on several factors, including industry requirements, regulatory standards, and the desired performance characteristics.

1. **Compressive Strength:** The bricks should possess a minimum compressive strength to ensure structural integrity. The target compressive strength may be set based on regional or national building codes and standards.

- First-class brick has a compressive strength of 105 kg/cm^2.
- The compressive strength of a second-rate brick is 70 kg/cm^2.
- Common building bricks have a compressive strength of 35 kg/cm^2
- The compressive strength of sun-dried brick is between 15 and 25 kg/cm^2.

2. **Water Absorption:** Bricks should have a specific water absorption rate to prevent excessive moisture penetration and potential damage. The target water absorption rate is typically defined based on the intended application and environmental conditions.
   Water Absorption of First class brick should not exceed 12-15% of its dry weight & for second class it should be between 16-20%.

3. **Durability:** The bricks should demonstrate good resistance to environmental factors, such as freeze-thaw cycles, chemical exposure, and weathering. The target durability standards can be established through laboratory tests and performance evaluations (Water Absorption, Effloresce Test & Dimension Tolerance Test).

4. **Dimensional Stability:** Bricks should maintain their shape and dimensions under different conditions to ensure proper fit and compatibility during construction. The target dimensional stability requirements can be set to avoid excessive shrinkage or expansion.
   Indian standard brick dimensions: According to BIS, the standard brick measurement in India is 190 x 90 x 90 mm (length, depth, and height). Bricks Sizes as per Indian Standard (IS 1077).

5. **Toxicity and Contaminant Levels:** Bricks should comply with safety and environmental regulations regarding toxicity and contaminant levels. The target specifications may include maximum permissible concentrations of heavy metals, organic pollutants, or other harmful substances.

6. **Uniformity and Appearance:** The bricks should exhibit consistent color, texture, and overall appearance to meet aesthetic requirements. The target specifications can be defined based on the desired visual qualities and market expectations.
   The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in shape and color. (as per 13757:1993 as per fly ash bricks standards)

7. **Weight and Density:** The bricks should have appropriate weight and density to facilitate handling, transportation, and installation. The target specifications may consider factors such as ease of use and compatibility with existing construction practices.
   The density of brick should not be less than 2.5g/cm3 (as per IS2180:1998)

8. **Thermal Performance:** The bricks should provide adequate insulation or thermal mass properties depending on the desired thermal performance requirements. The target specifications may include thermal conductivity or R-value standards to ensure energy efficiency.

4.2.3. Innovative Elements/Components of the Project

The project can incorporate various innovative elements/components that distinguish it from conventional brick-making processes.

1. **Waste Valorization:** The project aims to address the issue of pharmaceutical sludge disposal by transforming it from a waste product into a valuable resource. This innovative approach helps reduce the environmental impact of sludge disposal while simultaneously creating a new avenue for waste valorization.

2. **Circular Economy Principles:** By utilizing pharmaceutical sludge as a raw material, the project aligns with the principles of the circular economy. It promotes the concept of resource efficiency, where waste materials are repurposed and integrated back into the production process, reducing the reliance on virgin resources and minimizing waste generation.

3. **Sustainable Construction:** The project contributes to sustainable construction practices by exploring alternative materials and processes. The use of pharmaceutical sludge in brick production offers the potential to reduce the environmental footprint associated with conventional brick manufacturing and promotes the development of more sustainable construction materials.

4. **Performance Optimization:** The project aims to optimize the formulation and processing parameters to ensure that the bricks made from pharmaceutical sludge meet the required performance standards. This involves investigating the effects of different additives, processing techniques, and curing methods to enhance the mechanical strength, durability, and other desired properties of the bricks.

5. **Market Analysis and Commercialization:** The proposal incorporates a market analysis component to assess the potential demand and acceptance of pharmaceutical sludge-based bricks in the construction industry. This innovative element focuses on understanding the market dynamics, identifying potential customers, and developing strategies for the commercialization and large-scale implementation of the technology.

6. **Multi-disciplinary Collaboration**: The project may involve collaboration between different disciplines, such as environmental science, materials engineering, and construction technology. This multidisciplinary approach fosters innovation through the integration of diverse expertise and perspectives, leading to a comprehensive understanding of the challenges and opportunities associated with utilizing pharmaceutical sludge in brick-making.

7. **Life Cycle Assessment:** An innovative component could be the inclusion of a life cycle assessment (LCA) to evaluate the environmental impacts of the entire process, from sludge collection to brick manufacturing and use. The LCA helps identify areas for improvement and enables the development of more sustainable practices throughout the entire life cycle of the sludge-based bricks.

4.3.Project Work Plan

a) Milestones with Dates, Work Elements & Organization responsible for it (in the form of Gantt Chart)

Activities/Milestones	Responsible organization		I year			2 year			3 year		
			I	II	III	I	II	III	I	II	III
Scale up studies	MREC	Sanray labs									
Pilot process optimization studies	MREC	Sanray labs/CURAJ									
Kinetic studies		CURAJ									
Brick making on large scale	MREC	Sanray labs									
TCLP analysis	MREC										
Thermogravimetric analysis	MREC										
Data compilation and demonstration	MREC										
Demonstration in front of the stakeholders	MREC/ Sanray labs										

b) Schedules/ Work-Packages (in the form of Gantt Chart) by PI/Co-PI/Partner institutes/Collaborating Industry

S.No	Work-Packages	PI/Co-PI/Collaborating Industry
1	**Data Collection and Characterization Phase** • Collect samples of pharmaceutical sludge • Collect samples of pharmaceutical sludge • Perform chemical composition and physical property analysis • Conduct toxicity tests and environmental impact assessment • Analyze leachate and determine contaminant levels	PI/Co-PI
2	Formulation Development and Optimization Phase • Experiment with different formulations of sludge and other raw materials • Conduct laboratory-scale tests to optimize brick composition and pilot scale optimization • Evaluate the effects of additives and processing parameters on brick properties	PI/Co-PI/Collaborating Industry

3	Sample Preparation and Testing Phase • Prepare brick samples using optimized formulations • Conduct various tests, such as compressive strength, water absorption, and durability • Compare the performance of sludge-based bricks to conventional bricks	PI/Co-PI
4	Environmental and Economic Analysis Phase • Perform life cycle assessments to evaluate the overall environmental impact • Conduct cost-benefit analysis to assess economic feasibility • Analyze potential market demand and acceptance	PI/Co-PI/Collaborating Industry
5	Reporting and Conclusion Phase • Compile and analyze all research data and results • Prepare research reports, including methodology, findings, and recommendations • Summarize the key conclusions and contributions of the study • Present research findings to stakeholders and scientific community	PI/Co-PI/Collaborating Industry

Section-5.Budget Summary (in ₹ 1,06,74,134-00 lakhs)

5.1. Consolidated budget

S	Item	1st Year			2nd Year			3rd Year			Total		
		DST	Host Institute	Industry	DST	Host Institute	Industry	DST	Host Institute	Industry	DST	Host Institute	Industry
1.	Manpower (1RA; 2JRF; 1PA; 1FA)	20,17,920	--	--	20,17,920	--	--	20,17,920	--	--	60,53,760	--	--
2.	Consumables	3,00,000	--	--	2,00,000	--	--	1,00,000	--	--	6,00,000	--	--
3.	Contingency	2,00,000	--	--	2,00,000	--	--	50,000	--	--	4,50,000	--	--
4.	Other Costs*	1,00,000	--	--	1,00,000	--	--	50,000	--	--	2,50,000	--	--
5.	Travel	1,00,000	--	--	1,00,000	--	--	50,000	--	--	2,50,000	--	--
6	Permanent Equipment	13,00,000	--	8,00,000	--	--	--	--	--	--	13,00,000	--	8,00,000
7	Overhead Charges (10%)	3,23,458			3,23,458		--	3,23,458	--	--	970374	--	-
	Total	43,41,378	--	8,00,000	29,41,378	--		25,91,378	--	--	**98,74,134**	--	**8,00,000**

(*Outsourced work, Fabrication & Testing)

(** Host Institute Contribution), (*** Industry's Contribution)

Total Project Budget = ₹ **1,06,74,134 lakhs**

Request for DST Grant = ₹ **98,74,134 lakhs**

Host Institute Contributions = --

Industry Contribution = ₹ **8,00,000** lakhs

Section-6. Itemised Budget

6.1. Manpower

Budget for Salaries - DST Grant

Designation	Qualification	Salary per month	Number of Persons	Amount (in ₹ lakhs)	Role Description
RA	Ph.D/ MD/ MS/ MDS or equivalent degree or having 3 years of research, teaching and design and development experience after MVSc/ M.Pharm/ ME/ M.Tech with at least one research paper in Science Citation lndexed (SCl) journal.	58,280-00	01	20,98,080-00	It is required for the manpower to plan and compile the study.
JRF	Post Graduate Degree in Basic Science Selection process through NET qualification or Graduate Degree/ or Post Graduate Degree in Professional course with NET qualification Selection process through National level Examinations conducted by Central Government Departments and their agencies and	38,440-00	02	27,67,680-00	It is required for the manpower to monitor the different treatment methods.

	institution such as DST, DBT, DAE, DSO, DRDO, MHRD, IIT, IISc, etc				
1PA	Graduate Degree in Basic Science	18,000-00	01	6,48,000-00	It is required for the manpower to maintain the experiments in a systematic manner.
1FA	SSC pass	15,000-00	01	5,40,000-00	It is required for the manpower to maintain the experimental site and reactors at a smooth environment.

6.2.Consumables

Please provide the quantified list of consumables along with cost estimates/quotations in the Annexure (*Item, Quantity & Unit cost*)

Budget for Consumable Materials - DST Grant *(in ₹ lakhs)*

1st Year	**2nd Year**	**3rd Year**	**Total**
₹ 3,00,000	₹ 2,00,000	₹ 1,00,000	₹ 6,00,000

6.3.Contingencies

Please provide the basis of cost estimates in the Annexure.

Budget for Contingencies- DST Grant (in ₹ lakhs)

1st Year	2nd Year	3rd Year	Total
₹ 2,00,000	₹ 2,00,000	₹ 50,000	₹ 4,50,000

6.4.Other Costs (Outsourcing/ Fabrication/ Testing/Patenting)

Please provide the basis of cost estimates/quotations in the Annexure.

Budget for Other Costs-DST Grant (in ₹ lakhs)

Item	1st Year	2nd Year	3rd Year	Total
Outsourcing	₹ 30,000	₹ 30,000	₹ 30000	₹ 90,000
Fabrication	₹ 20,000	₹ 20,000	₹	₹ 40,000
Testing	₹ 50,000	₹ 50,000	₹ 20000	₹ 1,20,000
Others (Define if any)	₹	₹	₹	₹

6.5.Domestic Travel – from – DST Grant (in ₹ lakhs)

Please provide the basis of cost estimates in the Annexure. (journeys, purpose)

1st Year	2nd Year	3rd Year	Total
₹ 1,00,000	₹ 1,00,000	₹ 50,000	₹ 2,50,000

6.6.Equipment proposed to be procured

Please provide justification in Annexure on the use of equipment in project. Provide supporting Quotation

Budget for Permanent Equipment – DST Grant

Description of Equipment	Foreign/ Indigenous	Unit Landed Cost	Number	CIF, Custom Duty of Items etc.)	Total(in ₹ lakhs)	Whether the equipment is already available in the institute or not (if yes justify)
Sludge dewatering unit along with Conveyor belt	Indigenous	₹			₹ 8,00,000	No
Sludge mixer	Indigenous	₹			₹ 5,00,000	No
Brickette machine	Indigenous	₹			₹ 8,00,000	No

6.7.List of equipment available with participating agencies, relevant to the project

Description of Equipment	**Foreign/ Indigenous**	**Agency where it is located**
UTM	Indigenous	MREC
Sieves	Indigenous	MREC
Brick analysis equipment	Indigenous	MREC

Section-7. Annexure: Justification for Itemized Budget

Please provide justification against each sub-heading below, along with supporting Quotation.

7.1.Consumables :

S. No	Material	Justification
1	Cement Fly ash Lime	Sludge Binding materials
2	Sand Gravel / Crushed stone	Aggregates for comparative study
3	Plasticizers	To improve workability and reduce water demand during mixing
4	Coloring agents	To give bricks a desired color
5	Stabilizers	To enhance the durability and resistance of the bricks to environmental factors
6	Chemicals for Analysis	Sludge characterization (Physical, chemical and biological tests) to assess the effectiveness of the treatment.

7.2.Contingency & Travel

1. Iron moulds of varying sizes
2. Trommel screens or vibrating screens
3. Drying yards
4. Crushers
5. Travel for field visit
6. Seminar
7. International/National conferences

7.3.Other Costs :

- XRD analysis charges for particle size identification
- Thermogravimetric analysis
- Toxicity leachate procedure (TCLP)

7.4. Permanent Equipment

S.No	Equipment	Justification
1	Sludge dewatering unit along with Conveyor belt	For drying the sludge
2	Sludge mixer	Uniform mixing of sludge with binders
3	Brickette machine	Brick making machine

Section-8. Biodata of Investigators

8.1.Principal Investigator (1):

8.1.1. Name, Designation, Agency:

Dr P SARITHA,
Associate Professor, Civil Engineering Department
Coordinator - Entrepreneurship Development Cell (EDC)
Malla Reddy Engineering college

8.1.2. Gender & Date of Birth: FEMALE & 23/06/1976

8.1.3. Qualifications: Ph.D, CSIR-RA

8.1.4. Employment Experience (Last 10 years) (Academic/Industry/R&D):

S. No.	Positio nsheld	Name of the Institute	From	To
1	Associate Professor	Malla Reddy Engineering College	June- 2014	Till date
2	CSIR-RA	Jawaharlal Nehru Technological University Hyderabad	April -2012	MAY-2014

8.1.5. Publications (Last 5 years):

1. Yamuna Rani M, Bhagawan D, Himabindu V, Venkateswara Reddy V, **Saritha P** (2017) Utilization of Polluted Dredged Sediment for Making of Bricks. JSM Chem 5(2): 1043.
2. Dheeravath Bhagawan, **Saritha Poodari**, Narala Chaitanya, Surya Ravi, Yamuna M. Rani, Vurimindi Himabindu, S. Vidyavathi, Industrial solid waste landfill leachate treatment using electrocoagulation and biological methods, Desalination and Water Treatment, 68 (2017) 137–142.
3. G. Shankaraiah, **P. Saritha**, D. Bhagawan, V. Himabindu, S. Vidyavathi, Photochemical oxidation of antibiotic gemifloxacin in aqueous solutions: A comparative study South African Journal of Chemical Engineering 24 (2017) 8-16.
4. Yamuna R M, Bhagawan D, **Poodari S**, Himabindu V, Venkateswara R V (2017) Recovery of SiO_2 from Pharma Waste and its Application for Environmental Remediation. Chem Eng Process Tech 3(2): 1040.
5. Yamuna Rani M, Bhagawan D, **Saritha P**, V. Himabindu, V. Venkateswara Reddy, Treatment of Hazardous Solid Waste Using Solidification and Stabilization Technique American Journal of Environmental Protection 2017; 6(4): 94-100.
6. D. Bhagawan, **P. Saritha**, G. Shankaraiah, and V. Himabindu, Fluoride Removal from Groundwater Using Hybrid Cylindrical Electrocoagulation Reactor ISSN 1063_455X, Journal of Water Chemistry and Technology, 2019, Vol. 41, No. 3, pp. 164–169.

7. **Saritha Poodari**, CM Vivek Vardhan, D Bhagawan, G Shankaraiah, Akella Naga Sai Baba Treatment Of Methylated Chloro Phenols Using Uv Mediated Oxidation Processes, Solid State Technology, 2020 63, 2s
8. Vivek Vardhan, **P Saritha**, Akella Naga Sai Baba Pharmaceutical Wastewater Treatment Using Natural and Chemical Coagulants, CM, Solid State Technology, 2020, 8360-8368

8.1.6. Patents:

S.No	Patent Title	Date of Filing of Application	Application Number	Publication Date
1	The transesterification of crude Mahua oil in two stages with different materials to produce maximum biodiesel	07-12-2022	202241070514A	16-12-2022
2	Application of Innovative Technology in the field of Agriculture	23-12-2021	202141060242 A	31-12-2021
3	Strengthening of Expansive Clayey Subgrade Pavement by using Admixture and Geosynthetic	22-02-2021	202141007413 A	26-02-2021
4	An efficient device and a methodology to identify the quality of construction materials	15-02-2020	202041006605 A	28-02-2020
5	System to collect Air Pollutant from Exhaust of a vehicle and further generates oxygen	30-05-2018	201841020231 A	08-06-2018

8.1.7. Research Thesis Guided:

- No. of B.Tech Projects Guided : 20
- No. of M.Tech Projects Guided : 10

8.1.8. Entrepreneurial Activities:

As a coordinator for EDC, organized many workshops, seminars, invited lectures, training programs in collaboration with DFO MSME, Ni-MSME, T-hub, university colleges, IIIT Hyderabad.

S. No.	Name of the Program
1	Workshop on Prototype/Process Design and Development.
2	Workshop on “An Idea can change the life
3	Workshop on Design Thinking, Critical thinking & Innovation Design
4	Organizing Innovation & Entrepreneurship Outreach Program in Schools/Community
5	Expert talk on Process of Innovation Development, Technology Readiness Level (TRL); Commercialization of Lab Technologies & Tech-Transfer
6	Workshop on Entrepreneurship Skill, Attitude and Behaviour Development: The Journey of a Successful Entrepreneur”
7	One day Program on Entrepreneurship Awareness
8	Entrepreneurship opportunities in Packaging industries
9	Entrepreneurship and Innovation as a career opportunity
10	Free Offline Capacity Building Program (National SC/ST Hub Scheme)
11	One Day Workshop on Accelerators / Incubation – Opportunities for Students & Faculties – Early-Stage Entrepreneurs
12	One day Program on Entrepreneurship Awareness
13	Invited talk on “Save Soil-Save the Planet”
14	Best out of Waste Competition
15	Free Offline Capacity Building Program (National SC/ST Hub Scheme)
16	Plastic Waste Management, Issues Challenges and Opportunities for SME’s
17	Scope of Entrepreneurship and Employment in Defense Sector and it’s PSU’s
18	Virtual T-Tribe Launch Pad program -Orientation Session on Entrepreneurship
19	e-National Level Awareness Programme on Entrepreneurship
20	Workshop on Entrepreneurship & Innovation as Career Opportunity
21	Invited talk on Hindrances faced by Entrepreneurs
22	Debate on Mindset of Entrepreneurs before and after Corona

8.1.9. Technology Transferred:--

8.2. Co-Investigator (1):

8.2.1. Name, Designation, Agency:

Dr.B.Sudharshan Reddy
Professor
Civil Engineering Department
Malla Reddy Engineering College

8.2.2. Gender & Date of Birth: Male & 01/03/1982

8.2.3. Qualifications: B.Tech, M.Tech and Ph.D

8.2.4. Employment Experience (Last 10 years): Teaching and Research

8.2.5. Publications (Last 5 years): 8

8.2.6. Patents: 4

8.2.7. Research Thesis Guided:Nil

8.2.8. Entrepreneurial Activities:Nil

8.2.9. Technology Transferred:Nil

8.2. Co-Investigator (2):

8.2.1. Name, Designation, Agency:

Dr. D. Bhagawan
Assistant Professor,
Department of Environmental Science
School of Environmental Sciences
Central University of Rajasthan
NH-8, Bandar Sindri,
Dist-Ajmer-305817, Rajasthan, INDIA

8.2.2. Gender & Date of Birth: Male & 25-08-1989

8.2.3. Qualifications: M. Sc, M. Tech & Ph.D

8.2.4. Employment Experience (Last 10 years):

S. No.	Position sheld	Name of the Institute	From	To
1	RA	National Institute of Technology Warangal	July- 2016	June- 2017
2	UGC- PDF	Jawaharlal Nehru Technological University Hyderabad	August-2017	July-2022
3	PDF	University of Toronto, Canada	August-2022	Feb. 2023

8.2.5. Publications (Last 5 years):

1. Sindhu Akinapally, **Bhagawan Dheeravath**, Kiran Kumar Panga, Vijaya Krishna Saranga, Shankaraiah Golla, Himabindu Vurimindi, Srinivasulu Sanaga, Treatment of pesticide intermediate industrial wastewater using different advanced treatment processes, Sustainable Water Resources Management, **(*Springer*),** ISSN:2363-5037 (Print) 2363-5045 (Online), 2022, 7, 74, https://doi.org/10.1007/s40899-021-00551-7.
2. Lavudya Sushma, Dheravath Bhagawan, Kiran Kumar panga, Shankaraiah Golla, Vijaya Krishna Saranga, Vurimindi Himabindu, Treatment of landfill leachate using advanced oxidation process and struvite precipitation process, Materials today: Proceedings, (***Elsevier-Science Direct***), 2023, https://doi.org/10.1016/j.matpr.2023.01.047
3. Srinivas Jukuri, Suresh Bastipati, **Bhagawan Dheravath**, Srinivas Jukuri, Biochemical process evaluation of an anaerobic digester: A case study on long sustain commercial Biogas plant,

Biomass Conversion and Biorefinery, (***Springer Nature***), 11, Electronic ISSN**:** 2190-6823. **I.F: 4.05**. https://doi.org/10.1007/s13399-021-01410-3. (UGC Journal No.: 14754)

4. Sindhu Akinapally, **Bhagawan Dheeravath**, Kiran Kumar Panga, Himabindu Vurimindi, Srinivasulu sanaga, Treatment Of Pesticide Intermediate Industrial Wastewater Using Hybrid Methodologies, Applied Water Science (***Springer Nature***), 11, 56, ISSN: 2190-549, **I.F: 5.4**, https://doi.org/10.1007/s13201-021-01387-4.
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8.2.6. Patents:

1. Electro oxidation treatment for the enhancement of dark fermentative biohydrogen production from distillery spent wash, application number: 201744020362, patent number: 420330, March 2023, Prof. V. Himabindu, Dr. Lakshmi Narasu Mangamoori, Dr. Chaitanya Narala, Dr. Bhagawan Dheravath

8.2.7. Research Thesis Guided: Nil

8.2.8. Entrepreneurial Activities:

S. No	Coordinator	Title of the Project	Funding Agency	Starting and Closing Date	Cost Of The Project (In Rs.)
1	**Dr.D. Bhagawan**	Treatment of wastewater using movable electrochemical reactor	MSME, Govt of India	2018-19	4.00 Lakhs
2	**Dr.D. Bhagawan**	Development of mobile electrochemical reactor	MSME Govt of India	2020-21	19.80 Lakhs

8.2.9. Technology Transferred:--

PROJECT SUMMARY

Project Title: - "UTILIZATION OF PHARMACEUTICAL SLUDGE IN THE MAKING OF ECO-FRIENDLY BRICKS"

1. **Summary of Lab Prototype Already Developed by PI in the Host Institute** (in 100 words)**:**

The immobilization of toxic metals in the pharmaceutical sludge was studied using the solidification/stabilization (S/S) technique. Different mixtures of cement and lime as binders and additives (pulverized fly ash and quarry dust) were used in the present study to reduce the mobility of the metal content of the pharma sludge as well as to strengthen the brick. The strength of the brick is measured using Universal Testing Machine and the toxicity of the brick is done by toxicity characteristics leaching procedure (TCLP) Tests. The results showed that S/S technique had a strong fixing capacity for heavy metals and all the brick specimens prepared were observed to be sufficient in achieving the target compressive strength (5 N/mm^2) and was also found to be economically feasible when compared with a normal brick.

The S/S method was observed to be effectively acceptable for solid waste treatment hazardous (Pharma sludge) and Non-Hazardous material (PFA and QD). Bricks were hardened within 2 days from manufacture time. The risk level of toxic metals leaching (Pb, Zn, Ni, Cu, Ni, Co, Cd, and Fe) after bricks (S/S) production was decreased to acceptable levels. Mixed binders (cement and lime) brick is recommended for external use in construction i.e. for pave of pedestrian roads. Negligible concentrations of heavy metals were found in the TCLP leachate. Therefore, the sludge from Pharma sludge has a potential to be reused as construction materials of different applications. As an extension of the work, some more applications of Pharma sludge to be explored by conducting more bench scale studies.

2. **Principal Investigator:**

Dr P SARITHA
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+919849332474

4. Date of Birth: 23/06/1976 **Age: 47** **GENDER: Female**

5. **Collaborating Institutions/Agencies/Industries (if any):**

1. Sanray Laboratories Private Limited
   Plot No 48 & 49 Sy No.302/3, 303/3
   EC extension, ECIL, Hyderabad-500062

2. Department of Environmental Science
   School of Environmental Sciences
   Central University of Rajasthan, NH-8, Bandar Sindri,
   Dist-Ajmer-305817, Rajasthan, INDIA

6. Duration (max Upto 3 years): - 3 years

7. Total Budget: Rs.1,06,74,134-00

7.1 DST Share: Rs. 98,74,134-00

7.2 Institute/Industry' Share: Rs. 8,00,000-00

7.3 Manpower: Rs. 60,53,760-00

7.3.1 Manpower Details: 1RA, 2JRF, 1PA, 1FA

7.4 Equipment Proposed: Rs. 21,00,000-00

7.4.1 Name of Equipment Proposed:

- Sludge dewatering unit along with Conveyor belt
- Sludge mixer
- Brickette machine

8. Objectives (*In bullet form***):**

- Assess the chemical composition and physical properties of pharmaceutical sludge to determine its suitability for brick-making.
- Investigate the potential environmental impact of pharmaceutical sludge disposal and explore the benefits of utilizing it as a raw material in brick production.
- Evaluate the effects of incorporating pharmaceutical sludge into brick manufacturing processes on the mechanical strength and durability of the resulting bricks.
- Optimize the formulation and processing parameters for the inclusion of pharmaceutical sludge in brick production to achieve desirable properties and meet regulatory standards.
- Compare the properties of bricks made with pharmaceutical sludge to conventional bricks to determine their suitability for various construction applications.
- Conduct a cost-benefit analysis to evaluate the economic feasibility of using pharmaceutical sludge in brick manufacturing, considering factors such as raw material cost, energy consumption, and waste disposal savings.
- Assess the potential market demand and acceptance of pharmaceutical sludge-based bricks among stakeholders in the construction industry.
- Explore potential avenues for commercialization and large-scale implementation of pharmaceutical sludge-based brick production.

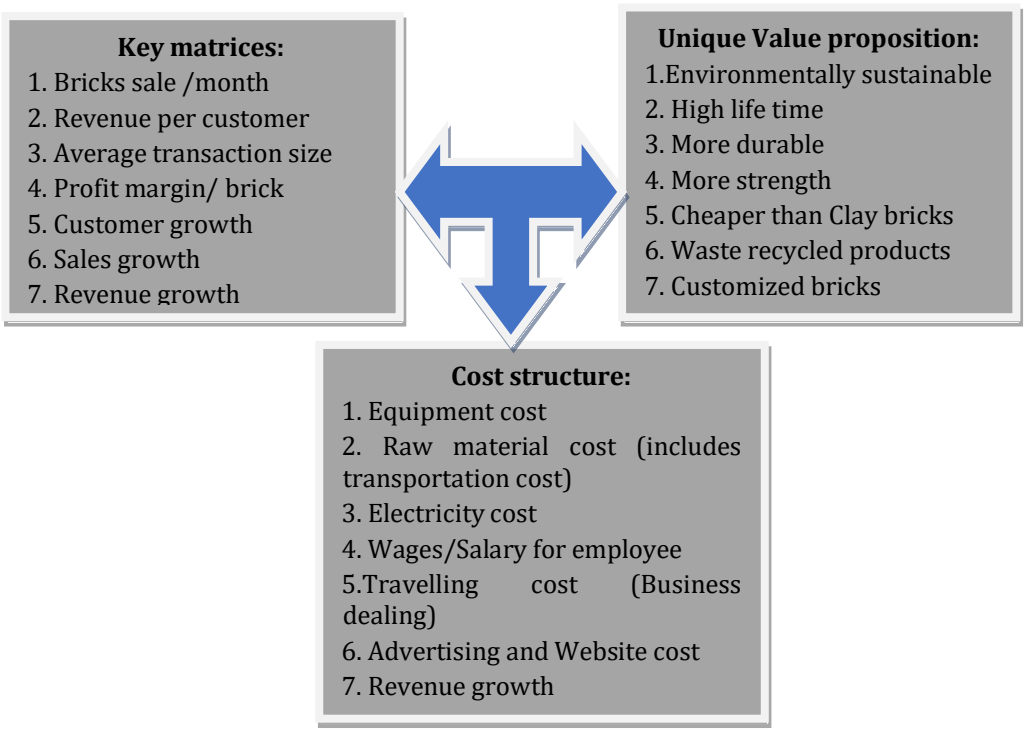
9. Novelty/Innovative Elements/S&T Components of the Project:

- **Waste Valorization:** The project aims to address the issue of pharmaceutical sludge disposal by transforming it from a waste product into a valuable resource. This innovative approach helps reduce the environmental impact of sludge disposal while simultaneously creating a new avenue for waste valorization.
- **Circular Economy Principles:** By utilizing pharmaceutical sludge as a raw material, the project aligns with the principles of the circular economy. It promotes the concept of resource efficiency, where waste materials are repurposed and integrated back into the production process, reducing the reliance on virgin resources and minimizing waste generation.

- **Sustainable Construction:** The project contributes to sustainable construction practices by exploring alternative materials and processes. The use of pharmaceutical sludge in brick production offers the potential to reduce the environmental footprint associated with conventional brick manufacturing and promotes the development of more sustainable construction materials.
- **Market Analysis and Commercialization:** The proposal incorporates a market analysis component to assess the potential demand and acceptance of pharmaceutical sludge-based bricks in the construction industry which further helps in understanding the market dynamics, identifying potential customers, and developing strategies for the commercialization and large-scale implementation of the technology.
- **Multi-disciplinary Collaboration**: This multidisciplinary approach of involving collaboration between different disciplines fosters innovation through the integration of diverse expertise and perspectives, leading to a comprehensive understanding of the challenges and opportunities associated with utilizing pharmaceutical sludge in brick-making.
- **Life Cycle Assessment:** The LCA helps identify areas for improvement and enables the development of more sustainable practices throughout the entire life cycle of the sludge-based bricks.

10. Outcome/ Deliverables and their Expected Impact (*In bullet form*):

- **TRL to be achieved: above 4**
- **Scale up model: Pilot scale**
- **Business plan:**



11. Target Beneficiaries & Benefits to the country:

The utilization of pharmaceutical sludge in brick-making has the potential to bring significant environmental, economic, and social benefits, and can be a sustainable and eco-friendly solution for waste management and building material production. It can benefit a range of stakeholders across various sectors.

1. Brick Manufacturers
2. Pharmaceutical Industry
3. Environment
4. Society

12. Role of Industry/Co-PI in the proposed project: -

Role of Industry:

- ✓ Supply of sludge material
- ✓ Provision of Equipment required for brick making
- ✓ Details of steps involved in the generation of sludge

Role of Co-PI: Knowledge transfer

13. Any other relevant information: - Nil