

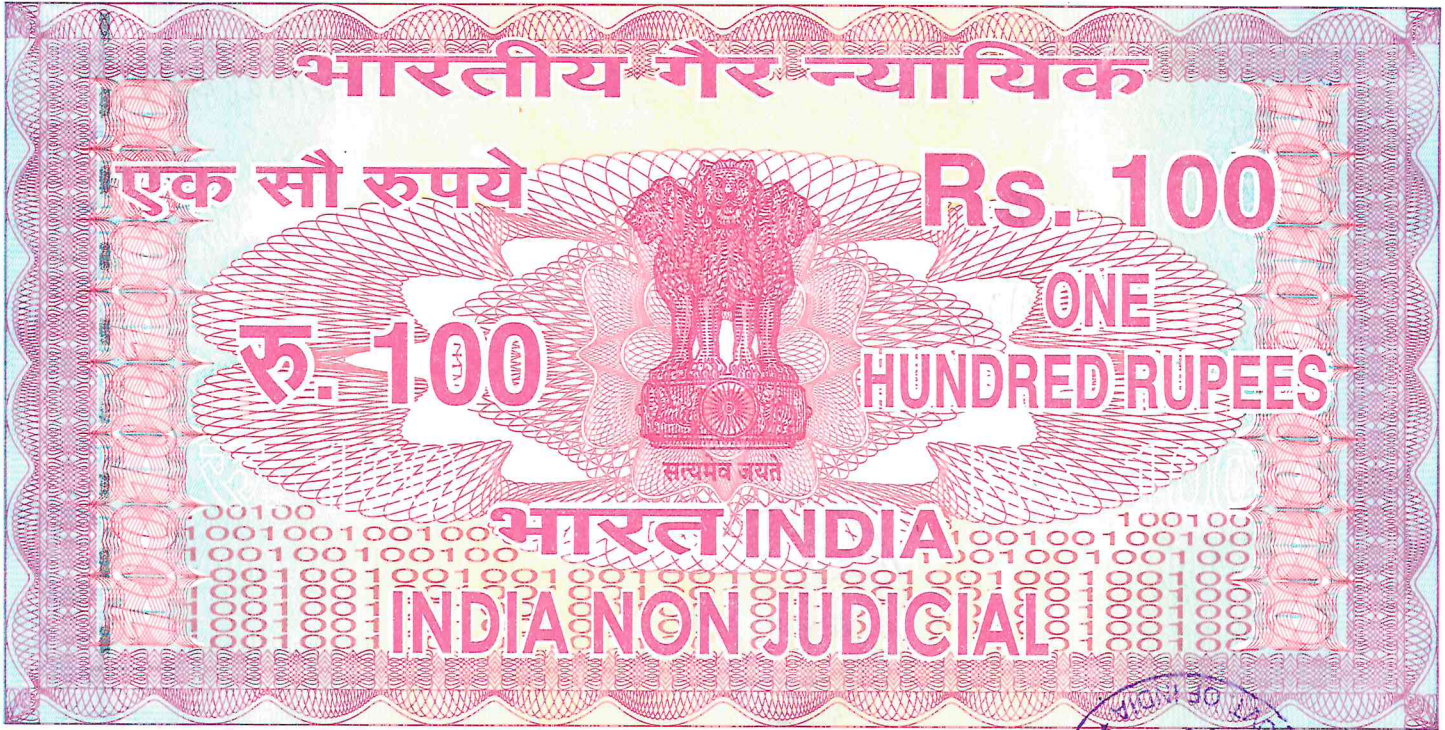
CONTENT

<b>S. No.</b>	<b>Title</b>
1.	Details of funded projects
2.	Sanction Letters



## RDC Cell Details of Funded Projects by Government Agencies

S. No.	Name of faculty members	Deptt. Name	Title of Project	Sponsoring Agency	Sanctioned Amount (In Lakhs)	Year
1	Dr. Mrinal Pandey (PI) Dr. Mamta Arora (Co-PI) Dr. Riya Sapra (Co-PI) Mr. Sohaib Siddiqui (Co-PI)	CST-MRU CST-MRU The North Cap University	Medical Insurance Claim Settlement using Blockchain Technology	IIT Bhilai Innovation and Technology Foundation (IBITF)	31.96	2022-23
2	Dr. Aditya Sharma (PI) Dr. Shiv Kumar (Co-PI)	Sciences-MRU Sciences-MRU	Development and Testing of Ion Implantation Induced Modified Charges Transport Layers in Lead Deficient Perovskite Solar cells for Enhancing the Efficiency/Stability and Reducing the Toxicity	Haryana State Council for Science, Innovation and Technology, Haryana	18.25	2022-23
3	Dr. Jitendra Pal Singh (Ramanujan Fellow/PI)	Sciences-MRU	Development of Garnet Structured Electrolyte Based Li-Rechargeable Thin Film Batteries for High Energy Applications	Science & Engineering Research Board (SERB)	119.00	2022-23
4	Dr. Meena Kapahi (PI)	Sciences-MRU	Waste to Resources on Environmentally Sound Management of Waste	Ministry of Environment, Forest and Climate Change	10.00	2021-22
<b>Total</b>					<b>177.23</b>	



हरियाणा HARYANA



## AGREEMENT

THIS Agreement is made and executed on this day \_\_\_\_\_ of \_\_\_\_\_ 2022 ("Effective date")

BY

IIT BHILAI INNOVATION AND TECHNOLOGY FOUNDATION (hereinafter referred to as **IBITF**), A Section-8 Company Registered under Companies Act 2013 with (CIN U80902CT2021NPL011186) having registered office IIT Bhilai Transit Campus at GEC Campus, Sejbahar, Raipur – 492015 Chhattisgarh, India

AND

Manav Rachna University (hereinafter referred to as '**MRU**') is a leading State Private University (established by Haryana State Legislature Act No 26 of 2014 & under section 2(f) of UGC Act 1956), offering globally relevant education. The University has evolved from Manav Rachna College of Engineering (MRCE), which was established in the year 2004, a NAAC accredited 'A' Grade institution.

AND

The North Cap University (hereinafter referred to as '**NCU**'), is promoted by the Educate India Society that was founded in 1996. Previously an engineering and management college (ITM), the institute gained the status of a State Private university in 2009, under Act No. 25/2009 by the Legislature of the State of Haryana and accorded UGC approval under Section 2(f) of the UGC Act 1956. NCU rebranded itself on 31 August 2015 vide Haryana Government Ordinance No. 2 of 2015, followed by a UGC notification dated 26 August 2015. NCU is a single campus university located in Sector 23-A,

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37995  
04/01/23

IIT Bhilai Innovation and Technology  
Foundation  
R/o Raipur  
Agg. with MRU



Gurugram, Haryana. It has been accredited by the National Assessment and Accreditation Council (NAAC) 2016-2021.

AND

Artificially Intelligent Workforce (hereinafter referred to as 'AIW'), is incorporated on 20 January 2021. It is classified as non-govt company and is registered at Registrar of Companies, Delhi. Its authorized share capital is Rs. 1,500,000 and its paid-up capital is Rs. 100,000. It is involved in other computer related activities [for example maintenance of websites of other firms/ creation of multimedia presentations for other firms etc.] AIW Works Private Limited's Corporate Identification Number is (CIN) U72900HR2021PTC092333 and its registration number is 92333. Its Email address is sohaib@ferntechnologies.com and its registered address is FW-11/11A, M3M GOLF ESTATE, SECTOR 65, GURUGRAM Gurgaon HR 122102 IN.

All the four parties referred to as "Parties" and individually referred as IBITF, MRU, NCU or AIW respectively as the case may be.

## I. Scope of the Agreement

### whereas

1. Manav Rachna University (MRU), and The North Cap University (NCU) along with AIW as industry partner submitted a project proposal titled "Medical Insurance claim settlement using Blockchain Technology", to IBITF for financial support under the Technology Development Scheme.
2. IBITF followed due process of two-step evaluation of the said project proposal with an expert committee and arrived at a conclusion of funding the project. An administrative approval No. IITBH/IBITF/Technology Development/2022-23/83/Vol.II/Proposal 1 -dated 09.12.2022 (copy enclosed) and annexures to this effect was issued.

## II Roles & Responsibilities of the Parties

### Manav Rachna University (MRU)

1. Data Collection from different resources (Unstructured Data)
2. Data Transformation (Structured Data) OCR and Open CV (Computer Vision/ ML/ DL will be used for model Building)
3. The development of decentralized Block Chain framework for Insurance Claim Medical Settlement.
4. Automation of the Block Chain framework for Insurance Claim Medical Settlement.

### North Cap University (NCU)

1. Data Collection from different resources (Unstructured Data)
2. Data Transformation (Structured Data)
3. Document Analysis
4. Testing of the proposed system

### Roles & Responsibilities of Artificial Intelligence Workforce (AIW)

1. Project Outline & Management and implementation.
2. Business development for the developed system, Deployment, customization & Testing
3. Product Selling, marketing, maintenance.



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### III. Obligations of the Parties

#### IBITF

1. IBITF put all its efforts and ensures timely release of funds as per the said administrative approval dated 09.12.2022.
2. Arranging six monthly review meetings for the monitoring of the project.

#### MRU:

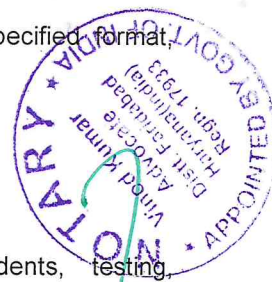
1. Acceptance of the said administrative approval and the terms and conditions.
2. Overall coordination and timely completion of the project by the PI and Co-PI as per the timelines mentioned in the administrative approval.
3. Timely availability of funds received from IBITF for the project and should ensure that the funds are utilised for the purpose that the funds are received.
4. Submission six monthly Technical and Financial progress report in the specified format, audited statement of expenditure and utilisation certificate
5. In the events of either the PI or Co-PI leaving the organisation or poor performance, assignment of the task to a suitable faculty as replacement
6. Put all efforts for timely payment of royalty to IBITF as agreed by the AIW

#### NCU:

1. Acceptance of the said administrative approval and the terms and conditions.
2. Timely completion of the project by the PI and Co-PI as per the timelines mentioned in the administrative approval.
3. In the events of either the PI or Co-PI leaving the organisation or poor performance, assignment of the task to suitable faculty as replacement.
4. Timely availability of funds received from IBITF for the project and should ensure that the funds are utilised for the purpose that the funds are received.
5. Submission six monthly Technical and Financial progress report in the specified format, audited
6. statement of expenditure and utilisation certificate

#### AIW:

1. Acceptance of the said administrative approval and the terms and conditions.
2. Development of full system along with the faculty (PI&CO-PI)/students, testing, Implementation, deployment, marketing and sale of the systems in various hospitals and user organisations.
3. Timely availability of the funds (contribution of AIW) and manpower for the timely completion of the project as mentioned in the administrative approval.
4. Timely payment of royalty of 20% on the sale of the system on monthly basis to IBITF.



### IV Dispute Resolution and Jurisdiction

Resolution of disputes shall be done amicably among the participating institutions. However, if no consensus is reached, final authority shall lie with the Board of IBITF. In case of disagreement if any, the settlement is through the courts in the state of Chhattisgarh.

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V Force Majeure.

Neither Party shall be liable for its failure to perform under this Agreement as a result of any event of force majeure events like acts of god, fire, pandemic, wars, sabotage, civil unrest, action of Statutory Authorities or local or Government's change in laws, rules and regulations, affecting the performance of such Party.

VI Amendment.

No change, alteration, modification or addition to this Agreement shall be valid unless made in writing and signed by the Parties hereto

Signed by <u>[Signature]</u> IIT Bhilai Innovation and Technology Foundation, IIT Bhilai Campus	Signed by <u>[Signature]</u> Manav Rachna University Dr. Kameshwar Singh Registrar
Name: <u>Smitosh Biswas</u> Designation: <u>Professor, IIT</u> Address: <u>EC5 IIT Dhu</u>	Name: <u>Manav Rachna University</u> Designation: <u>43 Aravali Hills, Suraj Kund Road,</u> Address: <u>Faridabad-121001</u>

Signed by <u>[Signature]</u> Col. Bikram Mohanty (Retd.) Registrar THE NORTH CAP UNIVERSITY Sector-23A, Gurgaon-122 017	Signed by <u>[Signature]</u> Artificially Intelligent Workforce (hereinafter referred to as 'AIW')
Name: Designation: Address	Name: <u>SOHAIB SIDDIQUI</u> Designation: <u>MANAGING DIRECTOR</u> Address: <u>225 VIPUL TRADE CENTRE, SECTOR,</u> <u>GURURAM, HR, 122018</u>



Identify  
I know the deponent/executor and  
he/she has signed/thumb impression  
LTI/PTI in my presence

ATTESTED AS IDENTIFIED

Notary Faridabad (Haryana)

04 JAN 2023

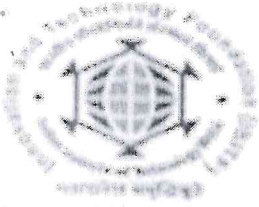


Dr. Kamelshah...  
Registrar  
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IIT BHILAI INNOVATION AND TECHNOLOGY  
FOUNDATION (IBITF)

IIT Bhilai, GEC Campus, Sejbahar, Raipur – 492015

**ADMINISTRATIVE APPROVAL**

Ref No: IITBH/IBITF/Technology Development/2022-23/83/Vol-II/Proposal 1

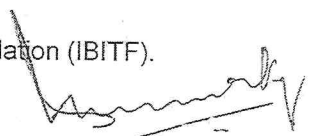
Dated:09.12.2022

To,

1. Dr. Mrinal Pandey  
Manav Rachna Campus Rd,  
Sector 43, Faridabad, Haryana 121004.
2. Dr. Riya Sapra  
The North Cap University  
HUDA Sector 23-A Gurugram – 122017.
3. Dr. Mamta Arora  
Manav Rachna Campus Rd,  
Sector 43, Faridabad, Haryana 121004.
4. Sohaib Siddiqui  
M1254,1<sup>st</sup> Floor Landmark Corporate Centre,  
Landmark CyberPark, Sector-67, Gurugram-122102.

**Sub: Administrative approval for the project entitled “Medical Insurance claim Settlement using Blockchain Technology”, under Technology Development scheme by IBITF to be implemented by Manav Rachna University along with North cap University and AIW as industry Partner.**

1. The undersigned is directed to convey the administrative approval of the competent Authority for the project entitled, “ Medical Insurance claim Settlement using Blockchain Technology”, under the Technology Development scheme at a total estimated cost of Rs 31.965 Lakh in contribution from Rs 19.965 Lakh (Rupees Nineteen lakhs Ninety-six Thousand Five Hundred Only) as grants-in-aid from IIT Bhilai Innovation and Technology Foundation (IBITF) and Rs.12 Lakh ( Rupees Twelve Lakh Only) from AIW Industry Partner over a period of Two years, to be implemented by Manav Rachna University, Haryana and The North Cap University, Gurugram.
2. The details of the project are given in the Annexure-I enclosed. The other Terms & conditions governing release of Grant-in-aid from IBITF are given in Annexure-II.
3. The release of funds will be subjected to signing of Multi Party agreement by Manav Rachna University (MRU), The North Cap University (NCU) and Artificially Intelligent Workforce (AIW).
4. The funds are from the grant received from Department of Science and Technology, Government of India, under the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) for the Technology Innovation Hub (FINTECH) at IIT Bhilai.
5. This is issued with the approval of Chairman, IIT Bhilai Innovation and Technology Foundation (IBITF).

  
Dr. B. K. Murthy  
CEO (IBITF)

Copy To:

1. Finance & Accounts Office, IIT Bhilai
2. Vice Chancellor, MRU, Haryana
3. Vice Chancellor, NCU, Gurugram
4. CEO, IBITF
5. Project Director, IBITF



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Registrar*

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**Annexure-I**

**Administrative Approval No:** IITBH/IBITF/Technology Development/2022-23/83/Vol-II/Proposal1 **Dated:**09.12.2022

1	Name of the Project	Medical Insurance claim Settlement using Blockchain Technology
2	Objective	<ul style="list-style-type: none"> <li>To design and develop an efficient Database Management System to aid medical insurance claims settlement through Blockchain and AI based technologies.</li> <li>To develop a decentralized application for the stakeholders involved in the insurance claim settlement procedure.</li> <li>To provide automated information to the insurance company to reduce turnaround time, manpower as well as cost.</li> </ul>
2.1	Deliverables with TRL	As per Appendix 'A'
2.2	Intermediate Milestones on quarterly basis	As per Appendix 'B'
3	Name of the Implementing Agencies and Status	IIT Bhilai Innovation and Technology Foundation
4	Name of Chief Investigator	Dr. Mrinal Pandey, Professor, Department of CSE, Manav Rachna University
5	Total Project duration (i) Expected date of commencement (ii) Expected date of completion	18 Months Date of Signing of Agreement

6.Total Project Outlay: Rs 31.965 Lakh (Rupees Thirty-one lakh Ninety-six Thousand Five Hundred Only)

Head	1st Year	2nd Year (6 Months)	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops) +Printer	205000	0	Nil	205000
Web services	150000	50000		200000
Consumable	90000	55000	Nil	145000
Training & Workshops/Conferences	65000	25000	Nil	90000
Travel	35000	25000	Nil	60000
Manpower (2UG Students)	180000	90000	Nil	270000
Manpower (1 project manager)			1200000	0
Developer	360000	360000	Nil	720000
Contingencies	75000	50000	Nil	125000
Overhead @10%	116000	65500	Nil	181500
Total	1276000	720500		1996500
Grand Total			1200000	3196500



*Manav Rachna University  
Faridabad*

*Manav Rachna University  
Faridabad*

## MRU Budget

Head	1st Year	2nd Year (6 Months)	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops) +Printer	120000	0	Nil	120000
web Services	150000	50000		200000
Consumable	75000	50000	Nil	125000
Training & Workshops/Conferences	50000	20000	Nil	70000
Travel	30000	20000	Nil	50000
Manpower (2 UG Students)	180000	90000	Nil	270000
Manpower (1 project manager and)	0	0	1200000	0
Developer	360000	360000	Nil	720000
Contingencies	50000	30000	Nil	80000
Overhead	101500	62000	Nil	163500
Grand Total	1116500	682000	1200000	1798500

## NCU Budget

Head	1st Year	2nd Year (6 Months)	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops) +Printer	85000	0	Nil	85000
Consumable	15000	5000	Nil	20000
Training & Workshops/Conferences	15000	5000	Nil	20000
Travel	5000	5000	Nil	10000
Contingencies	25000	20000	Nil	45000
Overhead	14500	3500	Nil	18000
Grand Total	159500	38500	Nil	198000

### 7. Mode and extent of Funding:

(i)	Total Budget	Rs 31.965 Lakh
a)	Support from IBITF	Rs 19.965 Lakh
b)	Support from Industry Partner AIW	Rs 12 Lakh
(ii)	Internal generation	AIW would pay Royalty of 20% to IBITF during the sale of the DMS from AIW



*Registrar*

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## Appendix-A

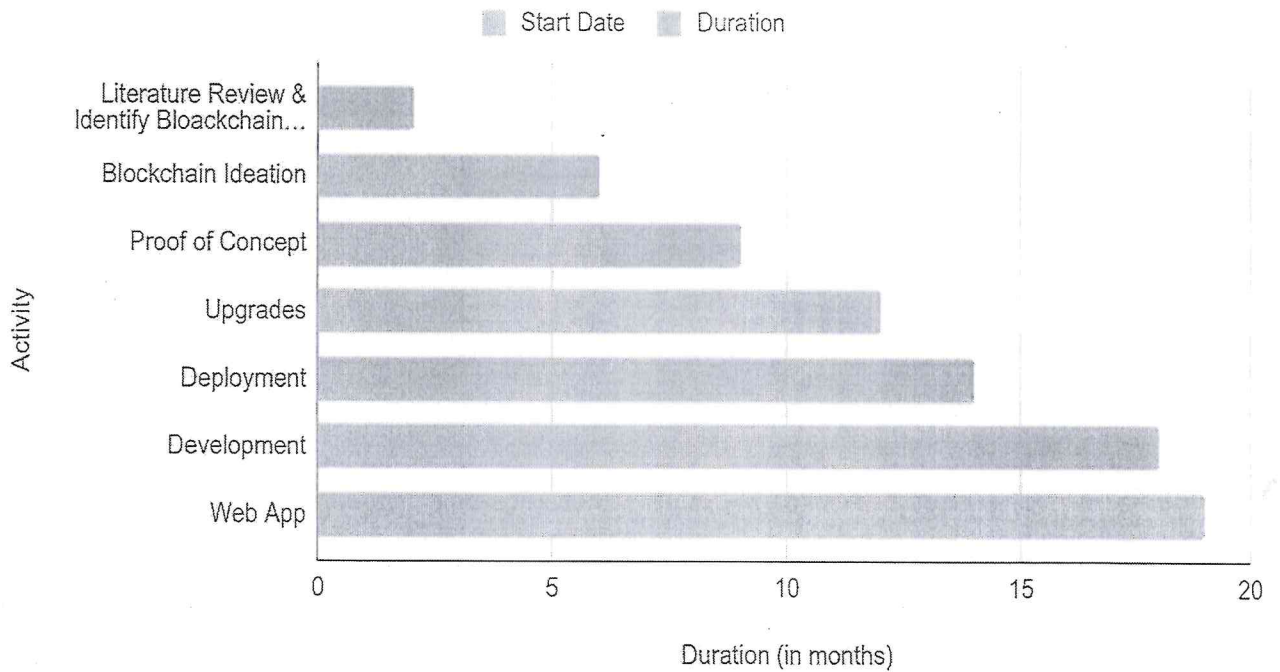
### Deliverables with TRL

Plans of translating the project into Start-ups and Spin-off companies

- Target number of Publications - 2  
Products: Decentralized WebApp  
IPRs:
- Target number of job creations

## Appendix-B

### Gantt Chart



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*Registrar*

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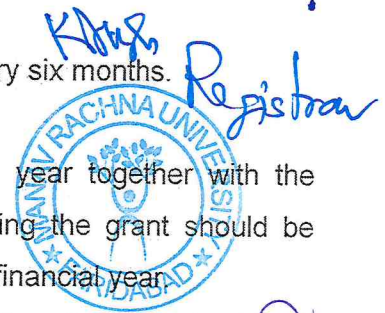
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## Annexure-II

### Terms & Conditions for Grant-in-Aid

The grant is for the specific project as approved by IIT Bhilai Innovation and Technology Foundation (IBITF) and shall be subject to the conditions listed below. The proposal originating industry and grantee institution shall give an undertaking that they agree to be governed by these conditions:

- 1) The grant amount shall be i) spent for the project within the specified time; and ii) Any portion of the grant, which is not ultimately required for expenditure for the approved purposes, shall be duly surrendered to IBITF.
- 2) The grantee institution shall maintain an audited record in the form of a register in the prescribed proforma for permanent, semi-permanent assets acquired solely or mainly out of IBITF grant.
- 3) The assets referred to in (2) above will be property of IBITF and should not, without prior sanction of IBITF, be disposed off or utilized for the purposes other than those for which the grant has been sanctioned.
- 4) At the conclusion of the project, IBITF will be free to sell or otherwise dispose of the assets which are the property of IBITF, and grantee institution shall render to IBITF the necessary support for facilitating the sale of these assets.
- 5) The grantee institution shall send to the IBITF at the end of each financial year as well as at the time of seeking further instalments of the grant a list of assets referred to in (2) above.
- 6) Should at any time grantee institution cease to exist, such assets etc., shall revert to IBITF.
- 7) The staff hired by the project funds will be only working full-time for the project activities, not for any of the institutional activities. The PI must work majority of his research time for the project. No additional remuneration for the permanent faculty.
- 8) IBITF shall appoint a Project Review and Steering Group (PRSG) comprising of representatives from academia, industry, and other experts. PRSG will periodically monitor the project in all aspects of the project implementation including technical and financial matters.
- 9) The funds are from the grants received from the DST, NM-ICPS the Technology Innovation Hub at IIT Bhilai, thus the actual disbursement of funds depends on receiving of funds from DST.
- 10) Principal Investigator (PI) is expected to publish research papers on the thematic areas in leading journals with due acknowledgements to IBITF.
- 11) All the products, prototypes and applications developed as part of the project will need to be reported to IBITF and will be property of IBITF.
- 12) The Host institute and PI should submit the financial and technical progress every six months.
- 13) The grantee institution shall render an audited statement of accounts to IBITF.
- 14) The audited statement of accounts relating to grants given during financial year together with the comments of the auditor regarding the observance of the conditions governing the grant should be forwarded to the IBITF within the three months following the end of the relevant financial year.
- 15) The utilization of grant for the intended purposes will be looked into by the Auditor of grantee institution according to the directives issued by the government of India at the instance of the Comptroller and Auditor General and the specific mention about it will be made in the report.
- 16) IBITF or its nominee(s) will have the right of access to the books and accounts of the grantee institution for which a reasonable prior notice would be given.



- 17) The grantee institution should maintain separate audited account for the project. If it is found expedient to keep a part or whole of the grant in a bank account earning interest, all the interest or other earnings against grant received would be ploughed back into the project or shall be allowed to be adjusted against further releases for the project.
- 18) Institute should not retain the sale proceeds of prototypes, etc. fabricated as a result of the development of the project arising directly from funds granted by the IBITF. The institute should return to IBITF funds thus generated.
- 19) The Intellectual property and the rights associated with it shall be owned by the IBITF. Any royalties or other benefits generated by licensing such IP would belong to IBITF.
- 20) Application by grantee institution for any other financial assistance or receipt of grant/loan from any other Agency/Ministry/Department for this project should have the prior approval of IBITF.
- 21) The Grantee institution(s) is not allowed to entrust the implementation of this project for which grant is received to another institution and to divert the funds received from IIT Bhilai Innovation and Technology Foundation as assistance to the later institution.
- 22) In case of any dispute on any matter, related to the project during the course of its implementation, the decision of the CEO, IBITF, shall be final and binding on the proposal originating industry/industry consortium and grantee institute.



*Reg. No.*

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**Format for Project Proposal under Technology Development in FinTech**

1. Title of the Project: Medical Insurance Claim Settlement using Blockchain Technology

2. Thematic Area Under Which Your Project Lies?

Blockchain

3. Proposed Duration of the Project: 18 Months

4. Principal Investigator (PI) and Co-Principal Investigators (Co-PIs)

Name	Dr. <a href="#">Mrinal Pandey</a>
Designation	Professor
Department	CST
Institution	Manav Rachna University
Postal Address	Manav Rachna Campus Rd, Sector 43, Faridabad, Haryana 121004
E-mail	mrinalpandey@mru.edu.in

**Co-Principal Investigator (PI)**

Name	Dr. Mamta Arora
Designation	Assistant Professor
Department	CST
Institution	Manav Rachna University
Postal Address	Manav Rachna Campus Rd, Sector 43, Faridabad, Haryana 121004
E-mail	mamta@mru.edu.in

**Co-Principal Investigator (PI)**



Name	Dr. Riya Sapra
Designation	Assistant Professor
Department	CST
Institution	The NorthCap University
Postal Address	HUDA Sector 23-A Gurugram – 122017
E-mail	riyasapra@ncuindia.edu

## 5. Aims and Objectives

- **To design and develop an efficient Database Management System to aid medical insurance claims settlement through Blockchain and AI based technologies.**
- **To develop a decentralised application for the stakeholders involved in the insurance claim settlement procedure.**
- **To provide automated information to the insurance company to reduce turnaround time, manpower as well as cost.**

## 6. Context/Background [Please elaborate on the existing literature relevant to the project?] (500 words)

Blockchain technology is being adopted in a wide range of application areas because of its features like distributed computing, encryption, no appending, etc. It is being used in various public and private sector organizations. There have been various start-ups adopting and providing Blockchain related services. In fact, in some countries, blockchain is being adopted by the governments also. In healthcare, it is being used to store and share medical data of patients. Medrec [1] is an Ethereum blockchain-based medical platform for patient's medical record management. It provides complete access controls to patients for the sharing of their medical records. It facilitates the patients with the complete historical log of data exchange done with any of the users of the application.

Similarly ModelChain [2] uses machine learning and blockchain technology for privacy preservation of the patient's medical data. The framework used the metadata of the transactions to find out the existing scenario of privacy in the blockchain and then used it to design the privacy model for the blockchain. It used private blockchain and proof of information consensus algorithms to provide security of medical data.

The NITI Aayog, India [3] also is trying to solve the issue of fake medicines using blockchain technology. On the other hand, there are multiple organizations who are using blockchain technology for automatic Insurance settlements. Bajaj Finserv [4] is also using blockchain to fasten its services of settling claims and travel insurances. Lemonade [21] is another Artificial Intelligence (AI) & Blockchain-based insurance platform for homeowners and tenants. It also provides term insurances as well as pet insurance.

The analysis of all these applications suggests that blockchain technology offers several benefits to the application process. It digitizes the whole process of the application and automates the transactions and payments involved in the application process through smart contracts. It also provides security from cyber thefts as it involves encrypting every transaction of the application.

## **7. Problems to be addressed** [Technical fallouts in the existing state-of-the-art methods that are proposed to be addressed] (1000 words)

In the current scenario, getting payment from insurance companies is a big pain point for the patients and healthcare providers. At the same time, it is also difficult for an insurance company to evaluate the variety of the claims submitted because of the rising medical insurance frauds.

The culprit for all of these issues is today's complicated, inefficient and outdated medical and payment system. Millions of dollars are wasted due to claim errors and unsettled disputes owing to the lack of transparency in the system.

Blockchain technology is the link that has been missing till now and can provide the required solution for this. With the implementation of this technology, all the stakeholders involved will have access to the same information or in other words, there would be a single version of the truth without any discrepancies.

All the information will be stored in decentralized servers, Impossible for anyone to Own your data will be distributed between nodes and entities although it is immutable. Every Hospital can share their data on a decentralized database.

Deploying blockchain in insurance helps set up a digitized platform with complete transparency, privacy, accuracy, and ultimate security. Besides aiding the insurers with effective & regulated processes, blockchain also benefits customers by saving their time & money. The shared and distributed ledger will allow all the parties to monitor and analyze the submitted claim and the services rendered against that claim.

As of now the existing models are on Ethereum blockchain and some private blockchains. When we talk about Ethereum blockchain. The platform is good for building the decentralized applications and the type of security provided to it but when it comes to scalability the Ethereum falls behind.

Due to the small block size and very low transactions per second it takes lot of time to update and mine the block then comes the gas fee when the entities need to add the data to the blockchain they need to pay some amount of fee in their native token then that amount would disperse to the miners to verify the transaction and add it into the blockchain. Due to less block space the gas fee is very high in Ethereum.

Every time the hospitals need to claim the settlements from insurance, they need to pay gas even the entity willing to use the gas station network they need to pay lot of gas for their customers and clients their financial model will not became much profitable and no one needs their customers and

clients to pay lots of fee to fetch and add the data on to the blockchain.

The other models are on private blockchains such as Hyperledger fabric and r3 corda. These are some of the private ledger blockchains which existing models are present. These blockchains are not fully decentralized; it has some permissions with different authorities in the consortium. If the blockchain is not decentralized enough to deal with the challenges then there is the chance of misusing one's authority given by the private blockchain and the mining system would be completely different to add the blocks to the blockchain.

All the documents submitted by the customer are not typed and printed, some of them are handwritten. Another challenge is the data being unstructured in most of the cases. The TPAs need to manually filter out the necessary information required to be forwarded to the insurance company for the process of mediclaim settlement to move forward. This takes a lot of time and effort and somewhat proves to be expensive for the TPAs. Therefore, we propose to introduce an artificial intelligence model specifically computer vision along with blockchain technology to revolutionize the medical insurance system. This AI model will be used to read the handwritten and illegible data using OCR (optical character recognition) as well as extract necessary information from the documents submitted by the person claiming the insurance and provide the readymade data to the insurance company making the process time and cost efficient.

#### **8. The novelty of the Project** [Mention how the proposal is novel with respect to the current state-of-the-art FinTech?] (250 words)

The proposed medical claims settlement model would be built on polygon (previously matic) which has all the features that Ethereum provides to make a decentralized application (Dapp) with additional features like scalability and less gas fee. These features help to make the transactions faster and yet in a very cost-efficient way due to more block space in polygon blockchain as compared with Ethereum based models. The main idea is to bring all the stakeholders on board the blockchain and to make it accessible to all the entities that are connected with the customers and insurance companies.

The current application of medical insurance claim settlement is built on private blockchain. Although it comes with the advantage of security, the aspect of decentralization reduces in the aforementioned category of blockchain. The decision-making responsibility relies upon the group of people appointed by the companies in the consortium. This does not favor the common masses claiming the insurance. Therefore, we propose to make the system more transparent and "equal" for the parties involved by building a system on public blockchain.

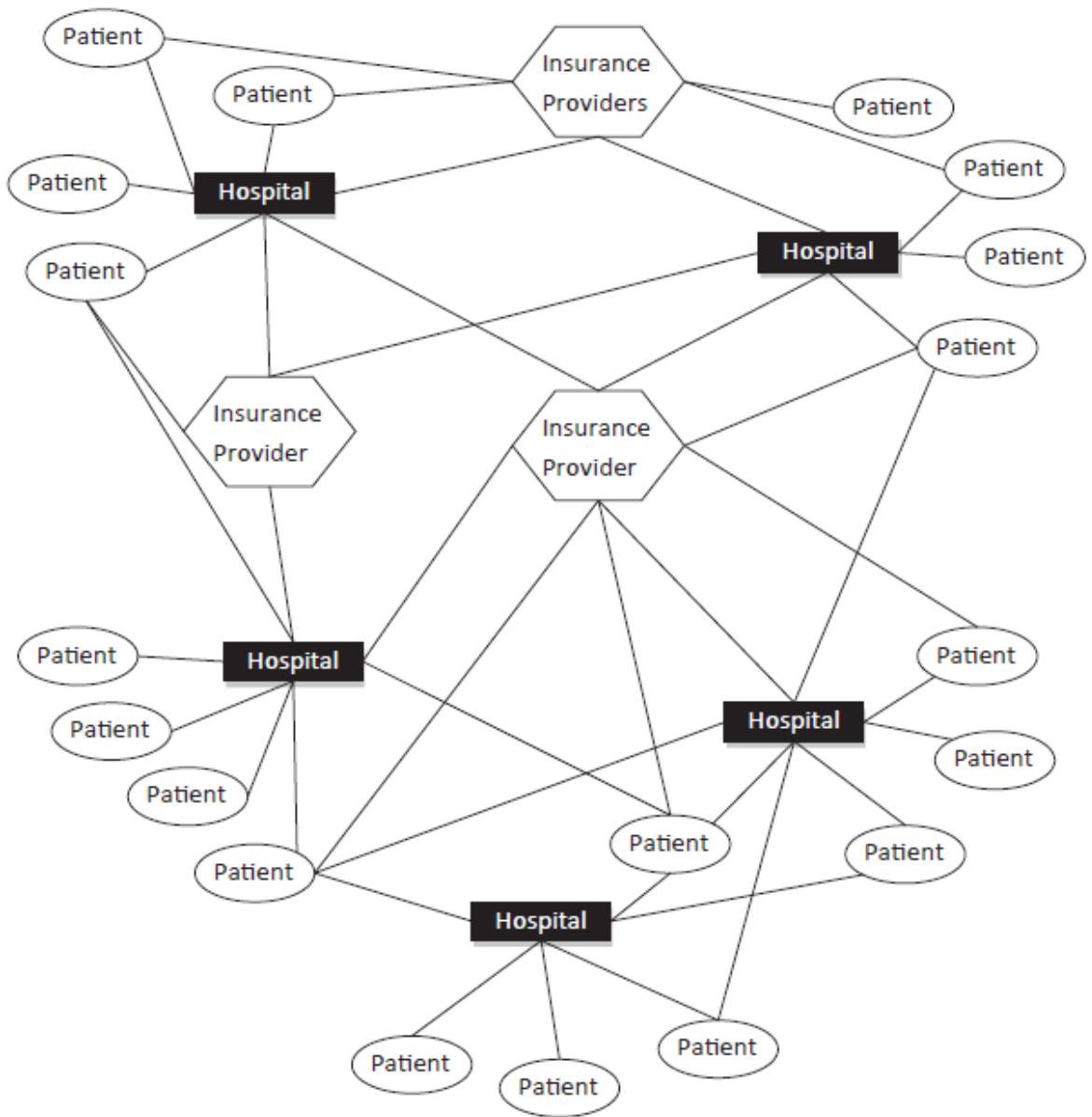
The system proposed would make suggestions on behalf of the company although its decisions can be overruled by the insurer due to the unforeseen threats of tampering and manipulation. Although the decision lies with the company, continuous negligence of the decisions made by the system will prove to be more expensive for the same.

Through this proposed system we target the TPAs by automating the process of information extraction using OCR and forwarding it to the insurance company to check the validity of the documents and making an informed decision. This system aims to reduce the efforts of TPAs in the hope that claims can be settled more quickly and efficiently with utmost reliability.

**9. Background work already done:** [This section should elaborate on the business development strategy, product viability, commercialization, etc.] (1000 words)

A sample blockchain-based framework for maintaining and sharing e-records among patients, hospitals, and insurance providers is shown in Figure 1. In the proposed framework, a federated blockchain network will be used to include various stakeholders in the blockchain network. So, whenever anyone wants to join the blockchain network, they will have to ask for permission to join the network. It will only be able to join the network after permissions are granted. In this way, the blockchain network will have trusted nodes only.

In the blockchain network, all the hospitals will be the full nodes and will maintain the copy of the blockchain with them. Patients and insurance providers will act as simple nodes in the network. Hospital authorities will assign a miner for mining of the blocks. So hospitals will be full nodes as well as miner nodes. Mining process will be assigned to hospitals on a rotation basis. The medical records will be stored after encryption. While adding records to the block, the data will be encrypted. The patients can provide access to his/her records and the doctor/insurance provider will be able to view the records only if they have the permissions for it.



Whenever a patient visits a hospital, he is assigned a unique id which will be recorded on the blockchain platform and will be used for updating his/her records. Patient's records will be updated in data structure as shown in Figure 2. So whenever there is any medical checkup or

doctor's follow-up visit, the whole data structure will be updated. The parameters in the data structure are the various medical checkups associated with patients like vitamin D3, hemoglobin, etc. It will act like a physical checkup booklet for the patient. So whichever parameter is not required, -NA- will be written.

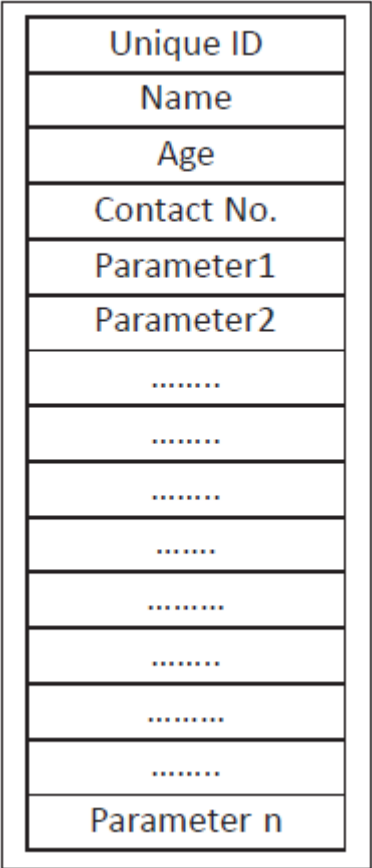


Figure 2 Patient Record Data Structure

The patients will be given all the access controls for their data with permissions to share or remove access from anyone. So if the patient wants to consult his medical history with any other doctor, he can easily show his historic medical conditions. Also his records will be updated every time there is a visit to the doctor; it can be shared with the insurance providers as a proof for the same. This will solve the big problem of medical reimbursements between the insurance providers and hospitals/patients.

Whenever a patient wants to apply for a medical reimbursement, he will just need to raise a request for the same with the access to his stored copy of medical records on blockchain. This will enable the smart contract for automatic payment by the insurance providers. This smart contract is stored on the blockchain network and is invoked whenever there is a request from the patient's end for medical claims. Figure 3 shows the process of smart contract between the insurance providers and hospitals/patients. The smart contract ensures automatic payment to the hospitals so that the patient need not suffer.

The proposed framework will ensure the privacy of the patient via unique IDs, restricted access controls, and data encryption. This framework will be patient-centric where patients have complete control over their data. Their task of claiming insurance will be reduced through smart contracts and they can remove or provide any access to their data anytime to anyone. This framework will also provide an insight to the health trends of the patient by checking their historical records.

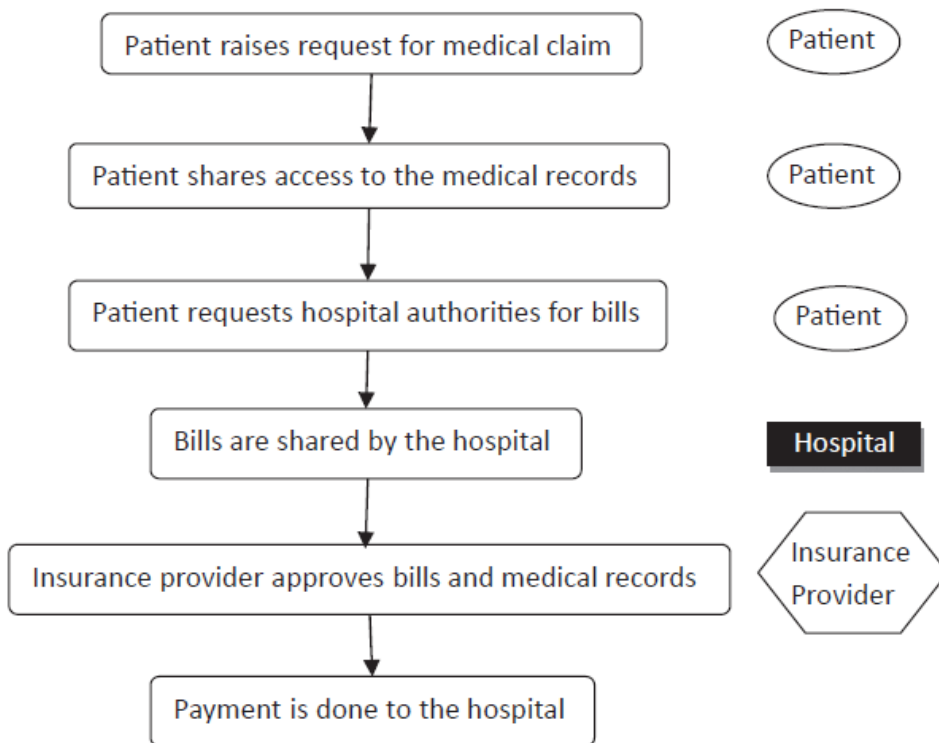


Figure 3 Process of Medical Reimbursement

**10. Technology readiness level of the project** [This section should elaborate on the technology readiness level in terms of Patents, and papers. Prototypes developed etc., if any] (1000 words)

**11. Target beneficiaries** (250 words)

The main ideology is to take all the stakeholders on to the blockchain. The stakeholders include hospitals, patients and medical insurance companies and third party agents (TPA). Abstract level of flow is depicted in figure 4 pertaining to medical insurance claim settlements.

The very first step would be the customer need to buy a medical insurance policy from an Insurance company. After buying the insurance whenever the customer undergoes a Medical Emergency then he visits the Hospital, gets treatment and hospital staff asks the customer if he has any insurance or not and takes policy ID from customer and then verifies with Insurance company, If it's verified then payment is initiated from Insurance company.

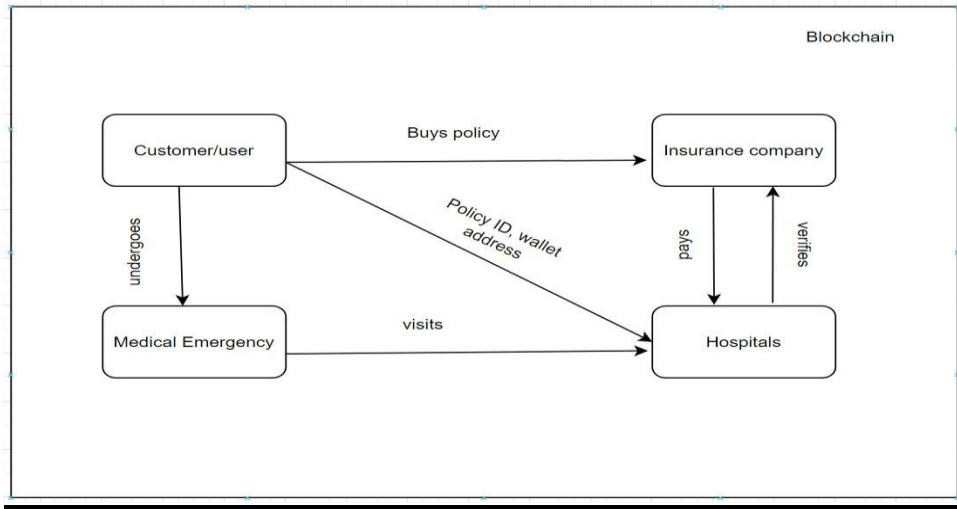


Figure 4

Next, Figure 5 explains about the on boarding of customers to an Insurance company. The customer checks Insurance plans and chooses suitable plans which fits the customer and then he needs to provide his public wallet address and required documents to the agent for verification. Then plan approval takes place from the Insurance company and the user will get unique Id associates user details and Insurance amount.

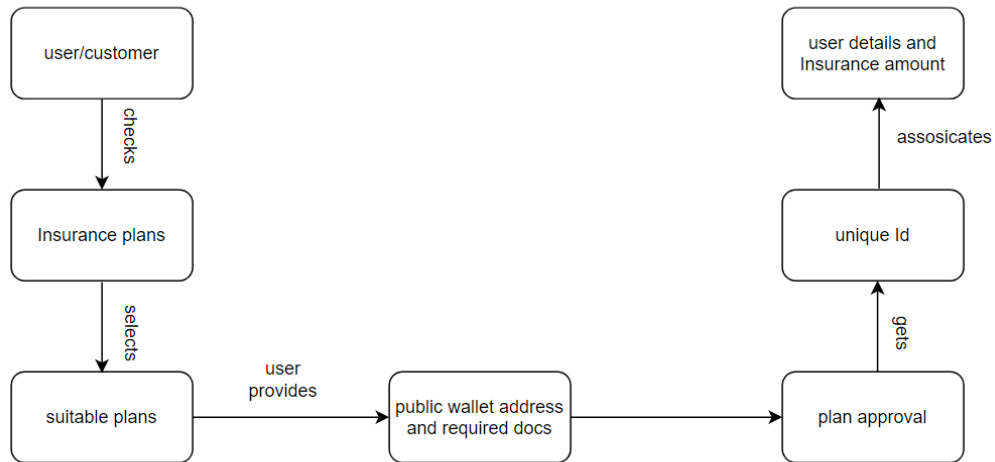


Figure 5

Figure 6 explains the scenario of on boarding hospitals to the insurance companies. At first the insurance companies approach hospitals and explain about their service and other ongoing products then the hospital approves to collaborate with insurance companies, for the process they need to provide wallet address, other required docs and finally insurance companies add them into the accessibility list .

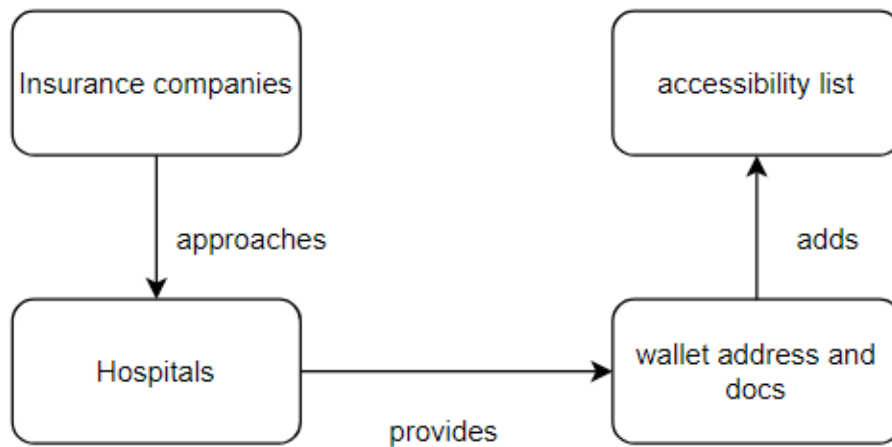


Figure 6

Customer claiming process shown in Figure 7. Medical insurance is only claimed if and only if the predefined rules are met. The process begins with the customer/user undergoing a Medical Emergency then they approach the Hospital once they examine the situation and initiate the treatment. The customer who is undergoing the treatment is a medical insured person. He informs the hospital that I had insurance with this company and they confirms from their data that they had collaborated with the insurance company or not then they asks user to provide the unique Id and contacts Insurance company with unique ID to cross verify the details like if he had the ongoing insurance or not then the insurance company will approves the claim amount.

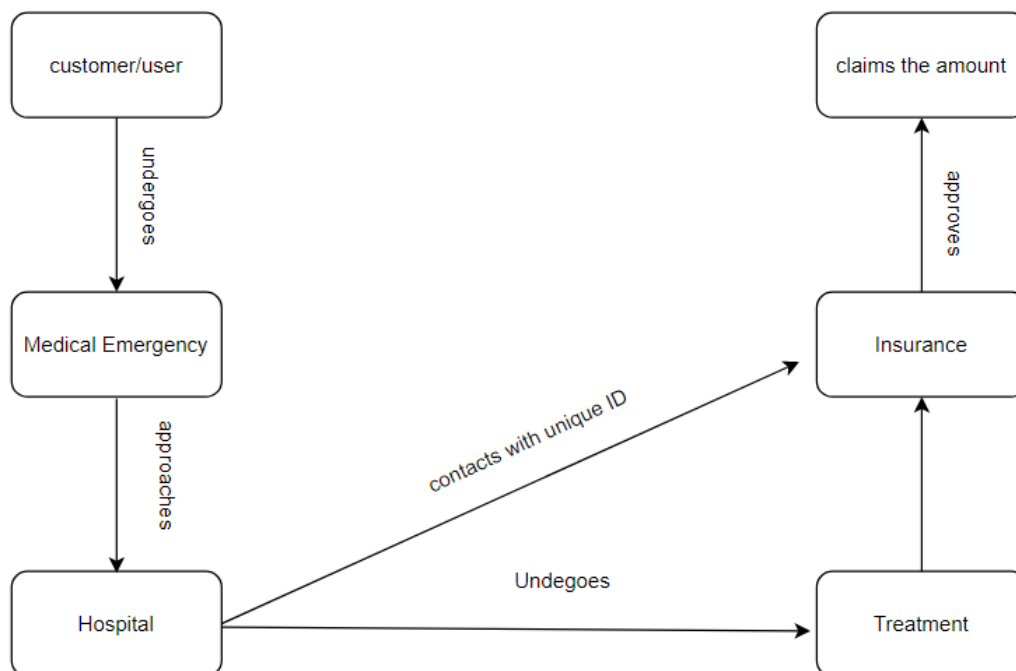
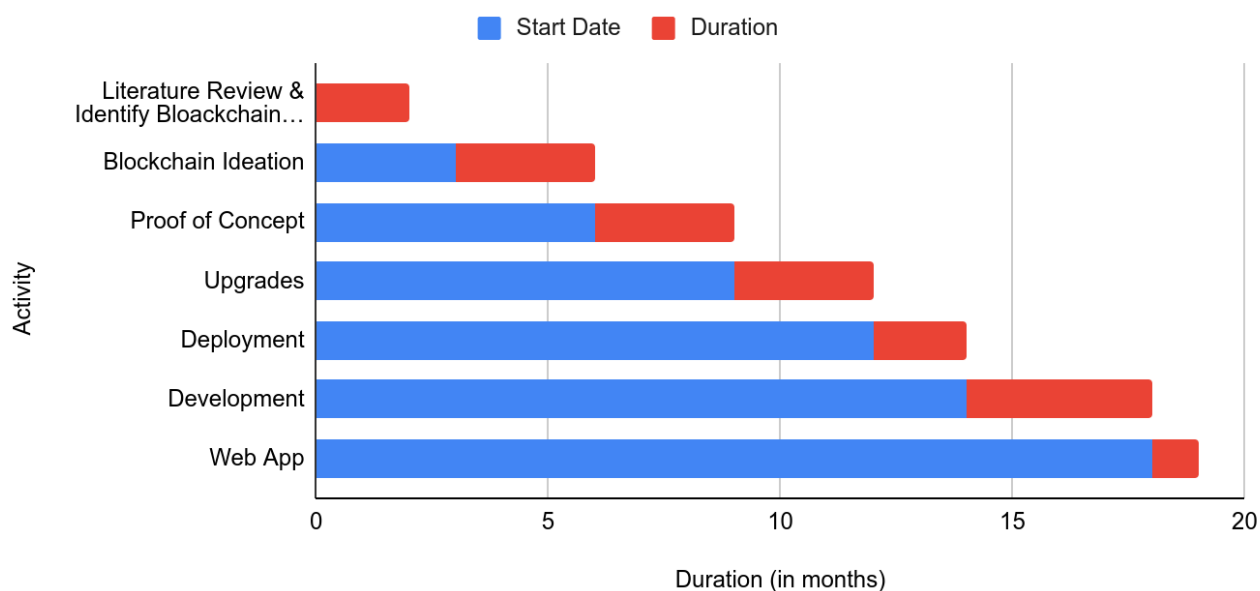


Figure 7



## 12. Gantt Chart of activities giving clear milestones for every quarter

### Gantt Chart



## 13. Please mention the deliverables under the following heads with relevant details: .

Plans of translating the project into Start-ups and Spin-off companies

- Target number of Publications - 2  
Products: Decentralized WebApp  
IPRs:
- Target number of job creations

## 14. Budget

### Total Budget

Head	1st Year	2nd Year	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops)+Printer	205000	0	Nil	205000
web services	150000	50000		200000
Consumable	90000	55000	Nil	145000
Training & Workshops/Conferences	65000	25000	Nil	90000
Travel	35000	25000	Nil	60000
Manpower (2UG Students)	180000	90000	Nil	270000
Manpower (1 project manager)			1200000	0
Developer	360000	360000	Nil	720000
Contingencies	75000	50000	Nil	125000
Overhead @10%	116000	65500	Nil	181500
Total	1276000	720500		1996500
Grand Total			1200000	3196500

## MRU Budget

Head	1st Year	2nd Year	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops)+Printer	120000	0	Nil	120000
web Services	150000	50000		200000
Consumable	75000	50000	Nil	125000
Training & Workshops/Conferences	50000	20000	Nil	70000
Travel	30000	20000	Nil	50000
Manpower (2 UG Students)	180000	90000	Nil	270000
Manpower (1 project manager and)	0	0	1200000	0
Developer	360000	360000	Nil	720000
Contingencies	50000	30000	Nil	80000
Overhead	101500	62000	Nil	163500
Grand Total	1116500	682000	1200000	1798500

## NCU Budget

Head	1st Year	2nd Year	Amount contributed by industry	Amount payable by IBITF
Equipment (High End Laptops/Desktops) +Printer	85000	0	Nil	85000
Consumable	15000	5000	Nil	20000
Training & Workshops/Conferences	15000	5000	Nil	20000
Travel	5000	5000	Nil	10000
Contingencies	25000	20000	Nil	45000
Overhead	14500	3500	Nil	18000
Grand Total	159500	38500	Nil	198000

### 15. The expertise of PI

PI has expertise include data science, AI, Python, Big Data, Computer Vision and Natural Language processing. She is consistently supervising many research projects and mentoring various graduates, post graduate students and research scholars through her specialized skills and knowledge. One PhD scholar completed PhD under the supervision of the PI in the area of Machine Learning. Three scholars are counting research in the computer Vision and one is working in Machine Learning for Agriculture. She mostly offered Project based teaching learning pedagogies to bridge the gap between the academia and industry.

a.) **Bio-Data of the PI and Co-PI (as per annexure 4)**

**Annexure-4**  
**PROFORMA FOR BIO-DATA (PI)**

1. Name: Dr. Mrinal Pandey
2. Designation: Professor
3. Department: Computer Science and Technology
4. Institution: Manav Rachna University
5. Contact Number 9899557252
6. Email: mrinalpandey@mru.edu.in
7. Date of Birth: 13 December 1976
8. Gender: Female

9. Academic Qualification: (Undergraduate Onwards)

S.No.	Degree	Year	Subject	University/Institution	% of Marks
1	MSC	2011	CSE	MDU, Rohtak	62
2	M.Tech	2005	CSE	Banasthali Vidyapith,Rajasthan	67
3	Ph.D	2016	CSE	Banasthali Vidyapith,Rajasthan	NA

10. Work Experience (in chronological order)

S.No.	Position held	Institution	From	To	Pay Scale
1	Professor	Manav Rachna University	10 Aug 2022	Till date	37400-67000(10000 AGP)
2	Associate Professor	The NorthCap University	1 Dec 2021 2014	9 Aug 2022	1.25 lac /month
3	Associate Professor	Manav Rachna University	1 Aug 2018	30 Nov 2021	37,400 – 67,000 (9000 AGP)
4	Assistant Professor	Manav Rachna University	20 July 2009	30 July 2018	15600-39100

5.	Lecturer	BCIIT, New Delhi	6 July 2005	18 March 2008	8000-275-13500
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11. Professional Recognition/ Award/ Prize/ Certificate/ Fellowship received by the member

S.No.	Name of Award	Awarding Agency	Year
1.	Commendation Letter for Mentorship in AI Telengana Challenge	CDAC, NOIDA	2021
2.	Appreciation Letter	Virtual Labs, IIT Delhi	2021

12. Publications (List of papers published in SCI Journals, in year-wise descending order).

S.No	Authors	Title	Journal	Volume	Page	Year
1	Anju Mishra,Laxman Singh,Mrinal Pandey,Sachin Lakra	Image based early detection of diabetic retinopathy: A systematic review on AI based recent trends and approaches	Journal of Intelligent & Fuzzy Systems (SCIE)	44	1-33	2022
2	Mrinal Pandey & Monika Goyal	A Systematic Analysis for Energy Performance Predictions in Residential Buildings Using Ensemble Learning.	Arab J Sci Eng Scopus ,SCIE).	46	3155-3168	2020
3	Mrinal Pandey & Monika Goyal	Ensemble-based data modeling for the prediction of energy consumption in HVAC plants.	J Reliable Intell Environ ( Scopus).	7	49-64	2021
4	Mrinal Pandey & Monika Goyal	"Extreme Gradient Boosting Algorithm for Energy Optimization in buildings pertaining to HVAC plants"	EAI Endorsed Transactions on Energy Web	8	1-10	2018

### 13. Detail of Patents

S.No	Patent Title	Name of Applicant(s)	Patent No.	Award Date	Agency/Country	Status
1.	A System and a Method for Smart Disease Grading and Health Monitoring	Laxman Singh, Mrinal Pandey, Chitvan Gupta, Priyanka, Pawan kumar Shukla, Ranjan Kumar, Manoj Ojha, Sunil	11-4-22	22-04-22	IPR/India	Published

### 14. Books/Reports/Chapters/General articles etc.

S.No.	Title	Publisher	Year of Publication
1	"Sentiment Analysis for Predicting the Popularity of Web Series	Springer, Singapore,	2019
2	"Towards Prediction of Energy Consumption of HVAC Plants Using Machine Learning".	Springer, Singapore,	2019
3	"Exploratory Analysis of Machine Learning Techniques to predict Energy Efficiency in Buildings,"	Springer, Singapore,	2020
4	Deep Neural Network for Diabetic Retinopathy Detection	IEEE Xplore	2019
5	"An Exploratory Analysis Pertaining to Stress Detection in Adolescents.	Springer, Singapore,	2020
6	Data Modeling for Energy Forecasting Using Machine Learning.	Springer, Singapore,	2021
7	"Short Survey on machine learning techniques used for diabetic retinopathy detection,"	IEEE Xplore	2021

### 15. List of Projects implemented

#### 15.1 Details of Projects in progress

S.No.	Title	Cost in Lakh	Duration	Role (PI/Co-PI)	Agency
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1	"AI for Agriculture"	21 (Approx.)	2 Years	Co-PI	Miety
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#### 15.2 Details of Projects completed

S.No.	Title	Cost in Lakh	Duration	Role(PI/Co-PI)	Agency
	NA	NA	NA	NA	NA

#### 16. Any other relevant Information (maximum 500 words)

Dr. Mrinal Pandey is presently working as a Professor in CST Department, at Manav Rachna University, Faridabad. She has over 17 years of experience including academics & research. She has earned her PhD in Computer Science & Engineering from Banasthali Vidyapith in the area of Data Mining (Classification & Prediction) in 2016. Her research area includes Data Mining, Decision Support System, AI & Machine Learning and Pattern Classification. She is actively involved in research & development activities which include organizing various workshops on emerging technologies such as data science & machine learning, machine learning with python etc. She was also invited as speaker to esteemed organizations like IIIT Pune and Xavier University, Bhubaneswar. Dr. Mrinal has published various papers in reputed International journals and conferences. She has also served as session chair in many international conferences. Dr. Pandey was nodal coordinator of Virtual Lab associated with IIT Delhi. She is also participating in review process of research papers for reputed journal and conferences. Dr. Pandey is consistently supervising many research projects and mentoring various graduates, post graduate students and research scholars through her specialized skills and knowledge. She has expertise in data science, AI, Python, Big Data, Computer Vision and Natural Language processing.

#### **Annexure-4**

#### **PROFORMA FOR BIO-DATA (Co-PI-1)**

1. Name: Dr. Mamta Arora
2. Designation: Assistant Professor
3. Department: Computer Science and Engineering
4. Institution: Manva Rachna University
5. Contact Number 9873599315
6. Email: mamta@mru.edu.in

7. Date of Birth: 28 Jan 1986

8. Gender: Female

9. Academic Qualification: (Undergraduate Onwards)

S.No.	Degree	Year	Subject	University/Institution	% of Marks
1	BCA	2005	CS	MDU, Rohtak	83.8
2	MCA	2008	CS	MDU	83.1
3	M.Tech	2013	CSE	MDU	83.2
4	Ph.D	2022	AI in Healthcare	Kurukshetra University	NA

10. Work Experience (in chronological order)

S.No.	Position held	Institution	From	To	Pay Scale
1	Assistant Professor	Manav Rachna University	Jun 2013	till date	15600-39100
2	Technical Trainer	Aptech Pvt. LTd.	Aug, 2008	Dec, 2010	15600-39100

11. Professional Recognition/ Award/ Prize/ Certificate/ Fellowship received by the member

S.No.	Name of Award	Awarding Agency	Year
1	NET	UGC	Jun, 2013
2	GATE	AICTE	Mar, 2013

12. Publications (List of papers published in SCI Journals, in year-wise descending order).

S. No.	Authors	Title	Journal	Volume	Page	Year
1	Mamta Arora, Sanjeev Dhawan and Kulvinder Singh	Improved performance of machine learning algorithms for	Advances in Computational Design, An International	6	191-205	2021

		prognosis of cervical cancer	Journal, Technopress			
2	S. Dhawan , K. Singh, M. Arora	Cervix Image classification for Prognosis of Cervical Cancer using Deep neural network with transfer Learning	EAI Endorsed Transactions on Pervasive Health and Technology	7	1-9	2021
3	M. Arora, S. Dhawan, K. Singh	Data Driven Prognosis of Cervical Cancer Using Class Balancing and Machine Learning Techniques	EAI Endorsed Transactions on Energy Web: Online First	7	1-9	2020

### 13. Detail of Patents

S.No	Patent Title	Name of Applicant(s)	Patent No.	Award Date	Agency/Country	Status
	Nil					

### 14. Books/Reports/Chapters/General articles etc.

S.No.	Title	Publisher	Year of Publication
1	Deep Learning in Health Care: Automatic Cervix Image Classification Using Convolutional Neural Network	Springer	2021
2	Cervical cancer diagnosis and prediction: an application of machine learning techniques	Springer	2021
3	Sentiment Analysis for Predicting the Popularity of Web Series	Springer	2020
4	Exploring Deep Convolution Neural Networks with Transfer Learning for Transformation Zone Type Prediction in Cervical Cancer	Springer	2020
5	Deep Neural Network for Diabetic Retinopathy Detection	IEEE Xplore	2019



6	Deep Neural Network for Transformation Zone Classification	Springer	2018
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#### 15. List of Projects implemented

##### 15.1 Details of Projects in progress

S.No.	Title	Cost in Lakh	Duration	Role (PI/Co-PI)	Agency
	Nil				

##### 15.2 Details of Projects completed

S.No.	Title	Cost in Lakh	Duration	Role(PI/Co-PI)	Agency
	Nil				

#### 16. Any other relevant Information (maximum 500 words)

I have good hands on exposure in the area of Machine Learning, data Analytics, Artificial Intelligence, and Deep Learning. The credentials of research are evident from publications which have been published and cited in international journals of high reputes that include EAI Endorsed Transactions on Pervasive Health and Technology, EAI Endorsed Transactions on Energy Web, International Journal of Current Engineering and Technology (WoS), etc. I have successfully completed various courses from NPTEL and coursera like Python for Data Science Programming, Data Structures and Algorithms using Python, Introduction to Machine Learning, The Joy of Computing Using Python. I am working with various projects in the medical and healthcare domain along with student teams. I am looking forward to working in sponsored projects.

#### **Annexure-4**

#### **PROFORMA FOR BIO-DATA (Co-PI-2)**

1. Name: Dr. Riya Sapra
2. Designation: Assistant Professor
3. Department: Computer Science and Engineering
4. Institution: The NorthCap University
5. Contact Number 9654889582
6. Email: riyasapra@ncuindia.edu

7. Date of Birth: 02 October 1989

8. Gender: Female

9. Academic Qualification: (Undergraduate Onwards)

S.No.	Degree	Year	Subject	University/Institution	% of Marks
1	B.Tech	2011	CSE	MDU/UIET, Rohtak	77
2	M.Tech	2013	CSE	YMCAUST, Faridabad	81
3	Ph.D	2021	CSE	Manav Rachna University, Faridabad	NA

10. Work Experience (in chronological order)

S.No.	Position held	Institution	From	To	Pay Scale
1	Assistant Professor	The NorthCap University	18 July 2022	Till date	15600-39100
2	Assistant Professor	Manav Rachna University	15 Nov 2014	15 July 2022	15600-39100
3	Assistant Professor	Lingaya's GVKS Institute of Tech & Mgt	20 July 2014	14 Nov 2014	15600-39100
4	Assistant Professor	Jagannath University NCR, Bahadurgarh	15 July 2013	30 March 2014	15600-39100

11. Professional Recognition/ Award/ Prize/ Certificate/ Fellowship received by the member

S.No.	Name of Award	Awarding Agency	Year
1	GATE Scholarship	AICTE	2011-2013

12. Publications (List of papers published in SCI Journals, in year-wise descending order).

S. N O .	Authors	Title	Journal	Volume	Page	Year
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1	Riya Sapra, Parneeta Dhaliwal	Blockchain:The new perspective of Technology	International Journal of Healthcare Information Systems and Informatics	16	1-20	2021`
2	Riya Sapra, Parneeta Dhaliwal	Missing Chain: A Novel Blockchain System for Missing or Found Cases	Test Engineering and Management (Scopus)	83	12670-12677	2020
3	Riya Sapra, Parneeta Dhaliwal	PlasmaBlock: A Plasma donation Blockchain system in COVID-19	International Journal of Networking and Virtual Organisations (Scopus)	25	268-285	2021

### 13. Detail of Patents

S.No	Patent Title	Name of Applicant(s)	Patent No.	Award Date	Agency/Country	Status
	Nil					

### 14. Books/Reports/Chapters/General articles etc.

S.No.	Title	Publisher	Year of Publication
1	Blockchain for security issues of Internet of Things (IoT)	Springer, Singapore	2019
2	Blockchain solution for privacy protection of medical data	Elsevier	2021
3	Ubiquitous Computing: A New Era of Computing	Taylor & Francis	2019

### 15. List of Projects implemented

#### 15.1 Details of Projects in progress

S.No.	Title	Cost in Lakh	Duration	Role (PI/Co-PI)	Agency
	Nil				

## 15.2 Details of Projects completed

S.No.	Title	Cost in Lakh	Duration	Role(PI/Co-PI)	Agency
	Nil				

## 16. Any other relevant Information (maximum 500 words)

In the last few years, I have studied Blockchain Technology, its working, and its areas of applications. This is an upcoming technology which is being used in a lot of application areas to ease the process of work. I have worked in the application areas like: Internet of Things, Record management in HealthCare, Management and distribution of Convalescent Plasma donations during COVID-19, Generation and distribution of Birth Certificates and FIR management of missing and found people. I have successfully published 3 journal papers, 3 book chapters, 2 conference papers and few publications are in the pipeline.

In the future, since blockchain technology is being used in a variety of government applications, I am planning to propose projects in government funded projects. I am looking for collaboration of blockchain technology with other fields of research. In academics, I teach various technical subjects like C, Java, Software Engineering, Agile etc. I also teach design thinking in collaboration to technical subjects. I am also mentoring a few startups. I am looking forward to making students create Business ideas and projects by using their skills from the problems around themselves.

### b.) Infrastructural Facilities available with the investigator

#### Centralized AC in the University

The whole campus is accommodated with the temperature sensitive centralized air conditioning system. It creates a good environment for the students and the staff to work without feeling that they are tired to achieve maximum out of it.

#### High Speed Internet( LAN/WiFi)

Manav rachna university provides high speed internet in both wired and wireless way. Where it provides a couple of bandwidths 2.5Ghz and 5Ghz for longer and stronger connectivity of the internet. The 2.5GHz network works 24\*7 even at the times of powercut as well.

#### Research & Innovation Cluster

Research and Innovation Clusters provide technology and innovation support whereas Incubation helps the students to develop practical business models as startups or spin offs to become student entrepreneurs for working towards Government of India policy of "Make in India". ... team of Manav Rachna Innovation and Incubation cluster.

#### Centers of Excellence

Under the aegis of MRIIC, the following Centers of Excellence (CEs) are established in collaboration with reputed industries for enhancing the training & research skills of MR students: Smart Energy Center. Mitsubishi Center. Automotive Training & Research (Honda) Sports Science & Rehabilitation. Advanced Water Technology & Management.

## Libraries

The library has access to many books of technology, computer science, food science, nutrition, dietetics, physiotherapy and other allied subjects. It is a platform where students also explore the research journals of national and international repute for research purpose. The library has also access to bachelor's research projects as well as to master dissertations.

## Auditorium

University has a wide variety of auditoriums for different occasions. There are very large capacity auditoriums and less capacity as well based on the occasion. It also has open auditoriums for students where they can manage events and express their skills.

## Seminar Halls

Being in a huge resourceful university there is no doubt of having efficient seminar halls to educate and motivate students to make them in the path and help them to get knowledge in various aspects in their life.

### **c) Equipment available with the Institute/ Group/ Department/ for the project:( Related to this project)**

For block chain technologies limited resources are required in terms of hardware and software. As Most of the software is open source for block chain. The Manav Rachna University, Department of Computer Science & Technology has good computer labs (ICT enable) and a Research and Incubation center with high speed internet connections. MRU also has many collaborations with industries like AWS for clouds, Xebia for AIML and Devops and Full stack programs, Quick Heal for cyber security programs. MRU, CST also have agile classrooms and labs based on Agile methodologies are being offered in the Industries for the project development.

### **d) Prior Knowledge/Publications in the relevant area**

- Sapra, R., & Dhaliwal, P. (2021). "PlasmaBlock: A Plasma donation Blockchain system in Covid-19". International Journal of Networking and Virtual Organisations (IJNVO), 25(3-4), pp.268-285
- Sapra, R., & Dhaliwal, P. (2020). "MissingChain: A novel blockchain system for missing or found cases". In Test Engineering and Management Vol 83: May/June 2020. pp 12670-12677.
- Sapra, R., & Dhaliwal, P. (2021). "Blockchain - The perspective future of Technology". International Journal of Healthcare Information Systems and Informatics (IJHISI), IGI Global. Vol. 16 (2) pp 1-20. DOI: 10.4018/IJHISI.20210401.0a1.
- Sapra, R., & Dhaliwal, P. (2018). "Blockchain: The new era of Technology". In 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC) (pp. 495-499). IEEE. DOI: 10.1109/PDGC.2018.8745811
- Sapra, R. and Dhaliwal, P., 2021. A blockchain solution for the privacy of patients' medical data. In Machine Learning, Big Data, and IoT for Medical Informatics (pp. 327-347). Academic Press.
- Sapra, R., & Dhaliwal, P. (2020). Blockchain for Security Issues of Internet of Things (IoT). In: Peng SL., Pal S., Huang L. (eds) Principles of Internet of Things (IoT) Ecosystem: Insight

Paradigm (pp. 599-626). Intelligent Systems Reference Library, vol 174. Springer, Cham. DOI: 10.1007/978-3-030-33596-0

## Annexure-1

**CONSENT LETTER FROM INDUSTRY PARTNER**

This is to state that **AIW- Artificially Intelligent Workforce** (Name of Industry/Organization) hereby consent to Partner with IIT Bhilai Innovation and Technology Foundation (IBITF) in the proposed NM-ICPS Technology Innovation Hub (TIH) in FinTech Technologies. I am aware and agree to the activities mentioned in the proposal under Industry Partnership.

I hereby consent to support the TIH in terms of:

1. Royalty of 20% to be shared with IBITF during the sale of the DMS from AIW to other businesses.
2. Contribution in Kind ..... (List activities)
  - ➔ Project manager – Rs 12,00,000(Rupees Twelve Lakh, to be borne
  - ➔ Professional service person

Summary profile of the Industry is given below:

- Name of Industry/Organization: AIW – Artificially Intelligent Workforce
- Nature of Business: Hyper automation and Web3.0
- Number of Employees: 15
- Valuation: Valued at \$12Million

I hereby affirm that my Industry/Organization is committed to participating in the proposed TIH as indicated in the proposal including the financial liabilities as provided above.

Date : 25/11/2022



Head of Industry/Organization

Sohaib Siddiqui

Founder & CEO

AIW Works Pvt Ltd

M1254, 1st Floor Landmark Corporate Centre, Landmark Cyberpark,  
Sector-67, Gurugram- 122102 India

**ENDORSEMENT FROM THE HEAD OF THE INSTITUTION**

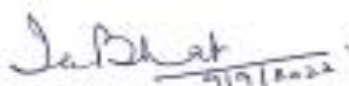
**PROJECT TITLE: Medical Insurance Claim Settlement using Blockchain Technology**

**Name of the PI: Dr. Mrinal Pandey,**

**Name of Co-PI : Dr. Mamta Arora**

It is certified that the institute welcomes the participation of the above as the Principal Investigator(s) and/or Co-PI(s) for the project.

1. Certified that the equipment, other basic facilities, and such other administrative and accounting facilities as per terms and conditions of the grant will be extended to the investigator throughout the duration of the project. In case of PI/Co-PI leaving the institution or proceeding on a long leave during the project period, prior permission will be sought from IBITF before relieving/sanctioning.
2. Certified that the investigators will be allowed to open a start-up company (unconditionally) to execute the project, as per the policy of the institute.
3. Institute assumes the financial and other management responsibilities of the project including timely submission of Progress Reports, UCs, SEs, and facilitates in conducting of external audits if required.



Name of the Head of Institution

Signature with stamp

Date

Place:







MANAV RACHNA  
Vidyanatirikshah

**MANAV RACHNA UNIVERSITY**

Estd. vide Haryana Act no. 26 of 2014  
(Formerly Manav Rachna College of Engineering)  
NAAC Accredited 'A' Grade

### CERTIFICATE FROM THE INVESTIGATOR


**PROJECT Title: Medical Insurance Claim Settlement using Blockchain Technology**


**Name of the PI's: Dr. Mrinal Pandey**

**Name of Co-PI's: Dr. Mamta Arora**

1. I/We agree to abide by the terms and conditions of the grant received from IBITF.
2. I/We did not submit this or a similar project proposal elsewhere for financial support.
3. I/We agree to open a start-up company to execute the project.
4. I/We undertake to submit progress reports, Statement of Expenditure (SE)/ accounts, Utilization Certificates (UC), etc. covering up to 31st March every year till the completion of the project as prescribed by DST.

Date: 9 sept' 2022

Signature of PI/PIs 

Signature of Co-PIs   
DR. MAMTA ARORA

Place: Faridabad.



MANAV RACHNA  
vidyaranat orikshah

**MANAV RACHNA UNIVERSITY**

Estd. vide Haryana Act no. 26 of 2014  
(Formerly Manav Rachna College of Engineering)  
NAAC Accredited 'A' Grade

### CERTIFICATE FROM THE INVESTIGATOR


**PROJECT Title: Medical Insurance Claim Settlement using Blockchain Technology**


**Name of the PI's: Dr. Mrinal Pandey**

**Name of Co-PI's: Dr. Mamta Arora**

1. I/We agree to abide by the terms and conditions of the grant received from IBITF.
2. I/We did not submit this or a similar project proposal elsewhere for financial support.
3. I/We agree to open a start-up company to execute the project.
4. I/We undertake to submit progress reports, Statement of Expenditure (SE)/ accounts, Utilization Certificates (UC), etc. covering up to 31st March every year till the completion of the project as prescribed by DST.

Date: 9 sept' 2022

Signature of PI/PIs 

Signature of Co-PIs   
DR. MAMTA ARORA

Place: Faridabad.

**Annexure-2  
CERTIFICATE FROM THE INVESTIGATOR**

(On official letterhead)

**PROJECT Title: Medical Insurance Claim Settlement using Blockchain Technology**

**Name(s) of the Co-PI's: Dr. Riya Sapra**

1. I/We agree to abide by the terms and conditions of the grant received from IBITF.
2. I/We did not submit this or a similar project proposal elsewhere for financial support.
3. I/We agree to open a start-up company to execute the project.
4. I/We undertake to submit progress reports, Statement of Expenditure (SE)/ accounts, Utilization Certificates (UC), etc. covering up to 31st March every year till the completion of the project as prescribed by DST.



Signature of Co-PIs

Date: 9 Sept 2022

Place: Gurgaon



Annexure-3  
ENDORSEMENT FROM THE HEAD OF THE INSTITUTION

(On official letterhead)

PROJECT TITLE: Medical Insurance Claim Settlement using Blockchain Technology

Name(s) of the Co-PI's: Dr. Riya Sapra

It is certified that the Institute welcomes the participation of the above as the Principal Investigator(s) and/or Co-PI(s) for the project.

1. Certified that the equipment, other basic facilities, and such other administrative and accounting facilities as per terms and conditions of the grant will be extended to the investigator throughout the duration of the project. In case of PI/Co-PI leaving the institution or proceeding on a long leave during the project period, prior permission will be sought from IBTF before relieving/sanctioning.
2. Certified that the investigators will be allowed to open a start-up company (unconditionally) to execute the project, as per the policy of the institute.
3. Institute assumes the financial and other management responsibilities of the project including timely submission of Progress Reports, UCs, SEs, and facilitates in conducting of external audits if required.

Name of the Head of Institution



Col. Bikram Mohanty (Retd.)  
Signature with stamp

THE NORTHCAP UNIVERSITY  
Date: 7 Sept 2022  
Sector 23/A, Gurugram-122 017

Place: NCU, Gurgaon



Nomination letter format for Ramanujan Fellowship

To,

**The Secretary,  
Science & Engineering Research Board (SERB),  
5 & 5A, Lower Ground Floor,  
Vasant Square Mall,  
Vasantkunj,  
New Delhi 110 070**

I wish to nominate **Dr. JITENDRA PAL SINGH.** for Ramanujan Fellowship of SERB, Department of Science & Technology, New Delhi, who is presently working at ...**POHANG ACCELERATOR LAB, POSTECH, POHANG, SOUTH KOREA.** and is not employed in India.

This is to certify\* that if the fellowship is offered to Dr. ...**Dr. JITENDRA PAL SINGH.** the institute/ University will provide office and laboratory space along with the necessary facilities to carryout research described in the proposed project. Institute/ University has obtained confidential report from the immediate past mentor or head of the department of postdoctoral assignment of the applicant and has carried out internal evaluation of the applicant before forwarding the application for the government's prestigious fellowship.

Date :

Place:

Name:

*Jatinder*  
13/8/2021

Signature of the Head of the Institute/

**Vice-Chancellor**  
**Manav Rachna University**

Seal: 43, Aravali Hills, Suraj Kund Road,

(Nominations must be sent only by Head of the organization/Institute/University or the person authorized by Head of the organization/ Institute / University, since this is an academic position)

\*The institute/ University are expected to acquire the confidential report from the immediate past mentor or head of the department of postdoctoral assignment of the applicant before and then have their own selection mechanism to decide the criteria for selection and apply the same before forwarding the application for the Ramanujan fellowship.

\*\* This fellowship is meant for working in new areas and laboratories in order to expand their research capabilities, other than the one where the candidate obtained the doctorate degree from.



## Application for Ramanujan Fellowship

( RJF/2021/000115 )

Dr. J P SINGH

Nominator	Nominee
<p>Prof. Inder Krishen Bhat Vice Chancellor vc@mru.edu.in <b>Contact No.</b> 919414076013</p>	<p>Dr. J P SINGH Senior Project Scientist,EUV jitendra86969920@gmail.com <b>Mobile No.</b> 919719127027</p>
<p>Manav Rachna University Manav Rachna Campus Address:- Sector - 43, Delhi-Surajkund Road, Faridabad - 121004, Haryana, India Phone: ++91-129-426-8587 Fax:- +91-129-4198211 , Pincode:- 121004</p>	<p>Pohang Accelerator Laboratory, Pohang, South Korea Address: 80 Jigokro-127-beongil, Nam-gu, Pohang, Gyeongbuk 37673, Korea <a href="#">South Korea</a></p>
<p><b>Nominating in capacity as :</b> Head of Institution</p>	<p><b>Working Since :</b> 24 Dec, 2018 <b>Working under the guidance of :</b> Prof Sangsul Lee <b>Excellence of the Nominee is claimed in :</b> Basic Research</p>

### Nominee Other Information :

<b>Area of</b>	: Materials Science (Physical & Mathematical Sciences)
<b>Gender</b>	: Male
<b>Date of Birth</b>	: 27 Sep, 1982
<b>Fax</b>	: 82542791503
<b>Nationality</b>	: INDIAN

### Any other relevant information:

Membership of Professional bodies Life Time Member: Indian Physics Association (GEN/LM/13009); Life Time Member: Magnetic Society of India (LM-623); Life Time Member: Ion beam Society of India (LM248); Life Time Member: Korean Vacuum Society Member: International Association of Advanced Materials (82927182162); Plasma Science Society of India (Student Member)-2004-05 Qualified: NET-2007 (Ranked Among Top 25) & GATE-2005 (AIR 210)

### Suitability of the proposed work in major national initiatives of the Government:

Make in India, Swachh Bharat, Smart Cities

### Theme of Proposed Work:

Energy, Materials

### Qualifications Details (from Bachelor degree onwards)

Post Doctorate , Materials Science (2012)

National Chung Cheng University Taiwan  
Class/Division

Post Doctorate , Materials Science (2011)

INTER University Accelerator Center New Delhi

Class/Division

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Ph.D. , Physics (2010)

GBPUAT PANTNAGAR UTTARAKHAND

Class/Division I

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Masters Degree , Physics (2005)

GBPUAT PANTNAGAR UTTARAKHAND

Class/Division I

Marks : 7.478 CGPA

---

B.Sc , Physics (2003)

MJPRU BAREILLY UTTAR PRADESH

Class/Division I

Marks : 67.33 Percentage

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Details of professional training and research experience

1. Faculty Development Programme organized by Academy of Business and Engineering Sciences (ABES) Engineering College, Ghaziabad, [03 Dec, 2013 to 05 Dec, 2013] 3 Day(s)

Participant

India

2. 6th INUP Hands-on Training Workshop on Nanofabrication Technologies, organized by IIT Bombay, Mumbai [10 Oct, 2011 to 14 Oct, 2011] 5 Day(s)

Participant

India

3. GBPUAT Pantnagar Uttarakhand [01 Jan, 2010 to 06 Jul, 2010] 6 Month(s) 6 Day(s)

Senior Research Fellow

India

4. GBPUAT Pantnagar Uttarakhand [01 Jan, 2008 to 31 Dec, 2009] 2 Year(s)

Junior Research Fellow

India

5. GBPUAT Pantnagar Uttarakhand [14 Nov, 2006 to 31 Dec, 2007] 1 Year(s) 1 Month(s) 17 Day(s)

Project Fellow

India

6. Institute for Plasma Research Gandhinagar [07 Jun, 2004 to 16 Jul, 2004] 1 Month(s) 10 Day(s)

Summer School Assistantship

India

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Details of employment/position (for last 10 years)



- 1. Senior Project Scientist [24 Dec, 2018 to 23 Dec, 2021] 3 Year(s)**  
Pohang Accelerator Laboratory  
Pohang Accelerator Laboratory Pohang South Korea
- 2. Commissioned Researcher [09 Nov, 2017 to 08 Nov, 2018] 1 Year(s)**  
Korea Institute of Science and Technology  
Advanced Analysis Center, Korea Institute of Science and Technology Seoul South Korea
- 3. Visiting Scientist [03 Oct, 2014 to 30 Sep, 2017] 2 Year(s) 11 Month(s) 29 Day(s)**  
Korea Institute of Science and Technology  
Advanced Analysis Center, Korea Institute of Science and Technology Seoul South Korea
- 4. Assistant Professor [01 Aug, 2012 to 30 Sep, 2014] 2 Year(s) 2 Month(s)**  
Krishna Engineering College Ghaziabad  
Krishna Engineering College Mohanagar Ghaziabad, Uttar Pradesh

#### Professional Recognition/Fellowship details

##### Guest Editor-Materials Letter (2021)

Guest Editor for Special Issue entitled “ Ion Implantation in Multifunctional Materials” published by Journal Materials Letters IF 3.4 Elsevier)

##### Topic Editor\_Magnetism (2020)

Magnetism, MDPI; <https://www.mdpi.com/journal/magnetism>

##### Guest Editor-Applied Nanoscience (2020)

Guest Editor for Special Issue entitled “ Interface Assisted Phenomena for Advanced Applications ” published by Journal Applied Nanoscience IF 3.6 (Springer-Nature)

##### Guest Editor-Vacuum (2019)

Guest Editor for Special Issue entitled “Creation, Control and Investigation of Defects in d<sup>0</sup> Ferromagnetic Materials (d<sup>0</sup> Ferromagnetic Materials)” published by Journal Vacuum IF 3.647 (Elsevier)

##### Best Poster Award (2018)

Korean Institute of Metals, South Korea

##### Editor -IJMEMS (2016)

Member of Editorial Board for Journal IJMEMS from 2016  
Cite Score 1.7  
ESCI

##### Young Scientist Award (2014)

DST Fast Track Scheme

##### Travel Fellowship Awards (2013)

Department of Science and Technology, New Delhi

##### CSIR Foreign Travel Grant -2011 (2011)

CSIR New Delhi, INDIA

##### Senior Research Fellowship (2010)

Council of Scientific and Industrial Research, New Delhi, INDIA

### Young Scientist Award (2009)

UCOST, Uttarakhand India

### Travel Fellowship Awards (2009)

Department of Science & Technology, New Delhi

### Best Poster Award (2009)

Cochin Nano 2009

### Junior Research Fellowship (2008)

Council of Scientific and Industrial Research, New Delhi, INDIA

### Project Fellowship (2007)

GBPUAT, Pantnagar, INDIA via UGC funded scheme

### Graduate Teaching Assistantship (2004)

GBPUAT, Pantnagar, INDIA

Up-to 10 Most significant publications came out during the last five years

#### 1. Fe<sup>+</sup> and Zn<sup>+</sup> ion implantation in MgO single crystals (2021)

Jitendra Pal Singh, Weon Cheol Lim, Jonghan Song, Sangsul Lee, Keun Hwa Chae

Journal Name : MATERIALS LETTERS

Journal Volume : 301

Journal Issue : 10

Start & End Page : 130232 to 130232

Corresponding Author : Yes

#### 2. Hierarchically Assembled Cobalt Oxynitride Nanorods and N-Doped Carbon Nanofibers for Efficient Bifunctional Oxygen Electrocatalysis with Exceptional Regenerative Efficiency (2021)

Ki Ro Yoon, C-K Hwang, S-h Kim, Ji-Wn Jung, Ji Eon Chae, J Kim, K Ah Lee, A Lim, Su-Ho Cho, Jitendra Pal Singh, J M Kim, K Shin, B M Moon, H S Park, H-Juhn Kim, K H Chae, H C Ham, Il-D Kim, Jin Y Kim

Journal Name : ACS Nano

Journal Volume : 15

Journal Issue : 7

Start & End Page : 11218 to 11230

Corresponding Author : No

#### 3. Highly active and thermally stable single-atom catalysts for high-temperature electrochemical devices (2020)

Jisu Shin, Young Joo Lee, Asif Jan, Sung Min Choi, ..... Jitendra Pal Singh, .....o Lee, Byung-Kook Kim, Hae-Weon Lee, Jongsup Hong, Yun Jung Lee, Kyung Joong Yoon

Journal Name : Energy & Environmental Science

Journal Volume : 13

Journal Issue : 12

Start & End Page : 4903 to 4920

Corresponding Author : No

4. Li(Ni<sub>1/3</sub>Co<sub>1/3</sub>Mn<sub>1/3</sub>)O<sub>2</sub> cathode investigated using X-ray absorption spectroscopy and transmission X-ray microscopy (2020)

Jae Yeon Park, Jitendra Pal Singh, Changhoon Jung, Jun-Ho Park, Jun Lim, Keun Hwa Chae, Sangsul Lee

Journal Name : MATERIALS LETTERS

Journal Volume : 261

Journal Issue : 2

Start & End Page : 126983 to 126983

Corresponding Author No

5. Porous Strained Pt Nanostructured Thin-Film Electrocatalysts via Dealloying for PEM Fuel Cells (2020)

Chang-Kyu Hwang, Jong Min Kim, S Hwang, J-H Kim, C H Sung, B-M Moon, K H Chae, Jitendra Pal Singh, Seung-Hoon Kim, Seung Soon Jang, Seung Woo Lee, Hyung Chul Ham, Seunghee Han, Jin Young Kim

Journal Name : Advanced Materials Interfaces

Journal Volume : 7

Journal Issue : 2

Start & End Page : 1901326 to 1901326

Corresponding Author No

6. Soft X-ray Absorption Spectroscopic Investigation of Li (Ni<sub>0.8</sub>Co<sub>0.1</sub>Mn<sub>0.1</sub>) O<sub>2</sub> Cathode Materials (2020)

Jitendra Pal Singh, Jae Yeon Park, Keun Hwa Chae, Docheon Ahn, Sangsul Lee

Journal Name : Nanomaterials

Journal Volume : 10

Journal Issue : 4

Start & End Page : 759 to 759

Corresponding Author Yes

7. Development of XANES nanoscopy on BL7C at PLS-II (2020)

JY Park, JP Singh, J Lim, S Lee

Journal Name : JOURNAL OF SYNCHROTRON RADIATION

Journal Volume : 27

Journal Issue : 2

Start & End Page : 545 to 545

Corresponding Author No

8. Mechanistic insights into the interaction between energetic oxygen ions and nanosized ZnFe<sub>2</sub>O<sub>4</sub>: XAS-XMCD investigations (2018)

Jitendra Pal Singh, Baljeet Kaur, Aditya Sharma, So Hee Kim, Sanjeev Gautam, R C Srivastava, Navdeep Goyal, W Cheol Lim, H-J Lin, JM Chen, K Asokan, D Kanjilal, Sung Ok Won, Ik-Jae Lee, Keun Hwa Chae

Journal Name : PHYSICAL CHEMISTRY CHEMICAL PHYSICS

Journal Volume : 20

Journal Issue : 17

Start & End Page : 12084 to 12096

Corresponding Author Yes

9. Tunichrome-inspired gold-enrichment dispersion matrix and its application in water treatment: a proof-of-concept investigation (2017)

Amarendra Dhar Dwivedi, Rega Permana, Jitendra Pal Singh, Hakwon Yoon, Keun Hwa Chae, Yoon-Seok Chang, Dong Soo Hwang

Journal Name : ACS Applied Materials & Interfaces

Journal Volume : 9

Journal Issue : 23

Start & End Page : 19815 to 19824

Corresponding Author : No

10. Mechanistic insights on the electronic properties and electronic/atomic structure aspects in orthorhombic SrVO<sub>3</sub> thin films: XANES-EXAFS study (2017)

Aditya Sharma, Mayora Varshney, Weon Cheol Lim, Hyun-Joon Shin, Jitendra Pal Singh, Sung Ok Won, Keun Hwa Chae

Journal Name : PHYSICAL CHEMISTRY CHEMICAL PHYSICS

Journal Volume : 19

Journal Issue : 9

Start & End Page : 6397 to 6405

Corresponding Author : No

List of all peer reviewed journal publications during the last 5 years

1. Calcite Nanocrystals Investigated Using X-ray Absorption Spectroscopy (2021)

Varsha Singh, Anil Kumar Paidi, Cheol-Hwee Shim, So Hee Kim, Sung Ok Won, Jitendra Pal Singh, Sangsul Lee, Keun Hwa Chae

Journal Name : Crystals

Journal Volume : 11

Journal Issue : 5

Start & End Page : 490 to 490

Corresponding Author : Yes

2. Phase transformation in Fe<sub>2</sub>O<sub>3</sub> nanoparticles: Electrical properties with local electronic structure (2021)

Suman Suman, Vikas Sharma, Seema Devi, Surjeet Chahal, Jitendra Pal Singh, KH Chae, Ashok Kumar, K Asokan, Parmod Kumar

Journal Name : PHYSICA B-CONDENSED MATTER

Journal Volume : 620

Journal Issue : 11

Start & End Page : 413275 to 413275

Corresponding Author : No

3. Local structure investigation of Co-Fe-Si-B ribbons by extended X-ray absorption fine-structure spectroscopy (2021)

AA Deshmukh, AP Srivastava, JP Singh, Manish Kumar, KH Chae, K Asokan, UA Palikundwar

Journal Name : JOURNAL OF SYNCHROTRON RADIATION

Journal Volume : 28

Journal Issue :

Start & End Page : 240 to 246

Corresponding Author : No

4. Probing Charge Transport in Manganite Film through Switching Parameters (2021)

KN Rathod, Hetal Boricha, Khushal Sagapariya, Bharavi Hirpara, Davit Dhruv, AD Joshi, DD Pandya, JP Singh, KH Chae, K Asokan, PS Solanki, NA Shah

Journal Name : CURRENT APPLIED PHYSICS  
Journal Volume : 28  
Journal Issue : 8  
Start & End Page : 98 to 103  
Corresponding Author : No

5. Characterizing the defects and ferromagnetism in metal oxides: The case of magnesium oxide (2021)

Shaffy Garg, Sanjeev Gautam, Jitendra Pal Singh, Kandasami Asokan, Navdeep Goyal

Journal Name : MATERIALS CHARACTERIZATION  
Journal Volume : 179  
Journal Issue : 9  
Start & End Page : 111366 to 111366  
Corresponding Author : No

6. Creation, Control and Investigation of Defects in do Ferromagnetic Materials (2021)

Jitendra Pal Singh, Sangsul Lee, Keun Hwa Chae

Journal Name : VACUUM  
Journal Volume : 190  
Journal Issue : 8  
Start & End Page : 110079 to 110079  
Corresponding Author : Yes

7. Effect of thermal annealing on the properties of ZnO thin films (2021)

Weon Cheol Lim, Jitendra Pal Singh, Younghak Kim, Jonghan Song, Keun Hwa Chae, Tae-Yeon Seong

Journal Name : VACUUM  
Journal Volume : 183  
Journal Issue : 1  
Start & End Page : 109776 to 109776  
Corresponding Author : No

8. Activity-stability benefits of Pt/C fuel cell electrocatalysts prepared via remote CeO<sub>2</sub> interfacial doping (2021)

Ki Ro Yoon, Jong Min Kim, Kyung Ah Lee, Chang-Kyu Hwang, Shedrack G Akpe, Yeo Jin Lee, Jitendra Pal Singh, Keun Hwa Chae, Seung Soon Jang, Hyung Chul Ham, Jin Young Kim

Journal Name : JOURNAL OF POWER SOURCES  
Journal Volume : 496  
Journal Issue : 6  
Start & End Page : 229798 to 229798  
Corresponding Author : No

9. Structural and Electronic Properties of Flexible ZnO and Ti/Mn: ZnO Thin Films (2020)

Manish Kumar, Jitendra Pal Singh, Hyun Hwi Lee, Keun Hwa Chae

Journal Name : JOURNAL OF THE KOREAN PHYSICAL SOCIETY  
Journal Volume : 77  
Journal Issue : 5  
Start & End Page : 452 to 456  
Corresponding Author : No

10. Local Electronic Structure of Calcite Investigated Using X-ray Absorption Spectroscopy at Different Span of Time (2020)

Varsha Singh, Jitendra Pal Singh, Cheol-Hwee Shim, Sangsul Lee, Keun Hwa Chae

Journal Name : JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY  
Journal Volume : 20  
Journal Issue : 11  
Start & End Page : 6713 to 6717  
Corresponding Author : No

11. Structural phase control and thermochromic modulation of VO<sub>2</sub> thin films by post thermal annealing (2020)

M Kumar, S Rani, JP Singh, KH Chae, Y Kim, J Park, HH Lee

Journal Name : APPLIED SURFACE SCIENCE  
Journal Volume : 529  
Journal Issue : 11  
Start & End Page : 147093 to 147093  
Corresponding Author : No

12. Correlating the size and cation inversion factor in context of magnetic and optical behavior of CoFe<sub>2</sub>O<sub>4</sub> nanoparticles (2020)

Jitendra Pal Singh, Jae Yeon Park, Varsha Singh, So Hee Kim, Weon Cheol Lim, Hemaunt Kumar, YH Kim, Sangsul Lee, Keun Hwa Chae

Journal Name : RSC Advances  
Journal Volume : 10  
Journal Issue : 36  
Start & End Page : 21259- to 21269  
Corresponding Author : Yes

13. MgO thin film growth on Si (001) by radio-frequency sputtering method (2020)

JP Singh, M Kumar, WC Lim, HH Lee, YM Lee, S Lee, KH Chae

Journal Name : JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY  
Journal Volume : 20  
Journal Issue : 12  
Start & End Page : 7530 to 7534  
Corresponding Author : No

14. New findings and current controversies on oxidation of benzyl alcohol by a copper complex (2020)

Zahra Zand, Jitendra Pal Singh, Robabeh Bagheri, Junfeng Cui, Keun Hwa Chae, Zhenlun Song, Mohammad Mahdi Najafpour

Journal Name : Materials Advances  
Journal Volume : 1  
Journal Issue : 3  
Start & End Page : 441 to 449  
Corresponding Author : No

15. Approaches to synthesize MgO nanostructures for diverse applications (2020)

Jitendra Pal Singh, Varsha Singh, Aditya Sharma, Ganesh Pandey, Keun Hwa Chae, Sangsul Lee

Journal Name : HELIYON  
Journal Volume : 6  
Journal Issue : 9  
Start & End Page : 04882 to 04882  
Corresponding Author : No

16. Influence of Cu doping on the local electronic and magnetic properties of ZnO nanostructures (2020)

Richa Bhardwaj, Amardeep Bharti, Jitendra P Singh, Keun H Chae, Navdeep Goyal

Journal Name : Nanoscale Advances  
Journal Volume : 2  
Journal Issue : 10  
Start & End Page : 4450 to 4463  
Corresponding Author : No

17. Annealing effect on phase transition and thermochromic properties of VO<sub>2</sub> thin films (2020)

M Kumar, J. P. Singh, K. H. Chae, J. Park, H. H. Lee

Journal Name : SUPERLATTICES AND MICROSTRUCTURES  
Journal Volume : 137  
Journal Issue : 1  
Start & End Page : 106335 to 106335  
Corresponding Author : No

18. Effect of oxygen vacancy gradient on ion-irradiated Ca-doped YMnO<sub>3</sub> thin films (2020)

Kunalsinh N Rathod, Keval Gadani, Davit Dhruv, Vipul G Shrimali, Sapana Solanki, Ashvini D Joshi, Jitendra P Singh, Keun H Chae, Kandasami Asokan, Piyush S Solanki, Nikesh A Shah

Journal Name : JOURNAL OF VACUUM SCIENCE & TECHNOLOGY B  
Journal Volume : 38  
Journal Issue : 6  
Start & End Page : 062208 to 062208  
Corresponding Author : No

19. Observation of Skyrmions at Room Temperature in Co<sub>2</sub>FeAl Heusler Alloy Ultrathin Film Heterostructures (2019)

S Husain, N Sisodia, A. K. Chaurasiya, A Kumar, J. P. Singh, B. S. Yadav, S. Akansel, K. H. Chae, A. Barman, P. K. Muduli, P Svedlindh, S. Chaudhary

Journal Name : Scientific Reports  
Journal Volume : 9  
Journal Issue :  
Start & End Page : 1085 to 1085  
Corresponding Author : Yes

20. Investigations on magnetic and electrical properties of Zn doped Fe<sub>2</sub>O<sub>3</sub> nanoparticles and their correlation with local electronic structures (2019)

Parmod Kumar, Vikas Sharma, Jitendra P Singh, Ashish Kumar, Surjeet Chahal, K Sachdev, KH Chae, Ashok Kumar, K Asokan, D Kanjilal

Journal Name : JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS  
Journal Volume : 489  
Journal Issue : 11  
Start & End Page : 165398 to 165398  
Corresponding Author : No

21. Design of zinc ferrite thin films with excess Tetrahedrally coordinated Fe<sup>3+</sup> ions and Their magnetic interactions (2019)

J. P. Singh, S. Lee, K. H. Chae

Journal Name : VACUUM  
Journal Volume : 168  
Journal Issue : 10  
Start & End Page : 108848 to 108848  
Corresponding Author :

No

22. Local electronic structure perspectives of nanoparticle growth: The case of MgO (2019)

Jitendra Pal Singh, K. H. Chae

Journal Name : ACS Omega

Journal Volume : 4

Journal Issue :

Start & End Page : 7140 to 7150

Corresponding Author No

23. A manganese (ii) phthalocyanine under water-oxidation reaction: new findings (2019)

Y Mousazade, M M Najafpour, R Bagheri, Z Jagličić, Jitendra Pal Singh, Keun Hwa Chae, Z Song, Margarita V Rodionova, Roman A Voloshin, Jian-Ren Shen, Seeram Ramakrishna, Suleyman I Allakhverdiev

Journal Name : DALTON TRANSACTIONS

Journal Volume : 48

Journal Issue :

Start & End Page : 12147 to 12158

Corresponding Author No

24. A nickel (II) complex under water-oxidation reaction: what is the true catalyst? (2019)

Zhenlun Song ORCID iD and Mohammad Mahdi Najafpour Hadi Feizi a, Robabeh Bagheri, Zvonko Jagličić, Jitendra Pal Singh, Keun Hwa Chae

Journal Name : DALTON TRANSACTIONS

Journal Volume : 48

Journal Issue :

Start & End Page : 547 to 557

Corresponding Author Yes

25. Electrochemical water oxidation by simple manganese salts (2019)

S Heidari, J Singh, H. Feize, R. Bagheri, K. Chae, Z. Song, M. Khatamian, M Najafpour

Journal Name : Scientific Reports

Journal Volume : 9

Journal Issue :

Start & End Page : 7749 to 7749

Corresponding Author No

26. Investigations on the Electronic Excitations through Spectroscopic Measures for Resistive Switching Character of Manganite Thin Films (2019)

Kunalsinh N. Rathod Keval Gadani Davit Dhruv Hetal Boricha Alpa Zankat Ashvini D. Joshi Jitendra P. Singh Keun H. Chae Kandasami Asokan Piyush S. Solanki Nikesh A. Shah

Journal Name : PHYSICA STATUS SOLIDI B-BASIC SOLID STATE PHYSICS

Journal Volume : 256

Journal Issue : 11

Start & End Page : 1900264 to 1900264

Corresponding Author No



27. Nanosized (Ni 1– x Zn x) Fe 2 O 4 for water oxidation (2019)

Somayeh Mehrabani, Jitendra Pal Singh, Robabeh Bagheri, Abdul Ghafar Wattoo, Zhenlun Song, Keun Hwa Chae, Mohammad Mahdi Najafpour

Journal Name : Nanoscale Advances

Journal Volume : 1

Journal Issue :

Start & End Page : 686 to 695

Corresponding Author No

28. A trimetallic organometallic precursor for efficient water oxidation (2019)

S Madadkhani, R. B. Aghakhanpour, Jitendra Pal Singh, Robabeh Bagheri, K. H. Chae, Z. Song, M. M. Najafpour

Journal Name : Scientific Reports

Journal Volume : 9

Journal Issue :

Start & End Page : 3734 to 3734

Corresponding Author No

29. An interplay among the Mg<sup>2+</sup> ion coordination, structural order, oxygen vacancies and magnetism of MgO thin films (2019)

Jitendra Pal Singh, Weon Cheol Lim, Keun Hwa Chae

Journal Name : JOURNAL OF ALLOYS AND COMPOUNDS

Journal Volume : 806

Journal Issue :

Start & End Page : 1348 to 1356

Corresponding Author No

30. Extraction of Switching Parameters for Sr-Doped YMnO<sub>3</sub> Thin Film (2019)

Kunalsinh N Rathod, Keval Gadani, Hetal Boricha, Khushal Sagapariya, Ajay Vaisnani, Davit Dhruv, Ashvini D Joshi, Jitendra P Singh, Keun H Chae, Kandasami Asokan, Piyush S Solanki, Nikesh A Shah

Journal Name : PHYSICA STATUS SOLIDI B-BASIC SOLID STATE PHYSICS

Journal Volume : 216

Journal Issue : 24

Start & End Page : 1900780 to 1900780

Corresponding Author No

31. Role of low energy transition metal ions in interface formation in ZnO thin films and their effect on magnetic properties for spintronic applications (2019)

Richa Bhardwaj, Baljeet Kaur, Jitendra Pal Singh, Manish Kumar, HH Lee, Parmod Kumar, RC Meena, K Asokan, Keun Hwa Chae, Navdeep Goyal, Sanjeev Gautam

Journal Name : APPLIED SURFACE SCIENCE

Journal Volume : 479

Journal Issue : 6

Start & End Page : 1021 to 1028

Corresponding Author No

32. UV-Vis Spectroscopic and NEXAFS Studies of Polycrystalline Zinc Ferrite Films (2019)

Jitendra Pal Singh, Keun Hwa Chae

Journal Name : PHYSICA STATUS SOLIDI A-APPLICATIONS AND MATERIALS SCIENCE  
Journal Volume : 216  
Journal Issue : 9  
Start & End Page : 1800997 to 1800997  
Corresponding Author No

33. Role of low energy transition metal ions in interface formation in ZnO thin films and their effect on magnetic properties for spintronic applications (2019)

Richa Bhardwaj, Baljeet Kaur, Jitendra Pal Singh, Manish Kumar, HH Lee, Parmod Kumar, RC Meena, K Asokan, Keun Hwa Chae, Navdeep Goyal, Sanjeev Gautam

Journal Name : APPLIED SURFACE SCIENCE  
Journal Volume : 479  
Journal Issue : 6  
Start & End Page : 1021 to 1028  
Corresponding Author No

34. Are organic templates responsible for the optical and magnetic response of MgO nanoparticles? (2018)

JP Singh, SH Kim, HK Kang, SO Won, IJ Lee, KH Chae

Journal Name : Materials Chemistry Frontiers  
Journal Volume : 2  
Journal Issue : 9  
Start & End Page : 1707 to 1715  
Corresponding Author No

35. Microstructure, local electronic structure and optical behaviour of zinc ferrite thin films on glass substrate (2018)

Jitendra Pal Singh, Byeong-Hyeon Lee, Weon Cheol Lim, Cheol-Hwee Shim, Jihye Lee, Keun Hwa Chae

Journal Name : Royal Society Open Science  
Journal Volume : 5  
Journal Issue :  
Start & End Page : 181330 to 181330  
Corresponding Author No

36. Synthesis and Characterization of Some Alkaline-Earth-Oxide Nanoparticles (2018)

Jitendra Pal Singh, Weon Cheol Lim, Sung Ok Won, Jonghan Song, Keun Hwa Chae

Journal Name : JOURNAL OF THE KOREAN PHYSICAL SOCIETY  
Journal Volume : 72  
Journal Issue : 8  
Start & End Page : 890 to 899  
Corresponding Author No

37. The application of a nickel (ii) Schiff base complex in water oxidation: the importance of nanosized materials (2018)

H Feizi, F Shiri, R Bagheri, JP Singh, KH Chae, Z Song, MM Najafpour

Journal Name : Catalysis Science & Technology  
Journal Volume : 8  
Journal Issue : 15  
Start & End Page : 3954 to 3968  
Corresponding Author No

**38. Surface structure of MgO thin films revealed from X-ray reflectivity and near-edge X-ray absorption fine structure measurements (2018)**

Jitendra Pal Singh, Weon Cheol Lim, Ik-Jae Lee, Sung OK Won, Keun Hwa Chae

Journal Name : Science of Advanced Materials  
Journal Volume : 10  
Journal Issue :  
Start & End Page : 1372 to 1376  
Corresponding Author : No

**39. Uptake, Distribution, and Transformation of Zerovalent Iron Nanoparticles in the Edible Plant Cucumis sativus (2018)**

Amarendra Dhar Dwivedi, Hakwon Yoon, Jitendra Pal Singh, Keun Hwa Chae, Sang-chul Rho, Dong Soo Hwang, Yoon-Seok Chang

Journal Name : ENVIRONMENTAL SCIENCE & TECHNOLOGY  
Journal Volume : 52  
Journal Issue : 17  
Start & End Page : 10057 to 10066  
Corresponding Author : No

**40. Links between peptides and Mn oxide: nano-sized manganese oxide embedded in a peptide matrix (2018)**

Mohammad Mahdi Najafpour, Sepideh Madadkhani, Somayyeh Akbarian, Zahra Zand, Małgorzata Hołyńska, Mohsen Kompany-Zareh, Tomo Tatsuya, Jitendra Pal Singh, Keun Hwa Chae, Suleyman I Allakhverdiev

Journal Name : NEW JOURNAL OF CHEMISTRY  
Journal Volume : 42  
Journal Issue : 12  
Start & End Page : 10067 to 10077  
Corresponding Author : No

**41. Water oxidation by simple manganese salts in the presence of cerium (IV) ammonium nitrate: Towards a complete picture (2018)**

Sima Heidari, Mohammad Mahdi Najafpour, Małgorzata Holynska, Jitendra Pal Singh, Keun Hwa Chae, Maasumeh Khatamian

Journal Name : DALTON TRANSACTIONS  
Journal Volume : 47  
Journal Issue : 5  
Start & End Page : 1557 to 1565  
Corresponding Author : No

**42. Structure, optical and electronic structure studies of Ti: ZnO thin films (2018)**

Manish Kumar, Jitendra Pal Singh, Keun Hwa Chae, Jong Hyun Kim, Hyun Hwi Lee

Journal Name : JOURNAL OF ALLOYS AND COMPOUNDS  
Journal Volume : 759  
Journal Issue :  
Start & End Page : 8 to 13  
Corresponding Author : No

**43. Unveiling the nature of adsorbed species onto the surface of MgO thin films during prolonged annealing (2018)**

JP Singh, MJ Ji, M Kumar, IJ Lee, KH Chae

Journal Name : JOURNAL OF ALLOYS AND COMPOUNDS  
Journal Volume : 748  
Journal Issue :  
Start & End Page : 355 to 362  
Corresponding Author : No

**44. Structural and electronic investigation of ZnO nanostructures synthesized under different environments (2018)**

R Bhardwaj, A Bharti, JP Singh, KH Chae, N Goyal, S Gautam

Journal Name : HELIYON  
Journal Volume : 4  
Journal Issue : 4  
Start & End Page : 00594 to 00594  
Corresponding Author : Yes

**45. Atomic-scale investigation of MgO growth on fused quartz using angle-dependent NEXAFS measurements (2018)**

JP Singh, SH Kim, SO Won, IJ Lee, KH Chae

Journal Name : RSC Advances  
Journal Volume : 8  
Journal Issue : 55  
Start & End Page : 31275 to 31286  
Corresponding Author : No

**46. Surface and local electronic structure modification of MgO film using Zn and Fe ion implantation (2018)**

JP Singh, WC Lim, J Lee, J Song, KH Chae

Journal Name : APPLIED SURFACE SCIENCE  
Journal Volume : 432  
Journal Issue : 2  
Start & End Page : 131 to 139  
Corresponding Author : No

**47. Electronic and magnetic structure investigation of vanadium doped ZnO nanostructure (2018)**

Richa Bhardwaj, Jitendra Pal Singh, Keun Hwa Chae, Navdeep Goyal, Sanjeev Gautam

Journal Name : VACUUM  
Journal Volume : 158  
Journal Issue :  
Start & End Page : 257 to 262  
Corresponding Author : No

**48. Nanosized manganese oxide/holmium oxide: a new composite for water oxidation (2017)**

Mohammad Mahdi Najafpour, Saeideh Salimi, Zahra Zand, Małgorzata Hołyńska, Tatsuya Tomo, Jitendra Pal Singh, Keun Hwa Chae, Suleyman I Allakhverdiev

Journal Name : NEW JOURNAL OF CHEMISTRY  
Journal Volume : 41  
Journal Issue : 22  
Start & End Page : 13732 to 13741  
Corresponding Author : No

**49. Tunichrome mimetic matrix, its perspective in abatement for carcinogenic hexavalent chromium and specific coordination behavior (2017)**

Amarendra Dhar Dwivedi, Rega Permana, Jitendra Pal Singh, Hakwon Yoon, Keun Hwa Chae, Yoon-Seok Chang, Dong Soo Hwang

Journal Name : CHEMICAL ENGINEERING JOURNAL

Journal Volume : 328

Journal Issue :

Start & End Page : 629 to 638

Corresponding Author No

**50. A new strategy to make an artificial enzyme: photosystem II around nanosized manganese oxide (2017)**

Mohammad Mahdi Najafpour, Sepideh Madadkhani, Somayyeh Akbarian, Małgorzata Hołyńska, Mohsen Kompany-Zareh, Tatsuya Tomo, Jitendra Pal Singh, Keun Hwa Chae, Suleyman I Allakhverdiev

Journal Name : Catalysis Science & Technology

Journal Volume : 7

Journal Issue : 19

Start & End Page : 4451 to 4461

Corresponding Author No

**51. Tuning and Characterizing Nanocellulose Interface for Enhanced Removal of Dual-Sorbate (AsV and CrVI) from Water Matrices (2017)**

Amarendra Dhar Dwivedi, Naresh D Sanandiyaa, Jitendra Pal Singh, Syed M Husnain, Keun Hwa Chae, Dong Soo Hwang, Yoon-Seok Chang

Journal Name : ACS Sustainable Chemistry & Engineering

Journal Volume : 5

Journal Issue : 1

Start & End Page : 518 to 528

Corresponding Author No

**52. Optical behavior of MgO nanoparticles investigated using diffuse reflectance and near edge X-ray absorption spectroscopy (2017)**

Jitendra Pal Singh, Sung Ok Won, Weon Cheol Lim, Cheol-Hwee Shim, Keun Hwa Chae

Journal Name : MATERIALS LETTERS

Journal Volume : 198

Journal Issue :

Start & End Page : 34 to 37

Corresponding Author Yes

**53. Effect of precursor thermal history on the formation of amorphous and crystalline calcium carbonate (2017)**

Jitendra Pal Singh, Mi-Jung Ji, Cheol-Hwee Shim, Sang Ok Kim, Keun Hwa Chae

Journal Name : Particuology

Journal Volume : 33

Journal Issue :

Start & End Page : 29 to 34

Corresponding Author No

54. Correlation of oxygen vacancies to various properties of amorphous zinc tin oxide films (2017)

Nark-Eon Sung, Han-Koo Lee, Keun Hwa Chae, Jitendra Pal Singh, Ik-Jae Lee

Journal Name : JOURNAL OF APPLIED PHYSICS  
Journal Volume : 122  
Journal Issue : 8  
Start & End Page : 085304 to 085304  
Corresponding Author No

55. Role of silver doping on the defects related photoluminescence and antibacterial behaviour of zinc oxide nanoparticles (2017)

Vinod Kumar, Jai Prakash, Jitendra Pal Singh, Keun Hwa Chae, C Swart, OM Ntwaeaborwa, HC Swart, Viresh Dutta

Journal Name : COLLOIDS AND SURFACES B-BIOINTERFACES  
Journal Volume : 159  
Journal Issue :  
Start & End Page : 191 to 199  
Corresponding Author No

56. Cu<sub>2</sub>O nanocrystals with various morphology: Synthesis, characterization and catalytic properties (2017)

Mojtaba Bagherzadeh, Narges-alsadat Mousavi, Mojtaba Amini, Sanjeev Gautam, Jitendra Pal Singh, Keun Hwa Chae

Journal Name : CHINESE CHEMICAL LETTERS  
Journal Volume : 28  
Journal Issue : 5  
Start & End Page : 1125 to 1129  
Corresponding Author No

57. Magnetic Behaviour of Granular GdMnO<sub>3</sub> Film (2017)

Puneet Negi, HM Agrawal, Jitendra Pal Singh, Hemaunt Kumar, RC Srivastava, K Asokan, Keun Hwa Chae

Journal Name : Journal of Superconductivity and Novel Magnetism  
Journal Volume : 30  
Journal Issue :  
Start & End Page : 1419 to 1425  
Corresponding Author No

58. Synthesis and characterization of DyxCoFe<sub>2-x</sub>O<sub>4</sub> nanoparticles (2017)

Hemaunt Kumar, Jitendra Pal Singh, RC Srivastava, KR Patel, Keun Hwa Chae

Journal Name : SUPERLATTICES AND MICROSTRUCTURES  
Journal Volume : 109  
Journal Issue :  
Start & End Page : 296 to 306  
Corresponding Author No

**Title:** Development of Garnet Structured Electrolyte based Li-Rechargeable Thin Film Batteries for High Energy Applications

**PI:** Jitendra Pal Singh, Pohang Accelerator Laboratory, Pohang, South Korea

**Nominator:** Manav Rachna University, Haryana, India

### **a. Proposed Area of Research**

Experimental Condensed Matter Physics and Materials Science

**Title: Development of Garnet Structured Electrolyte based Li-Rechargeable Thin Film Batteries for High Energy Applications**

**Abstract:** Developing Li-batteries with solid-state electrolytes is getting attention for the scientific community. This kind of development make electrical vehicle available commercially with the optimization in the sense of cost and their uses. However, main drawback of these electrolytes is conductivity followed by interface related issues. Attempts are made by researchers to enhance conductivity by doping. However, doping concentration has limitation as after some extent doped systems may get impurity phases. Apart from this, it is shown by researchers that heavy ion-based techniques as irradiation and implantation have capability to modify the property of the materials. Thus, these techniques will be utilized to improve conductivity of garnet structure based solid-state electrolytes.

### **b. Research Work at Present Engaged In**

X-ray absorption spectroscopy is being utilized to energy materials [1, 2], magnetic materials and oxide insulator in order to investigation underlying phenomena during battery operation, growth and external influence like heavy ion irradiation [3] and implantation [4]. Following work is under preparation or communication

- [1]. **Jitendra Pal Singh**, A. K. Paidi, Sangsul Lee,  $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$  Electrolytes for Li-ion Thin Film Battery (*To be communicated*)
- [2]. **Jitendra Pal Singh**, Jae Yeon Park, Anil Kumar Paidi, Yeji Lee, Jun Lim, Keun Hwa Chae, Docheon Ahn, and Sangsul Lee, Probing Origin of First Cycle Irreversibility in Ni-rich Layered Oxide Cathode Materials, (*To be communicated*)
- [3]. **Jitendra Pal Singh**, Anil Kumar Paidi, Jun Lim, Keun Hwa Chae, Sangsul Lee and Docheon Ahn, Synchrotron Radiation Based Investigation to Understand Solid State Transformation in Cathode Materials, **RSC Advances** (*To be Communicated: Invited Review Article*)
- [4]. Implantation Studies in  $\text{ZnFe}_2\text{O}_4$  Thin Films Using X-ray Absorption Spectroscopy (*Under preparation*)
- [5]. Fe/MgO Interfaces: Impact of Heavy Ion Irradiation (*Under preparation*)

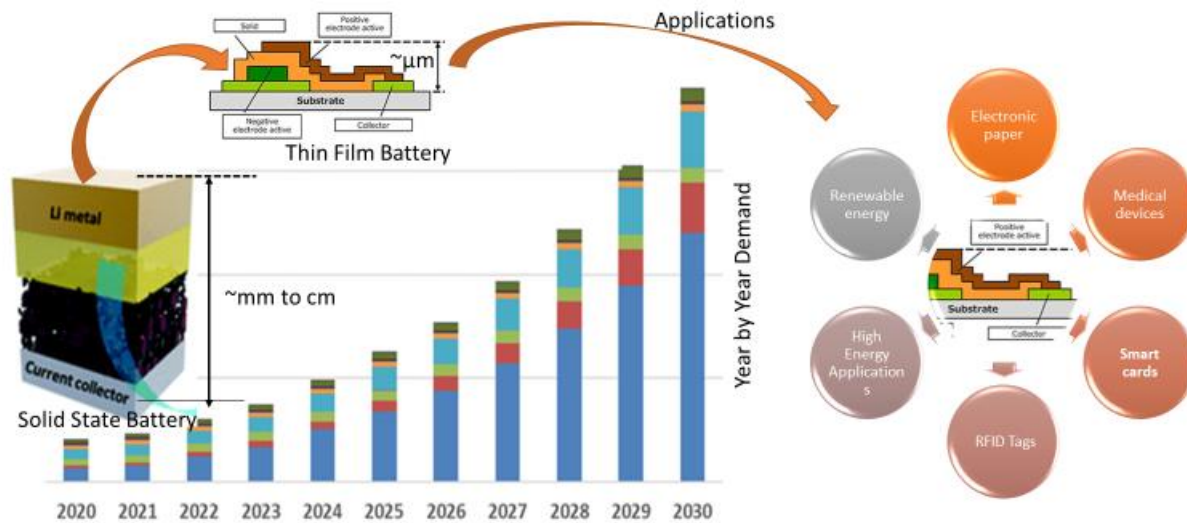
### **c. Details of the proposed project to be undertaken:**

**Title: Development of Garnet Structured Electrolyte based Li-Rechargeable Thin Film Batteries for High Energy Applications**

- **Origin of proposal**

Growing demands for safe energy, motivated researchers to develop solid state batteries (Figure 1) with better performance as well to integrate them into devices. These requirements meet if the solid-state batteries are designed in the form of thin film or integrated circuits. Thus, numerous

efforts are being made by the researchers to miniaturize the energy devices by designing several rechargeable batteries. Li-rechargeable batteries based on thin films are gaining attention, however, optimization of solid-state electrolyte is very important to better utilize these rechargeable batteries [1]. The main components of this battery are cathode, anode and electrolyte as required for normal rechargeable battery [8]. However, these batteries have basic difference in the nature of electrolyte. The basic requirement for this battery is the electrolyte to be in the form of solid state [2, 3].



**Figure 1: Energy demands based on Solid State Battery. Thin film is a kind of solid-state battery having total size ~µm which has potential to utilize for many applications**

Thus, Li-ion battery (LIB) which is based on Li-ion migration [4] is considered suitable for thin film counterpart with nickel cobalt manganese (NCM) oxide as cathode material [5] and  $\text{Li}_7\text{La}_3\text{Zr}_2\text{O}_{12}$  (LLZO) as solid-state electrolyte (SSE) [6]. The main issues that need attention behind developing these batteries is conductivity of solid electrolyte as well electrolyte-anode and electrolyte-cathode interface [7, 8], Apart from this stabilization of cathode material on suitable SSE is another aspect to be taken care while designing a thin film battery [9]. Though, these batteries are continually improving [9, 10], but still are not available for commercial applications. Thus, the work is focused to resolve these issues in a thin film battery and explore their use for commercial application such as electrical vehicle.

- **Objectives of the proposed project**

The objectives of the present proposal are:

- Optimizing composition of solid-state electrolyte (SSE): LLZO
- Growth optimization of LLZO thin films (doped by Ga) and LLZO/ $\text{Li}_3\text{N}$  layers
- Stabilization of LLZO on NMC811 cathode and related anode material.
- Optimizing conductivity of SSE either by doping, implantation and heavy ion irradiation. Suitable ions will be selected on the basis of SRIM code calculation.
- Modified SSE Based Battery Design: Performance and Application
- Development of Micro batteries for Integration in Circuits

- **Review of R&D in the proposed area (National & International Status, Importance, patents etc.)**

- **International**

In recent years, solid state batteries show promise towards energy demands. Thus, research is continuing in directions. This is evident from recent reviews on these batteries by international



scientific community [6-10]. Samsung Company, Korea reported solid state battery that works for longer cycle (~1000) based on high-Ni NMC cathode [11]. No such structure based on thin film is reported so far.

➤ **National**

At national level, Sharma et al investigated the transport characteristics of garnet type solid state electrolyte [12]. Polymer-ceramic composites as a solid-state electrolyte are being investigated by Ahmed et al. [13]

➤ **Patent Till date**

Some limited patents are available for fabrication methods of solid-state battery [14, 15]. For better understanding, status of solid-state batteries is depicted which shows insufficient commercial activities in this direction. Moreover, commercial applications based on thin film batteries are hardly available.

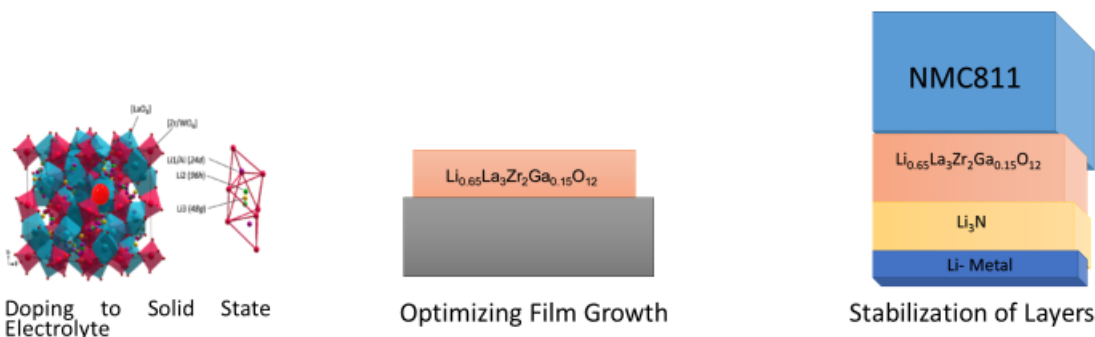


**Figure 2: Region wise commercial development of solid-state batteries. Source: IDTechEx Research report: "Solid-State and Polymer Batteries 2020-2030: Technology, Patents, Forecasts, Players"**

- Work Plan

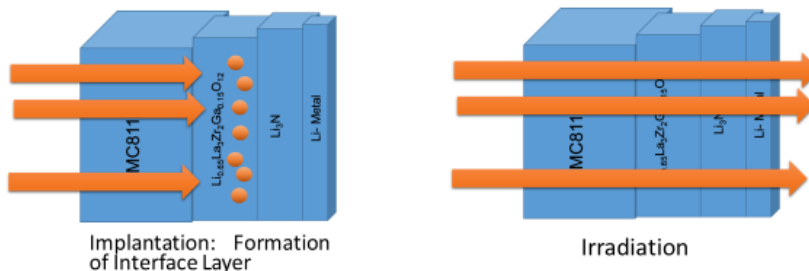
**Step 1: Optimization for Conductivity of Solid-State Electrolyte.**

To achieve this goal, solid state electrolyte is planned to synthesize using solid state reaction methods followed by doping strategy with special focus on Ga ions. This will be done to optimize the conductivity. Obtained optimized target will be transformed into thin film form with the help of radio frequency sputtering. After this, stabilization of various layers is planned to achieve battery structure.



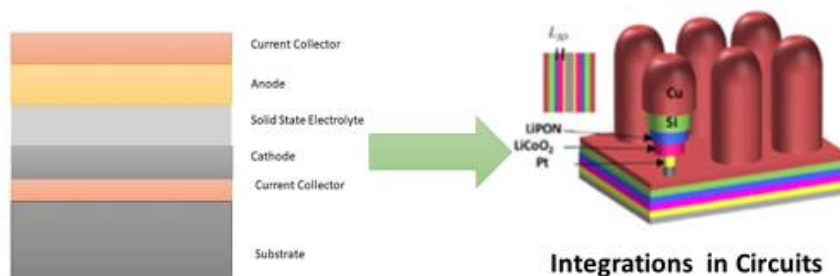
**Step 2: Device Optimization for Electrochemical Performance.**

Obtained battery structure is planned to irradiate and implant with appropriate ions to resolve interfacial and conductivity issues. The ions will be selected by the calculation using SRIM code. The electrochemical performance will be checked for irradiated and pristine structure.



### Step 3: Microbatteries Fabrication for Integration in Circuits.

The optimized battery structure is planned to grow in the form of microbatteries. These micro batteries are planned to miniaturize the devices.

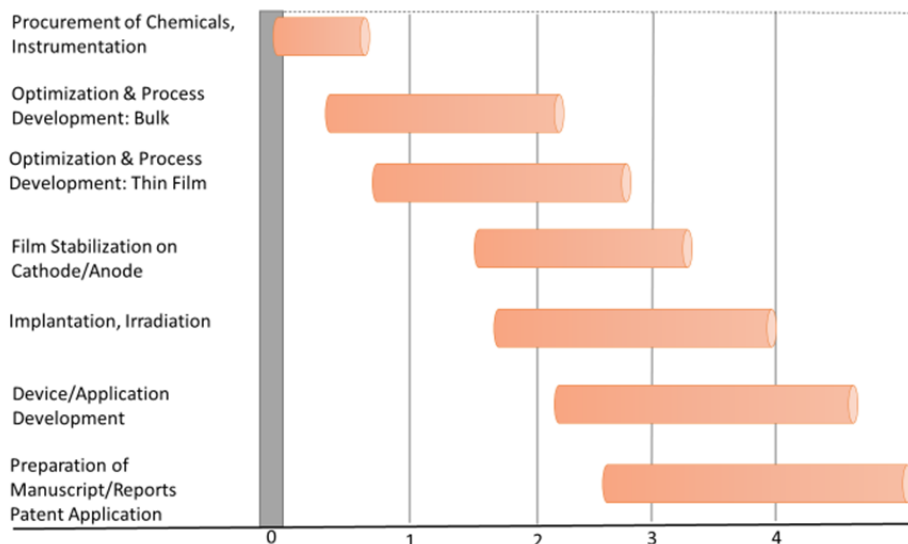


- **Future plans**

The development of such work can be utilized to check the efficiency of these devices for integrated circuits and other high frequency applications.

### 2. Prospects after the fellowship

After receiving fellowship, the time line of various step is depicted in the following figure.



### 3. Proposed work in context of basic research in the country

The proposed work will open a pathway to optimize the solid-state electrolytes for high-energy applications, especially for electrical vehicle applications. This kind of work will be helpful to fulfill the energy demands not only for electrical vehicle applications and integrated circuits. The proposed work laid the foundation of understanding of interface structure at cathode and solid electrolyte interface. This will also through light the propagation of ions through inorganic electrolytes, which ultimately will be helpful to develop batteries for different applications.

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- [15]. A method of developing sodium-ion conductor for next generation solid-state battery, Yogesh Sharma, Allu Vinodhkumar, Brahma Prakash Dubey, Indian Patent, File No.: 202011030681

FILE NO. RJF/2021/000115  
SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

Science and Engineering Research Board  
3rd & 4th Floor, Block II  
Technology Bhavan, New Mehrauli Road  
New Delhi - 110016

Dated: 07-Jul-2022

**ORDER**

Subject: Financial Sanction of the award Ramanujan Fellowship to Dr. J P SINGH, Physics, Manav Rachna University, Sector 43, Aravalli Hills, Manav Rachna Campus Rd, Faridabad, Haryana, Faridabad, Haryana-121004.

Sanction of Science and Engineering Research Board (SERB) is hereby accorded to the above mentioned fellowship at a total cost of Rs. 1,19,00,000/- (Rs. Rupees One Crore Nineteen Lakh only Only) with break-up of Rs NIL under Non-Recurring and Rs. 1,19,00,000/- under Recurring for a duration of 5 years. The items of expenditure for which the total allocation of Rs. 1,19,00,000/- has been approved for a period of 5 years, are given below:

(Amount in Rs)

Year	Non-recurring	Recurring			Total
		Fellowship @Rs.1,35,000/- p.m.	Research Grant/year	Overhead Charges/year	
1	NIL	16,20,000	7,00,000	60,000	23,80,000
2	NIL	16,20,000	7,00,000	60,000	23,80,000
3	NIL	16,20,000	7,00,000	60,000	23,80,000
4	NIL	16,20,000	7,00,000	60,000	23,80,000
5	NIL	16,20,000	7,00,000	60,000	23,80,000
<b>Total</b>	NIL	81,00,000	35,00,000	3,00,000	1,19,00,000

2. Sanction of the SERB is also accorded to the payment of Rs. 20,60,000/- (Rupees Twenty Lakh Sixty Thousand only) to Manav Rachna University, Sector 43, Aravalli Hills, Manav Rachna Campus Rd, Faridabad, Haryana under Recurring head (Grant-in -aid General) being the grant for the year 2022-2023 for implementation of the said fellowship.

3. The expenditure involved is debitable to Fund for Science & Engineering Research (FSER) .This release is being made under Ramanujan Fellowship.

4. The Sanction has been issued with the approval of the competent authority vide Diary No. SERB/F/2638/2022-2023 dated 06 July, 2022 .

5. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at website ([www.serb.gov.in](http://www.serb.gov.in)) and as per Ramanujan Fellowship Guidelines.

6. Overhead expenses are meant for the host Institute towards the cost for providing infrastructural facilities and general administrative support etc. including benefits to the staff employed in the fellowship.

7. The total release amount of Rs. 20,60,000/- (Rupees Twenty Lakh Sixty Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

PFMS Unique Code	HRFR00002793
Account Name	MANAV RACHNA UNIVERSITY PROJECT
Account Number	5010Q510695095
Bank Name & Branch	HDFC BANK LTD FARIDABD, SEC-9, HARYANASCF NO 222/223, SECTOR-09FARIDABAD, HARYANA-121001
IFSC/RTGS Code	HDFC0000619
Email address of PI	jitendra86969920@gmail.com
Email id of A/C Holder	aparna.ahq@mru.edu.in
Email address of concerned officer	dey.sukumar@serb.gov.in

8. As per rule 211 of GFR, the accounts of fellowship shall be open to inspection by sanctioning authority/audit whenever the institute is called upon to do so.

9. The institute will furnish to the SERB, New Delhi, Utilization certificate and an audited statement of accounts pertaining to the grant immediately after the end of each financial year i.e.31st March.

10. Date of start of the fellowship will be as per the joining date at the Host Institution.

11. The research personnel sanctioned in the fellowship , if any is co-terminus with the duration of the fellowship and SERB will have no liability to meet the fellowship etc, beyond the duration of the fellowship.

12. The sanctioned equipments would be procured as per GFR 2005 and its disposal would be done with prior approval of SERB.

13. The unspent balance ,if any, may be returned to SERB through DD in favor of "Fund for Science & Engineering Research" payable at New Delhi, within one month from the Date of completion of the project.

14. As this is the first grant being released for the fellowship, no previous U/C is required.

15. The organization/institute/university should ensure that the technical support/financial assistance provided to them by the Science & Engineering Research Board, a statutory body of the Department of Science & Technology (DST), Government of India should invariably be highlighted/ acknowledged in their media releases as well as in bold letters in the opening paragraphs of their Annual Report.

16. In addition, the investigator/host institute must also acknowledge the support provided to them in all publications, patents and any other output emanating out of the project/program funded by the Science & Engineering Research Board, a statutory body of Department of Science & Technology (DST), Government of India.

*Sukumar Dey*

(Dr. Sukumar Dey)  
Scientist C

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To,  
Under Secretary  
SERB, New Delhi

Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R. Building, IIIrd Floor I.P. Estate, Delhi-110002
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3.	File Copy
4.	Dr. J P SINGH Physics Manav Rachna University, Sector 43, aravalli hills, manav rachna campus rd, faridabad, haryana, Faridabad, Haryana-121004 Email: jitendra86969920@gmail.com Mobile: 919719127027  -Kindly send receipt of the grant by post.
5.	VICE CHANCELLOR, Manav Rachna University, Sector 43, Aravalli Hills, Manav Rachna Campus Rd, Faridabad, Haryana -For guidance ,terms and condition etc, please visit www.serb.gov.in and also intimate the start date by post.

*Sukumar Dey*

(Dr. Sukumar Dey)  
Scientist C

dey.sukumar@serb.gov.in



NIHARIKA THAKUR &lt;niharika@mru.edu.in&gt;

## Fwd: Proposal - The journey from the "Wastes to Resources" – An awareness campaign for Waste Management for Haryana

2 messages

Deepa Arora <deepa@mru.edu.in>  
To: NIHARIKA THAKUR <niharika@mru.edu.in>

Mon, Nov 4, 2024 at 2:41 PM



**Prof.(Dr.) Deepa Arora**  
Director - IQAC  
Professor, Department of Sciences  
School of Sciences  
[Manav Rachna University](#)  
Mobile No:9818470909

----- Forwarded message -----

From: **Meena Kapahi** <[meenakapahi@mru.edu.in](mailto:meenakapahi@mru.edu.in)>  
Date: Mon, Oct 21, 2024 at 4:25 PM  
Subject: Fwd: Proposal - The journey from the "Wastes to Resources" – An awareness campaign for Waste Management for Haryana  
To: Deepa Arora <[deepa@mru.edu.in](mailto:deepa@mru.edu.in)>

----- Forwarded message -----

From: **Meena Kapahi** <[meenakapahi@mru.edu.in](mailto:meenakapahi@mru.edu.in)>  
Date: Sun, Jan 16, 2022 at 3:03 AM  
Subject: Re: Proposal - The journey from the "Wastes to Resources" – An awareness campaign for Waste Management for Haryana  
To: <[jsnpg.mefcc@gov.in](mailto:jsnpg.mefcc@gov.in)>  
Cc: <[n.subrahmanyam@gov.in](mailto:n.subrahmanyam@gov.in)>, <[satyendra.kumar07@nic.in](mailto:satyendra.kumar07@nic.in)>

Respected sir

Greetings!

Kind ref. trailing email, please find attached herewith the Annexure 2\_Biodata of Prof. (Dr.) DS Sengar, hon'ble PVC MRU (Faculty Advisor for the Proposal). Kindly ignore the Annexure 2 appended in the previous email. Please accept my due apologies for the inconvenience caused.

Thanking you  
Best Regards  
Dr. Meena Kapahi

On Sun, Jan 16, 2022 at 2:21 AM Meena Kapahi <[meenakapahi@mru.edu.in](mailto:meenakapahi@mru.edu.in)> wrote:  
Respected Sir

Warm greetings from Manav Rachna University!

Please find attached herewith the proposal "**The journey from the "Wastes to Resources" – An awareness campaign for Waste Management for Haryana**" and the following attachments submitted under the scheme "**ORGANIZING AWARENESS PROGRAM WITH VARIOUS STAKEHOLDERS FOR IMPLEMENTATION OF VARIOUS WASTE AND CHEMICALS MANAGEMENT RULES**" for your kind consideration.

The objective of the project is to sensitize and engage the stakeholders in urban and rural settings regarding managing their wastes by implementing activities that are environmentally and socially sustainable and economically viable.

**Attachments:**

1. **Annexure 1**\_Outcome document
2. **Annexure 2**\_Prof. (Dr.) DS Sengar (Biodata)
3. **Annexure 3**\_Prof. (Dr.) Meena Kapahi (Short Profile)
4. **Annexure 4**\_Information Booklet on *Rebuilding relationship with the Butterflies*.

Please feel free to contact for any questions regarding the proposal. We thank you again for this opportunity and look forward to hearing from you soon.

--



Thanks and best regards

Dr. Meena Kapahi  
Professor, Department of Chemistry  
Chairperson - Office of International Affairs  
Coordinator - Accreditations & Ratings  
Manav Rachna University  
(formerly Manav Rachna College of Engineering, NAAC Accredited 'A' Grade Institution)  
Faridabad  
Mob. no. 9810101328

[www.mru.edu.in](http://www.mru.edu.in)

--



Best Regards

Dr. Meena Kapahi  
Professor, Department of Chemistry  
Chairperson - Office of International Affairs  
Coordinator - Accreditations & Ratings  
Manav Rachna University  
(formerly Manav Rachna College of Engineering, NAAC Accredited 'A' Grade Institution)  
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[www.mru.edu.in](http://www.mru.edu.in)

--  
Best Regards



Prof. (Dr.) Meena Kapahi  
Director International Relations  
Manav Rachna University  
Mobile No.: 9810101328

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**Annexure 2\_Prof. (Dr.) DS Sengar .pdf**  
145K

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**Deepa Arora** <deepa@mru.edu.in>  
To: NIHARIKA THAKUR <niharika@mru.edu.in>

Mon, Nov 4, 2024 at 3:03 PM

[Quoted text hidden]

[Quoted text hidden]

[Quoted text hidden]

Best Regards



Prof. (Dr.) Meena Kapahi  
Director International Relations  
Manav Rachna University  
Mobile No.: 9810101328

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#### 5 attachments

**APPLICATION FORM FOR FINANCIAL ASSISTANCE FOR PROJECT PROPOSAL FOR THE SUBSCHEME\_Final.pdf**  
1405K

**Annexure 2\_Prof. (Dr.) DS Sengar .pdf**  
227K

**Annexure 3\_Meena Kapahi \_Brief Profile .pdf**  
330K

**Annexure 4\_Rebuilding Relationship with the Butterflie\_V.8.pdf**  
2768K

**Annexure 1\_OUTCOMES Document .xlsx**  
12K



**APPLICATION FORM FOR FINANCIAL ASSISTANCE FOR PROJECT PROPOSAL FOR THE SUBSCHEME 2.1 TO 2.4**

**ORGANIZING AWARENESS PROGRAM WITH VARIOUS STAKEHOLDERS FOR IMPLEMENTATION OF VARIOUS WASTE AND CHEMICALS MANAGEMENT RULES.**

**1. Project Title:**

The journey from the “Wastes to Resources” – An awareness campaign for Waste Management for Haryana.

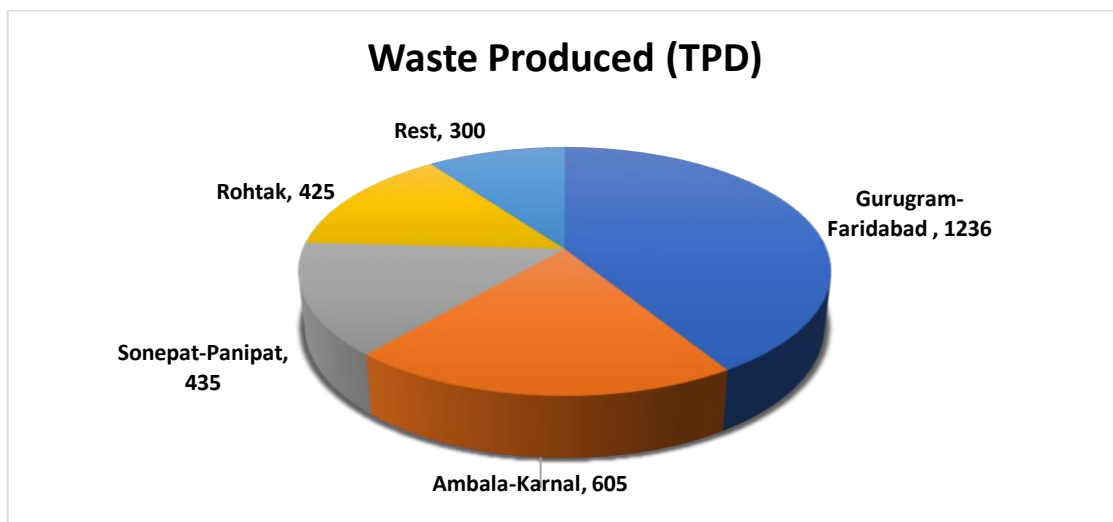
**2. Objective of the project:**

To sensitize and engage the stakeholders in urban and rural settings regarding managing their wastes by implementing activities that are environmentally and socially sustainable and economically viable.

**3. Project summary (maximum 500 words):**

**Background:**

The rapid population growth and urbanization, have led to the gigantic problem of Municipal Solid Waste Management (MSWM) in India leading to the issues related to the collection, treatment, and management of solid wastes. As reported by the Haryana State Pollution Control Board (HSPCB) (July 2019), only 17.5% of the total 4,635.79 tonnes of garbage generated is treated and recycled on daily basis. As per earlier reports, 78% of the waste ends up in landfills; 14.5% of the waste does not get collected. Of all the 14 clusters identified for solid waste management, Gurugram and Faridabad together top with 1,236 tonnes per day (TPD). There are 65 major dumpsites in the state with Bandhwari as the largest landfill receiving 1,200 TPD from Gurugram and Faridabad alone. However, almost none of the landfill sites in Haryana are monitored regularly for ground and water samples.



**Fig. 1: Cluster wise waste production (TPD)**

The unsegregated solid waste together with an unorganized informal sector of waste collection has aggravated the problem. Hence, the community plays an important role in the waste cycle: from extraction and processing of raw materials to the manufacturing of products to their disposal. Apart from a strong regulatory framework, appropriate technical support, and financing strategy, a vital component in the waste management system is community sensitization and participation.

**Community awareness**

- It aims to raise awareness among the community, NGOs, students, and waste collectors on the impacts of “Solid Waste and “Plastic Pollution” on the environment which shall percolate in the community mindset and be reflected in the behavioural change. Every citizen should fully realize his/her

responsibility in supporting the sustainable community and circular economy by suitably converting waste into resources.

- Towards the “Swachh Bharat Abhiyan”, the following SGDs shall be addressed:



### Community empowerment, entrepreneurship and circular economy

An effort shall be made to create a supply chain model to provide skill to economically weaker sections of the society to convert waste to resources for a circular economy leading to sustainable and resilient communities. Waste management offers a plenty of employment possibilities by providing training to make new items like bio enzymes, compost, shopping bags, paper recycling and craft items.

### Climate change and environment

The project promotes **environmentally sound waste disposal** through avoiding single use plastic, waste reduction, and avoiding waste disposal in waterbodies.

### Health and safety

The project **improves public health by reducing mismanagement practices**.

### Social inclusion – waste collectors/recyclers

The informal sector, involved in collecting, sorting, and recycling wastes, plays a crucial role in waste management. The project addresses **its livelihood and conditions through measures like training them to maximize their profits and the provision of safe working conditions and child labor restrictions**. Lesser waste produced in the environment shall help in improving environmental and health conditions.

### Target groups:

Community members, house wives, students, teachers, waste cluster units, fruit and vegetable markets, NGOs, waste collectors, community heads and city authorities in urban and rural areas.

### Movers and shakers:

Students, staff, experts, **tie ups with NGOs**

To execute the programmes, students shall be involved and trained with the necessary skills.

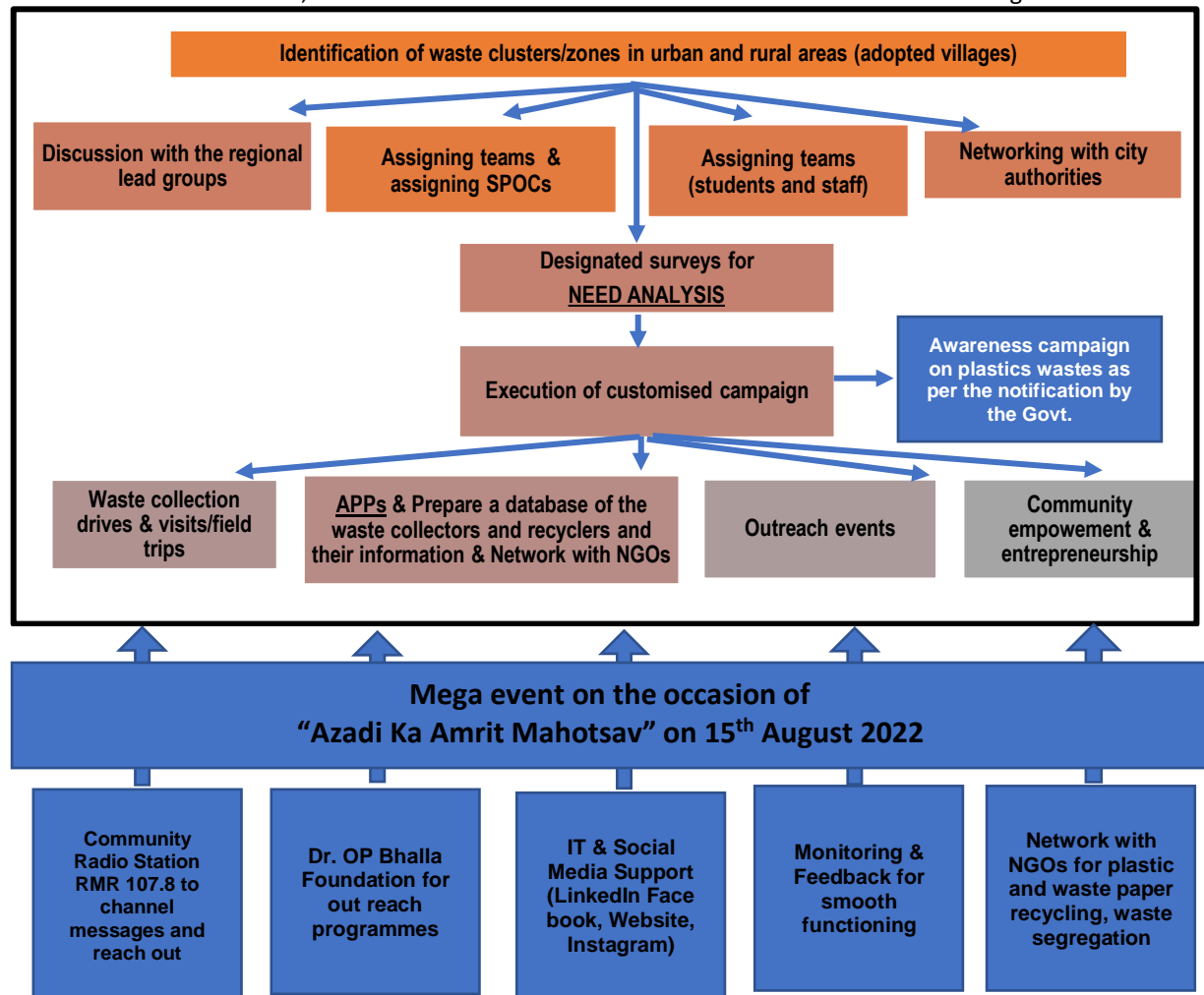
## 4. Work plan:

### 1. Methodology

Managing waste appropriately is vital for sustainable and liveable regions, but it remains a challenge that requires an efficient and sustainable, and socially supported system. The waste produced should be counted as a valuable resource for the whole community and the natural environment.

The entire area (Faridabad) shall be divided into zones and the campaign shall be backed by the teams of human resources – experts, staff, and students dedicated for each zone. Each zone shall be assigned a coordinator or single point of contact (SPOC). For need analysis, the surveys shall be conducted to identify the quantity and nature of wastes produced, social, cultural background, and skillsets of the community/stakeholders. A database shall be maintained for each zone for the community, type of waste clusters, recyclers, NGOs, end-use of wastes. This shall help in customizing the campaign for better communication and effective results.

For the awareness material, e-versions shall also be made available to take care of the COVID guidelines.



MRU has adopted initiatives regarding sustainable development and environmental protection in collaboration with the following agencies:

- **Radio Manav Rachna (RMR 107.8; <https://manavrachna.edu.in/radio-manav-rachna-107-8-fm/>)**, the community radio station, is a 24X7 first and only radio station Community Radio Station powered by 'Manav Rachna Vidyanatariksha' and is dedicated to the community on social issues like Sanitation, Women Empowerment, Drug addiction, Anti-smoking, Water Conservation, Blood donation, Education. RMR, being our broadcast partner, shall play a key role in spreading awareness.
- **Dr. OP Bhalla Foundation (registered trust under section 12-A; <http://dropbhallafoundation.org>)**, an independent trust, working tirelessly and undertakes developmental activities, research, and training in various fields, such as education, sustainable development, waste management, gender equality, health, and wellbeing. The campaign is backed by the foundation during different stages. The foundation and university have initiated various programs on creating awareness and implementation of solid waste management not only within the campus of MRIU but also for Faridabad city;

sensitization of students and staff towards waste management and setting up of dustbins for waste segregation and collection and Sensitization of housekeeping staff towards waste management.

- **MRU has adopted 5 villages under the Unnat Bharat Abhiyaan**; various activities for the development of these villages are being conducted especially in the field of education and environmental protection. The campaign shall target these villages (community heads & members, teachers and students at schools). The villages are:
  - Chhainsa
  - Gadh kheda
  - Atali
  - Dayalpur
  - Mothuka

### **Campaign methods and tools**

An effective campaign must be flexible and involve several tools – means of communication as per the requirements of the target group.

- **Public and outreach events**
  - **Training/workshops/nukkad nataks/roadshows**, etc. involving awareness-raising lead to multiple positive impacts. They help in shaping an environmental consciousness mindset and in building an understanding of the positive impacts of sustainable management practices. The activities shall be organized to involve children and youth by organizing competitions in govt. and private schools.
  - **Nukkad natak/Road shows** on creating awareness about plastic waste pollution & Govt. notifications regarding the prohibition of items like **ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol]** for decoration, etc.
  - **Workshops** (Manage kitchen waste sustainably) –
    1. Biogas out of waste
    2. Bioenzyme
    3. Composting
    4. Grow food out of food scrap (left over fruit and vegetable waste)
    5. **Workshop** on oyster mushroom cultivation
  - **Competitions** shall be an integral part of the campaigns - in schools and community like best of waste, cleanest neighbourhood, etc. to motivate the public.
    1. Best out of waste
    2. Clean neighbourhood competition
    3. Slogan writing
    4. Drawing competition

**Nukkad natak/road shows** on plastic waste pollution

#### **Trainings**

1. Waste cloth utilisation
- **Awareness lectures**
  - **During cultural celebrations**, waste separation at the source should be encouraged by placing bins to separate the waste, so that messages are put into practice.
  - **City authorities** can also join other regular celebrations and take advantage to deliver the key campaign messages.
- **Awareness campaign on “Curb Plastic Pollution” through nukkad nataks/road shows & Designated Posters**
  - **Mega Event on the occasion of “Azadi Ka Amrit Mahotsav” on 15<sup>th</sup> August 2022**
    - **Release** of the **“Own your Waste”** Calendar 2023 (print and e-versions) consisting of solid waste management techniques and slogans

- **Launch of the information booklet on “Wastes to Resources”** - how to manage kitchen waste sustainably (print and e-versions) & **Curb Plastic Pollution” Posters distribution**
- Prize distribution to all the winners
- Stakeholders meet
- **Awareness tool kits – knowledge creation**
  - The awareness tool kits including the print material shall be tailored to each target group to enhance awareness about waste reduction, reuse, recycling, and resource recovery.
  - The awareness material shall be shared with all the target groups.
  - E-copies of the toolkit shall be made including Information **booklets and calendar 2023**
  - Designated posters on **plastic waste pollution** as per the Govt. notifications.
    1. To be prohibited from 1st July 2022 (as per Ministry of Environment, Forest and Climate Change Notification; 12th August, 2021):
      - ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;
      - plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.
    2. Urging and encouraging Producer (P), Importer (I), Brand owner (BO) and Plastic Waste Processor to register with CPCB.
    3. Plastic Waste Management (Second Amendment) Rules, 2021 regarding the usage of carry bags made of recycled plastics for the food stuffs.
- **APPs**
  - StopWasteApp – locate the waste concentration points in the city lists the location and information of the recyclers for the appropriate management and
  - FoodApp – avoid food waste – a collection of extra food from the marriages and parties to the needy ones
- **Internet**

The dedicated social media accounts shall channel the information and post key messages, activities, initiatives, events, and competitions on a daily or weekly basis.

  - <https://www.facebook.com/MRUFaridabad>
  - <https://manavrachna.edu.in/university/>
  - <https://www.linkedin.com/school/mrufaridabad>
  - [https://instagram.com/manav\\_rachna?utm\\_medium=copy link](https://instagram.com/manav_rachna?utm_medium=copy_link)
- **Broadcasting media** – Radio Manav Rachna 107.8 (RMR 107.8; <https://manavrachna.edu.in/radio-manav-rachna-107-8-fm/>). To channel the key messages and increase awareness on sustainable resources and waste management. The extent of coverage is urban, rural and semi-rural areas within 25 km range. The awareness programmes consists of the following:
  - >>RJ mention & promos - hourly/daily
  - >>Talk show/series on solid waste - 01/week
- It shall be shared on all the social media handles of RMR 107.8
  - <https://www.facebook.com/rmr107.8fm/>
  - [https://instagram.com/radiomanavrachna?utm\\_medium=copy link](https://instagram.com/radiomanavrachna?utm_medium=copy_link)
  - <https://www.youtube.com/channel/UCfQZV-O6l3DAoqQqA53lPCQ>
- **School activities (Govt. and Private)**

Activities shall be organized at schools in both rural and urban areas.

  - Faculty trainings & awareness & students awareness
- **Community empowerment and entrepreneurship**
  - Training for the economically weaker sections
  - Creative workshops for the faculty empowerment to make new items utilizing waste materials, organizing competitions on waste reduction in each class, establishing a composting area; constructing benches/shelters with plastic bottles filled with other waste or sand, etc.

- **Visit to waste treatment plant**
  - Visits to waste treatment plants can be very effective in gaining practical knowledge on sound waste management practices.
- **Waste collection drives**
  - The drives shall be conducted involving the teams and the target groups.
- **Regular monitoring and feedback from** the stakeholders to ensure the smooth conduction of the campaign
- **Bottom-up approach** by holding discussions with the lead groups of the area regarding the mindset, waste issues, and expertise enabling the citizens to be part of the solutions.

## 2. Organization of work elements

### Stage 0 – Pre-preparation phase

Inviting nominations from the students, faculties and contacting experts to be a part of the project. After receiving the nominations, the student and faculty members are divided into the following teams:

Team	Role	Approx. No. (students)
Faculty Incharge	Prof. (Dr. Meena Kapahi)	--
Advisor	Prof. (Dr.) D.S. Sengar, Pro VC-MRU	--
Faculty Core Committee	Dr. Deepa Arora Mr. Piyush Mahendru Dr. Yogita Sharma Dr. Chaitali Wadhwa Dr. Ritu Sharma	--
Design & Development	Design the print material for creating awareness	5
Survey & Feedback for Need Analysis	Design the surveys and feedbacks	5
Technical	<ul style="list-style-type: none"> <li>• Develop Apps</li> <li>• Social media handles to build a social media presence</li> </ul>	5
Finance	<ul style="list-style-type: none"> <li>• Prepare the budget</li> <li>• Track the expenditure for audit</li> </ul>	3
Planning and Coordination	<ul style="list-style-type: none"> <li>• Coordinate between different stake holders</li> <li>• Contact the experts and prepare the schedules</li> <li>• Monitor the progress of the project regularly</li> <li>• Coordinate with the area coordinators</li> <li>• Content writing</li> </ul>	12
Execution & Implementation	<ul style="list-style-type: none"> <li>• Create awareness on social media platforms</li> <li>• Distribution of print material</li> <li>• Execute the entire programme</li> </ul>	10
Cultural	Perform nukkad natak/roadshows & outreach events	10

### Stage I – Preparation Phase

#### a) **Prepare and conduct extensive surveys to**

- a. Identify & characterize the wastes clusters and establish their appropriate end-use supply chain like flower waste from temples & fruits and vegetable waste for composting and bio enzymes; coconut water sellers – biodegradable planters, composting; agro-wastes – oyster mushrooms
- b. Identify the low-income groups for their knowledge and skills
- c. Assess background awareness levels on the solid waste and their potential health effects (community including waste collectors)
- d. Prepare a database of the waste collectors, recyclers and NGOs and their information

#### b) **Design and develop awareness toolkit** including print material like booklets, leaflets and posters and online resources for easy and long-term access

#### c) **Develop the feedback mechanism** (volunteers and the target groups)

- d) **Develop Apps** by engaging the student community to identify the open dumping sites and waste concentration clusters in the areas and to develop linkages with the concerned offices, waste collectors, NGOs and recyclers for timely action for a cleaner and healthier environment
- e) **Discussions with the lead groups** of the area regarding the mindset, waste issues and expertise enabling the citizens to be part of the solutions
- f) **Training and capacity building** of the involved members if required
- g) **Waste collection drives** involving the community and volunteers (staff and student)

**Stage II – Execution Phase**

- h) **Conduct awareness drives** to stimulate the community change (including waste collectors) by creating awareness on waste reduction and segregation at source, its reuse, and the resulting benefits.
  - o Conduct regular follow-ups thereafter for the sustenance of the system
  - o Distribution of the awareness toolkit
  - o Sharing the information online
  - o To value and recognize the work of waste pickers in recovering recyclable materials and to improve their working conditions
- i) **Develop links with the recyclers** (e.g. - household wastes - empty milk packets and polyethylene to the recyclers)
- j) **Organize trainings, workshops, lectures, competitions and encourage start-ups**

Trainings/Workshops/ Competitions on	Wastes Targeted	Target Groups
Composting, liquid fertilizer	<ul style="list-style-type: none"> <li>• Household - kitchen food waste, plant trimmings, vegetable and fruit peels</li> <li>• Temples - flower waste</li> <li>• Coconut waste</li> <li>• Plastic bottles/containers</li> </ul>	Households, schools and universities, corporates, farmers, waste collectors, fruits and vegetable markets
Bioenzymes		Households, schools and universities, corporate firms
Best out of waste competitions and activities	<ul style="list-style-type: none"> <li>• Domestic wastes like egg trays, metallic and plastic containers</li> </ul>	Schools and universities
Gardening/Vegetative Propagation	<ul style="list-style-type: none"> <li>• Trimmings, vegetable and fruit wastes, seeds to grow plants</li> </ul>	Households, schools and universities, corporate firms
Oyster Mushroom Cultivation	<ul style="list-style-type: none"> <li>• Agro-waste like wheat and rice husk, plastic containers <b>shall target the air pollution problem by utilizing the wheat husk instead of burning</b></li> </ul>	Farmers, community
Shopping bags, rugs	Waste cloths	Households, low income groups, domestic helps
<b>Others (e.g. orange/lemon peel powder)</b>	Citrus fruits peels <b>Polythene and milk packets can be sent to recyclers and reduce the clogging of drains</b>	Households, schools and universities, corporates, farmers

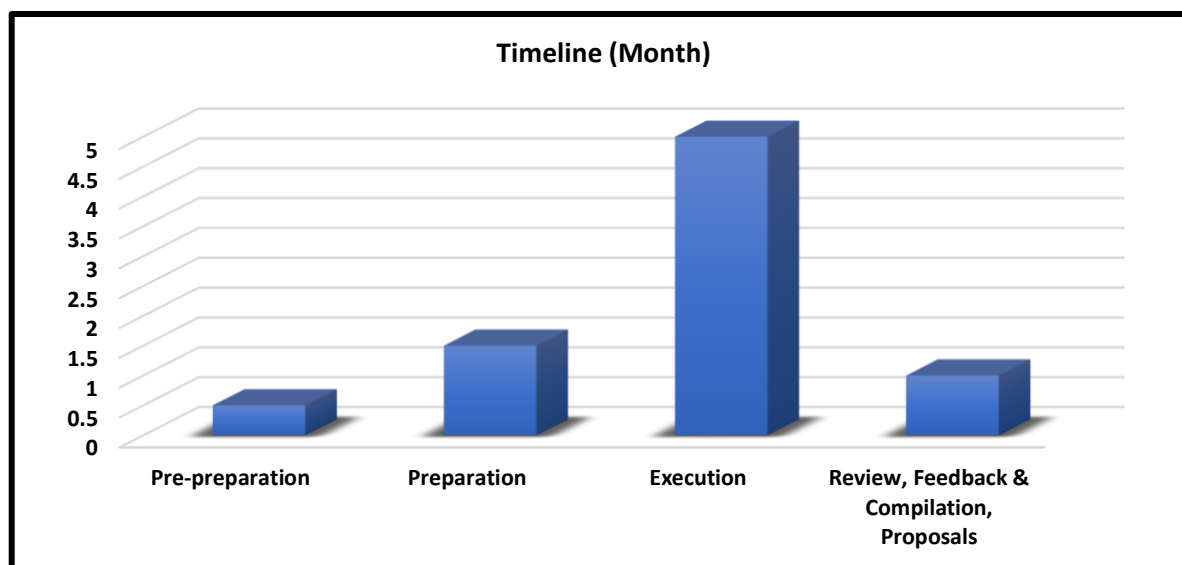
**Stage III – Review, Feedback & Compilation**

- k) **Obtain the feedback** from the stakeholders (volunteers and the target groups) on a regular basis for the smooth conduct and success of the programme
- l) **Present the case study** – on the successful implementation of the programme, the case study shall be compiled and shared at various platforms; survey results (before and after the project) shall be communicated with the researchers community through journal publications/conferences
- m) After the successful completion of trainings under the guidance of E cell, **the proposals for start ups - cloth bags/craft items/stationery items utilising waste cloth and paper, etc. shall be submitted to NewGen IDC for funds.**

**3. Time schedule of activities giving milestones (also append to bar diagram)**

Phase	Timeline (month)	Milestone Achieved
Pre-preparation	0.5	Expert and teams finalization

Preparation	1.5	Design and develop awareness Tool kit, Apps, survey and feedback forms
Execution	5	Awareness drives, trainings and workshops, nukkad natak, establishing sully chains involving waste utilization
Review, Feedback & Compilation, Proposals	1	Obtain feedback and compile the entire data, proposals for start ups



**4. Suggested plan of action for utilization of outcome expected from the project**

- **Present the case study** – on the successful implementation of the programme, the case study shall be compiled and shared at various platforms.
- **Proposal submission for Start-ups to MR NewGen IDC**

S. No.	Event	Outcome		
		Areas covered & No. of Stakeholders impacted	Stakeholders	Event objective
1	Surveys & discussion with Community heads & MCF (Need Analysis)	<b>Urban (Faridabad city)</b> <ul style="list-style-type: none"> <li>• Old Faridabad</li> <li>• NIT 1–5 areas</li> <li>• Fruit &amp; vegetable markets</li> </ul> <b>Rural</b> <ul style="list-style-type: none"> <li>• <b>Chhainsa</b> (Families: 2483; population: 14216)</li> <li>• <b>Garh khera</b> (Families: 717; population: 3878)</li> <li>• <b>Atali</b> (Families: 3041; population: 6640)</li> <li>• <b>Dayalpur</b> (Families: 1368; population: 7350)</li> <li>• <b>Mothuka</b> (Families: 145; population: 712)</li> </ul>	>>Community heads >>Faculty >>Students >>General public >> Waste collectors >> Waste recyclers >>NGOs of the area >>MCF officials	>> <b>Customise the awareness campaign</b> >>Identification of waste clusters >>Characterisation of wastes - nature/type & quantity of wastes; waste produced in the kitchen >>To compile a data base of the best practices >> Socio-cultural background & skillsets of people >>Faculty/teachers Interactions for trainings >> Prepare a database of recyclers, NGOs of the area to establish an effective link/supply chain

**\*Outcomes document attached (as Annexure 1)**



### 5. Budget Estimates: Summary

	Item	Budget			(in Rupees)
		1st Year	2nd Year	3rd Year	.Total
<b>A.</b>	Recurring				
	1.Salaries/wages	--			
	2. Consumables	8,00,000/-			
	3. Travel	1,00,000/-			
	.4. Other costs	9,00,000/-			
<b>B.</b>	Equipment	2,00,000/-			
	Grand Total (A+B)	20,00,000/-			

### b. Budget for Salaries/Wages

Designation & Number of Persons	Monthly Emoluments	.Budget			(in Rupees)
		1st Year	2nd Year	3rd Year	Total
----	----	---			
----	----	---			
<b>Total</b>	NIL	---			

Justification for the manpower requirement: NA

### b. Budget for Consumable Materials

Item	Budget			(in Rupees)
	1st Year	2nd Year	3rd Year	.Total
Refreshment	2,00,000/-			
Prizes	2,00,000/-			
Print material	4,00,000/-			
Total	8,00,000/-			

Justification for costly consumable:

- Refreshments and prizes are required for the participants, experts, and volunteers during public outreach events and mega event during Azadi Ka Amrit Mahotsav (15th August).
- Print materials include leaflets, brochures, creatives, posters, the information booklet, calendar 2023 and certificates shall be distributed across the city and the adopted villages during multiple events and mega event during Azadi Ka Amrit Mahotsav (15th August).
- Miscellaneous expenditures are the expenditure incurred during procurement of raw materials are for conducting trainings, workshops (Oyster mushroom cultivation), etc.

### c. Budget for Travel

	Budget			(in Rupees)
	1st Year	2nd Year	3rd Year	.Total
Travel (Only Inland Travel)	1,00,000/-			
Total	1,00,000/-			

Justification for intensive travel, if any: Travel to the desired locations like identified waste clusters; visit to the waste treatment plants, progress meetings and interactions with coordinators

### d. Budget for Other Costs/Contingencies

Sl. No.	Other Costs/Contingencies Costs	Budget			(in Rupees)
		1st Year	2nd Year	3rd Year	.Total
1	APPs, advertising, social media & IT support	1,00,000/-			

2	Experts lectures & workshops	1,00,000/-			
3	Coordinators (villages)	3,00,000/-			
4	Student incentives	2,00,000/-			
5	Waste collection drives	2,00,000/-			
	Total	9,00,000/-			

Justification for specific costs under other costs, if any:

#### e. Budget for Equipment

SI. No.	Generic Name of the Equipment along with the Make and Model	Imported/Indigenous	Estimated Costs	Spare time for other users (in %)
1	Biotech India Nano Bio Gas Plant	Indigenous	35,000/-*2 = 70,000/-	The equipments shall be used for conducting demonstrations, trainings on a regular basis inhouse and for others.
2	R U Reducing recycling RGGC-XS Green Gold Aerobic Home Composter	Indigenous	20,000/-*2 = 40,000/-	
3	Sewing machines Anand manual Sewing machines	Indigenous	5000/-*10 = 50,000/-	
4	MYSA Spintech Polyethylene Portable Twin Drum Composter	Indigenous	40,000/-	
	<b>Total</b>		2,00,000/-	

Justification for the proposed equipment: .

The targeted wastes:

- **Biogas plant:** For training on biogas production for domestic and community usage; fruits and vegetable wastes from fruit markets shall be targeted for biogas production
- **Composters:** For workshop on compost production for domestic and community usage; fruits and vegetable wastes from fruit markets shall be targeted
- **Sewing machines:** Trainings for economically weaker sections for cloth bags and other useful items

8. List of facilities being extended by parent institution(s) for the project implementation. a. Infrastructural Facilities:

Sr. No.	Infrastructural Facility	Yes/No/ Not required Full or sharing basis
1.	Workshop Facility	Yes
2.	Water & Electricity	Yes
3.	Laboratory Space/Furniture	Yes
4.	Power Generator	Yes
5.	AC Room or AC	Yes
6.	Telecommunication Including E-mail & fax	Yes
7.	Transportation	Yes
8.	Administrative/Secretarial support	Yes
9.	Information Facilities like Internet/Library	Yes
10.	Computational Facilities	Yes
11.	Any other special facility being provided	Bio composter and waste water treatment plant at MR campus

	Auditorium to invite the target groups for various waste sensitisation events
--	---

b. Equipment available with the Institute/Group/Department/Other Institutes for the project:

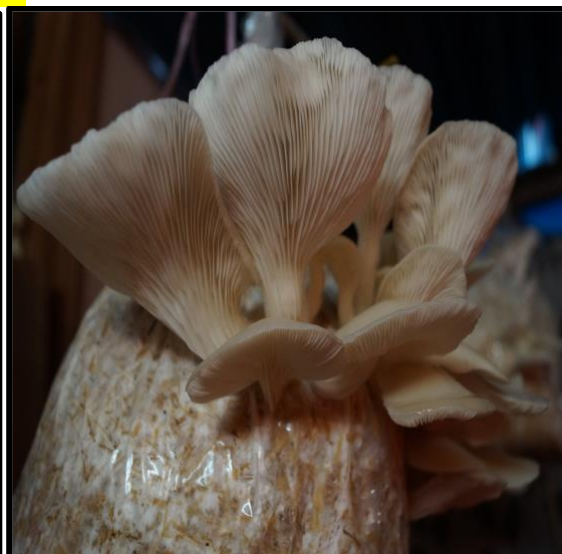
Equipment available with	Generic Name of Equipment	Model, Make & Year of Purchase	Remarks including Accessories Available and Current usage of Equipment
PI & his group	--	--	--
PI's Department	--	--	
Other Inst In the region	--		--

9. Detailed Bio-data of the Investigator(s)/Co-Investigator(s) including - -

	Investigator Name
Name	Prof. (Dr.) Meena Kapahi
Date of Birth	23 June 1975
Institution Address	Manav Rachna University, Manav Rachna Campus Address:- Sector – 43, Delhi–Surajkund Road, Faridabad – 121004, Haryana, India
Academic Qualification	B.Sc., M.Sc. (Environmental Science), M.Tech. (Environmental Science & Engineering) from Guru Jambheshwar University of Science & Technology (Hisar, Haryana), Ph.D. (Department of Biotechnology, Manav Rachna International Institute of Research and Studies, Faridabad, Haryana)
Biodata	Attached

10. Any other relevant matter.

- Dr. Meena Kapahi has designed a course on Environment and Sustainable Development which is being offered to the students as open elective.
- Dr. Kapahi has conducted workshops on “Waste to Taste” **proposing sustainable solution – oyster mushroom farming to tackle the agro-waste (rice/wheat husk) which is ultimately burned and leads to air pollution menace in Delhi-NCR.**




- Dr. Kapahi has guided university and international students:



UG students from Lahti University of Applied Sciences, Finland (Sept 2016 – Jan 2017) for their industrial training cum project (5-month duration) **which included development and user testing of low cost and micro composting tumbler for organic waste management (which was donated to the village) and Concept testing of a Dry toilet for individual households.**

- PG student from McMaster University, Canada (May – June 2018) for the Field Practicum, and on the issues **related to personal, dental and menstrual hygiene among the rural females of India.**
- B.Sc. and M.Sc. students on solid waste management, food adulteration and bioremediation of wastewater.
- Dr. Kapahi has **filed/published patents**
  - S.W. Rose Bins - Eco-friendly dustbin to collect and treat menstrual/sanitary waste in a hygienic and efficient manner (application no. 201711035100); published)
  - Multipurpose medicated and biodegradable absorbent material/pad related to the multipurpose, biodegradable and medicated absorbent material meant to retain body fluids in a hygienic way (Patent date Jan 2019 (application no. 201811049912); published.)
  - DESIGN APPLICATION - Low cost composting tumbler to take care of the biodegradable waste - Horizontal Aerobic & Biodegradable Composting Tumbler (application no. 317375-001).
  - Recently filed a provisional patent application “TeaTest” to test the adulteration in tea/coffee.


- Have guided students' participation in various international and national competitions on solid waste management




Proposal for **Land Use: Agriculture, Forestry, Waste Management 2018**

**From agro-wastes to a sustainable income**


**3 members**





Akanksha Ahuja



Meena Kapahi



B.m Bahal

**Semi-Finalist Evaluation**

**Judges' ratings** ⓘ

- *Novelty:* ★★★★★
- *Feasibility:* ★★★★★
- *Impact:* ★★★★★
- *Presentation:* ★★★★★


**Judges' comments**




The proposal is well thought out and we appreciate that you've considered the logistical aspects of the project as well as the cultural and economic aspects. We also believe that the proposal is replicable if successful and could create widespread change in current practices. We are pleased to advance this proposal to the next stage with the following comments:

Bioconversion is generally a good idea, if it can be carried out efficiently. During the next round it would be good to identify a specific village to show that it is really feasible - including what are the actual costs and timeline for such a project.

The GHG emissions reductions should also be clarified.

<https://www.climatecolab.org/contests/2017/land-use-agriculture-forestry-waste-management/c/proposal/1334158>



## New Zealand-India Sustainability Challenge

**Certificate of Participation**

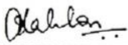
presented to

MEENA KAPAH


of

MANAV RACHNA UNIVERSITY, HARYANA

for participating at the Regional Round  
held on 31 August and 1 September in New Delhi

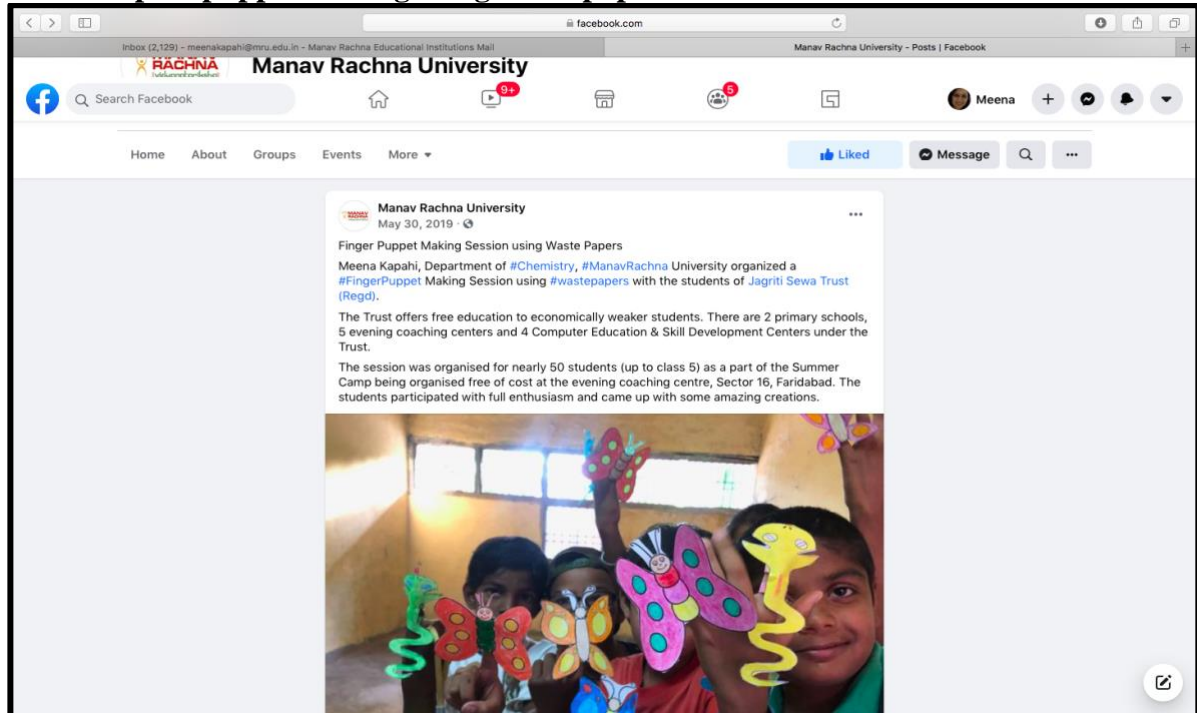


**Livleen K Kahlon**  
The Energy and Resources Institute



**Jugnu Roy**  
Education New Zealand

## Workshop on puppet making using waste papers



## Workshop on “Grow food out of food scrap”



## Workshop on “Bioenzymes”



### Bioenzyme

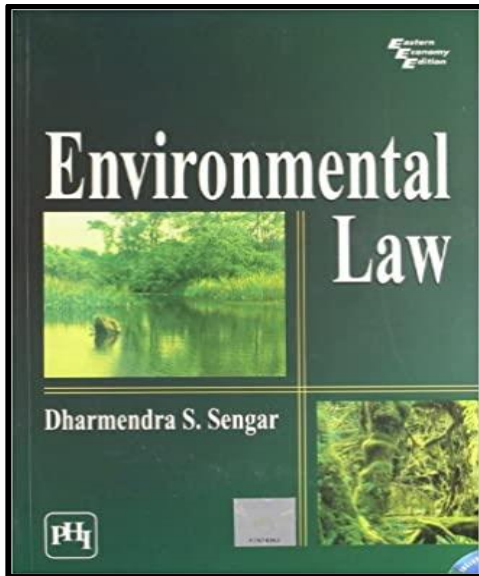
Cleans and disinfects all surfaces in the house.

Very effective in removing limescale on taps and other steel appliances (can be used directly)

Removes pesticides and harmful chemicals from fruit and vegetables

Acts a natural pesticide and herbicide (spray diluted solution on plants)

Acts as an excellent fertilizer for plants and enriches the soil naturally



Environmental Law by Prof. (Dr.) DS Sengar



*Rebuilding Relationship with the Butterflies* is an information booklet on promoting growing plants (commonly found) that act as host and nectar plants for butterflies.

Meena Kapahi  
(Signature of the Applicant)

**Attachments:**

1. **Annexure 1**\_Outcome document
2. **Annexure 2**\_Prof. (Dr.) DS Sengar Biodata
3. **Annexure 3**\_Prof. (Dr.) Meena Kapahi Short Profile
4. **Annexure 4**\_Information Booklet on *Rebuilding relationship with the Butterflies*

**File No. 07/1/2022-HSMD**  
Government of India  
Ministry of Environment, Forest and Climate Change  
HSM Division

\*\*\*

Vayu Block, Level-III  
Indira Paryavaran Bhawan  
Jor Bagh Road, New Delhi-110 003

**Dated: 30<sup>th</sup> March, 2022**

To,

The Pay and Accounts Officer,  
Ministry of Environment, Forest and Climate Change,  
Jorbagh Road, New Delhi-110003.

**Sub: Central Financial Assistance for conducting awareness programme – “Waste to Resources” on environmentally sound management of wastes to sensitize and engage the stakeholders in urban and rural settings of Haryana (Faridabad and surrounding areas) by Manav Rachna University under the scheme “Creation of Management Structure for Hazardous Substances”.**

Sir,

This has reference to the project proposal forwarded by Manav Rachna University vide letter dated 21<sup>st</sup> February, 2022 for conducting awareness programme - “Waste to Resources” on environmentally sound management of wastes to sensitize and engage the stakeholders in urban and rural settings of Haryana (Faridabad and surrounding areas) under the scheme “Creation of Management Structure for Hazardous Substances” for year 2012-2017.

2. In this regard, I am directed to convey the sanction of the President for an amount of Rs.10 lakhs for a period of one year for conducting awareness programme – “Waste to Resources” on environmentally sound management of wastes to sensitize and engage the stakeholders in urban and rural settings of Haryana (Faridabad and surrounding areas) under the scheme “Creation of Management Structure for Hazardous Substances” for year 2012-2017. The undersigned is also directed to convey the sanction of the President for release of first instalment of Rs. 4.00 lakhs (Rupees four lakhs only) Manav Rachna University out of total sanctioned amount of Rs. 10 lakhs.

*N. Subrahanyam*



3. The Central financial assistance will be released in 3 instalments to **Manav Rachna University** in the following pattern:

- 1<sup>st</sup> instalment: Rs.4 lakh (40%) – along with sanction order.
- 2<sup>nd</sup> instalment: Rs.4 lakh (40%) – after completion of 50% work as provided in the scope interms of coverage of Faridabad Urban and 2 rural areas of Hayana along with UC.
- 3<sup>rd</sup> instalment: Rs.2 lakh (20%) – after completion of 100% work as per the scope of project proposal along with UCs/ES.

4. The Grant -in-aid General will be regulated in accordance with the provisions contained in chapter 9 of the General Financial Rules, 2017 as amended from time-to-time, read with the Government of India's decisions incorporated below:

- a. The content of the training modules and progress shall be uploaded at Ministry's website.
- b. The project shall provide indicators on outcomes and output along with number of persons benefited and geographical extent.
- c. It shall identify indicators to monitor the effectiveness and results of implementation which should be submitted along with completion report.
- d. The patterns of Assistance of rules governing such Grants-in-aid (General) have received the approval of the Ministry of Finance, as required under Government of India Decision No. 1 under DFPR-Rules 20.
- e. The accounts of Manav Rachna University shall be open for inspection by the sanctioning authority and audit both by the Comptroller & Auditor General of India under the provision of C&AG (DPC) Act, 1971 and internal audit party by the Principal Accounts Officer of the Ministry or Department, whenever it is called upon to do so.
- f. Manav Rachna University may furnish their performance -cum-achievement report to the sanctioning authority.
- g. Manav Rachna University will spend amount exclusively for the purpose for which it has been sanctioned.
- h. Manav Rachna University will submit the audited utilization certificate, Expenditure Statement for the unspent balance and the amount being released.
- i. Grants-in-Aid shall be utilized before the end of the current financial year and unspent balance, if any, will be refunded to the Govt. of India or will be carry over to next year.
- j. Manav Rachna University would maintain a separate register and accounts for the sub-programme to facilitate proper audit.
- k. Manav Rachna University will maintain and will present their annual accounts in the standard format as required under GFR 209 (xiii).
- l. Payments towards wages/remuneration as well as other contractual obligations will made through bank accounts of recipients

*N. Subrahmanyam*

- m. Evidence of deposit of TDS/ Service Tax in case of contract payments and CST in case of purchase of leviable goods.
- n. The fixed assets created out of this grant shall not be disposed off without concurrence of this Ministry. The equipment should be purchased as per GFR norms.
- o. A separate bank account shall be opened for the purpose and the account shall be open for audit by C&AG.
- p. Copy of purchase of permanent equipment may be furnished.
- q. All measurable parameters are to be adhered to.

5. The Drawing and Disbursing Officer, Ministry of Environment, Forest and Climate Change is hereby authorized to prepare and submit the bill for **Rs.4,00,000/- (Rupees Four Lakhs Only) i.e. first instalment** to Pay & Accounts Officer, Ministry of Environment, Forest and Climate Change to make payment electronically i.e. through CBS/RTGS to Manav Rachna University through PFMS, whose details are given below:

<b>Saving Account Number</b>	50100510695095
<b>Name of the Bank &amp; Branch</b>	HDFC Limited, Faridabad, Haryana
<b>Beneficiary's Name</b>	Manav Rachna University Project
<b>IFSC Code</b>	HDFC0000619
<b>MICR Code</b>	110240107

6. It is certified that this is the first release under the project and no earlier Utilization Certificate is pending against Manav Rachna University for this project.

7. The amount of Rs. 4,00,000/- (Rupees Four Lakh only) will be debit to Budget Head 3435.03.104.12.05.31 Grants-in-aid (General) under Demand No. 27 of the Ministry of Environment Forest and Climate Change during the current Financial Year 2021-22 (Plan).

8. It has been mentioned at Sl. No. \_\_\_ in the Expenditure Register under Major Head 3435.03.104.12.05.31- Grant-in-Aid General.

9. This issues with the approval of the Competent Authority and with concurrence of the JS&FA (IFD) vide their Dy. No. E- 176560 # 12 dated 29.03.2022.

Yours faithfully,

*N. Subrahmanyam*  
30/03/22  
(N. Subrahmanyam)  
Scientist D

Copy to:-

1. Cash Section (2 copies), MoEF&CC

2. Dr. Deepali Sinha Khatriwal, Co-founder and Director, M/s Inclusive Recycling Foundation, C-26, Meerut Road Industrial Estate, Ghaziabad, Uttar Pradesh, PIN- 201003
3. The Director of Audit, CW&M-II, AGCR Building, New Delhi 110002
4. IFD, MoEF&CC
5. B&A Division, MoEF&CC
6. PPS to AS(NPG)
7. Guard File/Sanction Folder/Budget File.

*N. Subrahmanyam*  
30/03/2022

(N. Subrahmanyam)  
Scientist D

**Certificate from the Project Investigator  
(PI)**

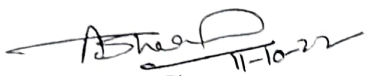
**Project Title:**

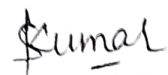
**"Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity".**

1. We agree to abide by the terms and conditions of the Council grant.
2. We have not submitted this or a similar project proposal elsewhere for financial support.
3. We have explored and ensured that equipment and basic facilities will actually be available as and when required for the purpose of the project.
4. We shall not request financial support under this project, for procurement of these items.
5. We undertake that spare time on permanent equipment will be made available to other users.
6. Certified that there is no duplication/plagiarism in the above research project.
7. Relation to Haryana: **Employee (Assistant Professor in Manav Rachna University, Faridabad, Haryana)**.....(please see Sr. No. 4(ii) of guidelines)
8. Duration spent in Haryana: **08 years (Co-PI) and 04 years (P.I.)** (Elaborate period and attach proof in support if working in the institution situated outside Haryana). **Endorsement Letter is attached.**
9. We have uploaded the following materials:

Sr. No.	Items	Numbers of Copies
(A)	Endorsement from the Head of the Institution (on letter head)	One
(B)	Details of the Proposals from the part 1 to 6 (attached)	One
(C)	Proof of relation to Haryana if working in the institution situated outside Haryana	

Date: 11.10.2022  
Place: Faridabad

  
Dr. Aditya Sharma  
Principal Investigator

  
Dr. Shiv Kumar Dixit  
Co-Principal Investigator





**Endorsement from the Head of Institution**


Project Title: - **"Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity"**

1. Certified that the institute welcomes participation of **Dr. Aditya Sharma** (Assistant Professor, Department of Physics) as the Principal Investigator and **Dr. Shiv Kumar Dixit** (Assistant Professor, Department of Physics) as the Co-Investigator for the project and that in unforeseen event of discontinuance by the Principal Investigator, the Co-Investigator will assume the responsibility of the fruitful completion of the project (with the intimation to council).
2. Certified that the equipment, other basic facilities and such other administrative facilities as per terms and conditions of the grant, will be extended to investigator(s) throughout the duration of the project.
3. Certified that there is no duplication/plagiarism in the above research project.
4. Institute assumes to undertake the financial and other management responsibilities of the project.
5. Institute agrees to indemnify the council against any legal action or liability of any kind that may arise in connection with the undertaking of the project.

Date: 11.10.2022  
Place: Faridabad

Prof. (Dr.) I.K. Bhat  
Vice Chancellor  
Manav Rachna University, Faridabad

Vice-Chancellor  
Manav Rachna University  
43, Aravali Hills, Suraj Kund Road,  
Faridabad-121001

<a href="#">Back</a>	Part 1
<b>Project Report</b>	
1. Project Title	Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity
2. Duration	3 years
3. Total Cost	1825000
4. Name of Project Investigator	Aditya Sharma
5. Aadhaar No.	560977830751
6. Designation	Assistant Professor
7. Department	Department of Physics
8. Organization	Manav Rachana Univeristy, Faridabad
9. Full Address	Manav Rachna University Department of Physics Manav Rachna University, faridabad
Telephone	8745864881 Fax
E-mail	adityasharma@mru.edu.in
<b>16. Bank Details of The Institution For Online Transfer of Funds</b>	
i. Name of the Institution (as in Bank passbook)	MANAV RACHNA UNIVERSITY
ii. Bank Name	HDFC bank
iii. Bank Address	H BLOCK, OPPOSITE CELEBRITY HOMES, PALAM VIHAR, GURGAON
iv. Account No.	50200045814055
iv. IFSC Code	HDFC0002549
MICR Code	110240247
 Signature of PI	

## Summary of Project Report


1. Project Title	Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity
2. Name of Project Investigator	Aditya Sharma
3. Project Objectives	The existing perovskite solar cells (PSCs) experience high toxicity (due to lead) and poor efficiency/chemical stabilities (due to less effective/stable charge transport and active layers). This research project is aimed to fabricate and examine the solar-cell devices with ion-implantation based new strategy for improving the efficiency/stability of devices. I Deposition of SrVO <sub>3</sub> thin-films (nearly 100 nm) on ITO substrate by RF-sputtering (Electron transport layer) followed by Cu/Ag ion-implantation with 100 keV ion beams. II making of lead deficient mixed halide solutions (Pb substitution by Bi/Sb and iodine replacement with Cl/F) and active layer deposition using spin-coating. III Deposition of polymer layer as a passivation layer. IV Deposition of Cu <sub>2</sub> O layer (as hole transport layer) and then implantation of Al/Ga ions (100 keV energy). V Deposition of Al electrode. Industry collaboration will be developed for large scale production/commercialization and testing of devices.
4. Workplace/ Methodology	Most of the experimental facilities like RF-sputtering, Spin-coating, ICP-OES, GC-MS, UV-vis, FTIR spectroscopy etc. are available in the University. We have sanctioned active beam-time projects from IUAC New Delhi for ion-implantation. XAS/XPS, AFM, TEM etc. will be done with active collaborative research centers. RF sputtering will be used produce a denser and moisture resistant films for ETL and HTL layers (100 nm) and ion-implantation (100 keV, Cu/Ag/Al ions) will be done to increase charge carrier density. Spin-coating will be used to deposit CH <sub>3</sub> NH <sub>3</sub> Pb <sub>3-x</sub> I <sub>x</sub> layer over the implanted SrVO <sub>3</sub> layer, and the polymer layer will be grown over the mixed halide perovskite layer which can act as moisture barriers, and can improve the stability. Since, the work function, LUMO of Cu/Ag implanted SrVO <sub>3</sub> , is more close to that of CH <sub>3</sub> NH <sub>3</sub> Pb <sub>3-x</sub> I <sub>x</sub> . A more efficient charge transfer can be achieved by the favorable energy level between the ETL/HTL and the perovskite film.
5. Anticipated Results/Benefits	This proposal targets the development and testing of new generation of organic-inorganic hybridized photo-voltaic devices belonging to the family of halide perovskites. In this project, development of lead deficient perovskites and ion-implanted CTLs are planned, which are not reported so far or less studies. The proposed work laid the groundwork for understanding the interface study between lead deficient perovskite and ion-implanted CTLs, which will be essential to minimize charge carrier combinations and increase moisture stability at the interface. The successful completion of the project will allow researchers worldwide to target a new variety of perovskite materials for solar energy harvesting. There is also a growing global demand for PSCs to capitalize on the recently implemented feed-in tariff. As a result, proposed project will have a significant impact on CO <sub>2</sub> emissions, off-grid community development, and will aid in transfer of ideas/devices between researchers and society.
6. Budget Details	1825000

(A) Budget Details : Recuring


1st Year	2nd Year	3rd Year	Total
145000	145000	135000	425000

(B) Budget Details Equipments : 1400000

Total Budget (A+B) = 1825000

  
Signature of PI

## Project Proposal in Perspective

1. Project Title	Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity
2. Name of Project Investigator	Aditya Sharma
3. Project Proposal in Perspective	
<p>Developing perovskite solar cells (PSCs) with functionalized charge transport layers (CTLs) are appealing in solar cell industries however, stability, efficiency, and toxicity are the main concerns before their practical uses as reported in review articles and other references therein [1-5]. This project proposes new generation of organic-inorganic hybridized halide perovskites-based photo-voltaic devices for improved power conversion efficiency (PCE), stability and low toxicity. We proposed three different strategies in this project. The first strategy consists use and thin layer deposition ( 200, 500 micron thick using spin coating method) of the lead deficient perovskite materials via incorporating different substituents of Pb and I (Pb: by Bi or Sb and I by other halides). The second strategy aims to implant ions into RF sputtering deposited charge transport layers (SrVO<sub>3</sub> as an Election transport layer ETL and Cu<sub>2</sub>O as Hole transport layer HTL). RF sputtering can provide dense and moisture-resistant thin films while retaining chemical stability. The implanted ions occupy the substitution sites and also create point/cluster defects and modify materials properties especially, the charge career density and band-gap energy [6-7] which are desirable for high PCE. In ETL, we planned to implant Cu, Ag ions (with 100 keV energy) for getting more n type character and reducing the band gap energy of SrVO<sub>3</sub> thin films (100 nm thick), and the HTL layer is planned to implant with Al, Ga ions (with 100 keV energy) to make more p type character to the Cu<sub>2</sub>O thin film (100 nm thick). In the third strategy, the polymer layer (200,300 micron thick) will be deposited as a passivation layer onto the surface of the perovskite thin film. This layer can reduce interfacial recombination of electrons and holes, resulting in higher VOC and fill factor [8]. It also works as moisture barrier to the active layer and provide stability to the device. The Al electrodes will be deposited using sputtering technique for more stability of the devices. XRD, SEM-EDX, PL, UV vis, FTIR and XAS, XPS will be used to characterize the devices individual layers. The PSCs will then be prepared, and the cell performances of the new PSCs will be determined using solar-simulator for commercial applications.</p> <p>International status- Use of different perovskite layers has been reported in the literature [1-3]. However, use of ion-implantation based strategy has not been reported so far for improving the PCE.</p> <p>National status- At national level, Sharma et al [7] and Saraswat et al [9] investigated the structural, and optical properties of Ion implanted SrVO<sub>3</sub> and SnO<sub>2</sub> thin films. However, the uses of such implanted SrVO<sub>3</sub> or Cu<sub>2</sub>O films, in the PSCs, is not been investigated in India/abroad.</p> <p>Patent Till date- A limited patents are available for fabrication methods of PSCs [10]. There is no such patent available for the use of ion-implantation and polymer layer based perovskite solar cell device.</p> <p>References</p> <p>[1] Tianhao Wu et al, , Nano-Micro Letters, 13, (2021) 152,  [2] Pengyu Zhang et al, Frontiers in Chemistry, 10 (2022), 802890  [3] Juntao Hu et al, Nature Communications Materials, 3, (2022) 39.  [4] T. J. Jacobsson et al, Nature Energy, 7, (2022) 107.  [5] Vincent Obiozo Eze et al, Scientific Reports 12, (2022) 7794.  [6] Surekha Chaudhary et al, Vacuum, 179 (2020) 109481.  [7] Aditya Sharma et al, Journal of Electronic Materials, 51, (2022) 1900.  [8] Kristina M. Knesting et al, J. Phys. Chem. Lett. 4, (2013) 4038.  [9] Himani Saraswat et al, Vacuum 181 (2020) 109655.  [10] Method of preparing perovskite material and solar cell containing it as a light absorber, Surya, Charles Ng, Annie Ren, Zhiwei, US Patent, File No US11251324BW2 (2020).  [11] Passivation of defects in perovskite materials for improved solar cell efficiency and stability, Huang, Jinsong, Zheng, Xiaopeng, File No US1133551382 (2020).</p>	
 Signature of PI	



## Technical Details

### 1. Project Title

Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity

### 1. Introduction

#### 1.1 Origin of the Proposal

It is known that the solar cell functionalities, technically, depends on the active layer, charge transport layer and buffer layers quality and physical-chemical properties. However, the previously reported layers have shown poor stability and undergone moisture issues. Moreover, less charge carrier transport has been reported for the chemically deposited CTLs. Therefore, it is desirable to deposit dense and moisture resistance CTLs with smooth surface morphology. Additionally, large carrier concentration is also required for a high-performance device. The proposed research project is aimed to (i) reduce the toxicity of lead based perovskite devices, (ii) enhance the stability of devices by depositing the dense and stable thin films of SrVO<sub>3</sub> and Cu<sub>2</sub>O as electron transport layer and hole transport layers, respectively, (iii) ion-implantation based device engineering for enhancing the charge carrier density. Ion implantation-based research is very limited in this area and need to be explored for achieving the high performance from the solar cell devices.

#### 1.2 Definition of the Problem

Existing lead-based perovskite devices are toxic and not stable because of moisture attracting nature. This research project addresses the issue of toxicity by replacing the Pb with Bi or Sb. Likewise different halide can also be used in the proposed perovskite (CH<sub>3</sub>NH<sub>3</sub>Pb<sub>3-x</sub>I<sub>x</sub>) for exploring the changes in the performance of devices. Likewise, the stability and charge carrier concentration are the other two issues in the existing devices. Such issues can be solved in this research project by applying deposition of SrVO<sub>3</sub> and Cu<sub>2</sub>O thin films using RF -magnetron sputtering and the ion-implantation based research. RF sputtering helps to deposit dense and moisture free thin films The ion implantation will help to provide high carrier density for better charge transport from the device. The work function of the pristine SrVO<sub>3</sub>, the Lowest Unoccupied Molecular Orbital (LUMO) of Cu/Ag implant SrVO<sub>3</sub> is more close to that of CH<sub>3</sub>NH<sub>3</sub>Pb<sub>3-x</sub>I<sub>x</sub>. A more efficient charge transfer could be achieved by the favourable energy level between the ETL and the perovskite film.

#### 1.3 Objectives of the Project

The main objective of this project is to solve the existing issues in perovskite solar cell research i.e., (i) to prepare less toxic Pb base solar cells, (ii) to enhance the charge carrier concentration and (iii) to enhance the stability of devices which ultimately enhances the photo conversion efficiency of the devices. The objectives of the present proposal are: 1. Fabrication of SrVO<sub>3</sub> thin film on ITO substrate by RF-sputtering technique (as ETL). 2. Cu and Ag ion implantation with ion energy (80-100 keV). 3. Preparation of lead deficient mixed halide solutions (CH<sub>3</sub>NH<sub>3</sub>Pb<sub>3-x</sub>I<sub>x</sub>: with Pb substitution by Bi/Sb and iodine replacement with Cl/F/Br) and deposition of thin-films using spincoating on ion-implanted SrVO<sub>3</sub> thin film. 4. Deposition of polymer layer (p-xyly-lenePPX) on lead deficient mixed halide thin-film. 5. Deposition of Cu<sub>2</sub>O layer (as HTL) on polymer layer by RF sputtering and then implantation of Al/Ga ions energy (with 60-100 keV). 6. Deposition of Al electrode on HTL by sputtering. 7. Development of PSCs and testing their stability and

### 2. Capability of the Organization

#### 2.1 Specialists Consulted/to be Consulted

The proposed research project will be carried out at Manav Rachana University (MRU), Faridabad, India. The samples will be synthesized in the University Instrumentation Centre (U.I.C) MRU. UIC has all the possible instrumentation for solar cell fabrication. P.I. of the project has sanctioned beam time project from IUAC New Delhi for utilization of Ion-implantation technique. U.I.C also has a few characterization techniques like UV-vis, FTIR, GC-MS, ICP-OES and other.

Collaborative research efforts will be made in national (NPL, New Delhi, IIT-New Delhi, IUAC New Delhi) and international research (KIST, South Korea) laboratories for other characterization techniques (if needed). P.I. of the project has active collaboration with above mentioned institutes.

## 2.2 Expertise Available with Group

P.I. the project has expertise of synthesis, processing and physical/chemical characterization of various Nano-structures, thin films, Bi-layers, multi-layers, Gas-sensors and Solar cell materials. Moreover, the research group of P.I. at Manav Rachana University has work place and instrumentation facilities for running of research projects (with the expertise in the instrumentation). Besides this, the P.I. of the project is availing research projects from the Inter University Accelerator Centre (IUAC), New Delhi for the Solar cell processing, using ion implantation. Additionally, the previous research group of P.I. (at Korea Institute of Science and Technology (KIST), Seoul, and Pohang Accelerator Laboratory (PAL) Pohang, South Korea) has rich facilities for material or device design, processing and analysis.

## 3. Work Plan

### 3.1 Phase Wise Plan of Action

In the first phase of project, we will prepare different combinations of lead deficient perovskite thin films using spin-coating method. It will help to understand and calibrate the best lead content required for optimizing the performance of device. In the second phase deposition of electron and hole transport layers (SrVO<sub>3</sub> and Cu<sub>2</sub>O respectively) will be done using RF sputtering for optimization and testing the required thickness of layers. In the third phase, ion implantation will be carried out for enhancing the charge transport. In the fourth phase, testing of prepared devices will be done using solar simulator. The device parameters will be analysed and documented for commercialization and paper, patent report. Several Characterization techniques like XRD, TEM, SEM, XAS, XPS, Raman, FTIR etc will be done for collecting the data and interpretation of device performance.

### 3.2 Time schedule of activities

In the first six months of first year Procurement of items associated with the proposed work will be done. The next six months of first year Experimental design/synthesis and optimization lead based perovskite thin films will be done. In the Second year, Physical and chemical properties testing is planned. Deposition of SrVO<sub>3</sub> and Cu<sub>2</sub>O layers and ion implantation will be done in the last six months of second year. In the third year, and in between of second year, testing of solar cell using solar simulator will be carried out. The data analysis/interpretation of results and writing reports/patents and industry interaction will be done from the mid of second year onward to achieve goal of the research project.

### 3.3 Organization of work elements

The vision and mission of this project is to fabricate/design new generation of, indigenous, organic-inorganic hybridized photo-voltaic devices belonging to the family of halide perovskites Solar cell. For this, the P.I. (from Department of Physics & University Instrumentation Centre, Manav Rachana University) is putting his efforts to synthesize, functionalize, characterize and test the devices for better performance of perovskite devices. Most of the research work will be carried out at Manav Rachana University. However, the collaborative research efforts will be made to successful completion of the project. IUAC, New Delhi, KIST South Korea, PAL South Korea and other institutes will be visited for research discussion and experiments.

### 3.4 Plan for utilising expected outcome of project

The fabricated devices will be tested and commercialized for their practical applications in solar energy harvesting industry. We are expecting developing of less toxic better stable and highly efficient solar cell devices as a research outcome of this project. The university will make collaborative plan with the industries/companies to utilize the devices after evaluating and optimization of the product applications. The experimental data will be interpreted and research papers/reports/patents will be submitted in international reputed journals/conferences.

## 4. Location Specific Information

### 4.1 Description of participatory group and their prioritized needs

The P.I. of the research project and Ph.D/Master degree students (working with him) will be working for this project for the material synthesis, processing, testing, optimization and applications. The Department of Physics and University Instrumentation Centre are having several instruments for the fabrication and testing/analysis of devices and thin films.

However, Additional equipment (Solar simulator) is needed for the successful implementation of this research project. We are demanding this equipment from HSCSIT. The detailed budget of this equipment is provided in the budget section. The same equipment will also be utilized to continue the research in Manav Rachna University and will support the other researchers (from other universities).

#### 4.2 Relevance of proposed activities to the work ongoing in the organization

The proposed research project is analogous to our on-going research activities in the Physics Department and University Instrumentation Centre, for the fabrication of solar cell devices, perovskite material thin films, Graphene oxide, oxide nano-materials and thin films. The synthesis of materials is progressively being done in the Department of Physics and Instrumentation by the faculty members and Ph.D/Master degree students. We have expertise in the solar cell device fabrication and synthesis of perovskite materials, Nano-particle, Nano-rod and quantum dot etc., their characterization and applications in solar cell, gas sensing, magnetic devices, Li and Na ion batteries, waste-water treatment, Anti-Bacterial applications. The students of the university will not only be benefited by getting the guidance in this field but also get expertise in the solar cell based research for their future development.

### 5. Assessment of the Project

#### 5.1 Techno-economic viability/cost benefits analysis

The research towards the development of new generation of, indigenous, organic-inorganic hybridized photo-voltaic devices is still under investigation and unexplored by using ion-implantation based approach. Therefore, this project will certainly enhance the progress in the photo-voltaic devices research with the anticipation of high efficiency, less toxicity and high stability. The commercially available photo-voltaic devices are less stable and obey low charge carrier concentration. Research project is planned by considering the viability of technical expertise available with the P.I and his research team. We have manpower (in terms of MSc and PhD degree students), along with the required research facilities in the department/institute. Therefore, the manpower with low expenses can be applied to complete this research project. Additionally, the photo-voltaic devices prepared in this research will be of high quality, less toxic and less expensive than commercially available photo-voltaic devices because of the high purity and vacuum based techniques to be applied in this project.

#### 5.2 Comment on the integration of the project with the development strategy of the area

The area of research in photo-voltaic devices is expanding with integration of Nano-science and Nano-technology. In this direction, the multidisciplinary approach of this research project will develop new comprehensions towards the high-quality photo-voltaic devices development, their processing and commercial implementation in the solar energy harvesting industry.

The ion-implantation technique is versatile for incorporating different atoms (as dopants) into the various compound. This project uses the strategy, which is less reported in the literature, for the development of photo-voltaic devices. The RF sputtering based device fabrication and then ion implantation-based approaches will certainly provide integration of the project with the existing development of photo-voltaic devices based research in India/Abroad.

#### 45.3 Comment on the likely impact on neighbouring areas/society

The integration of educational institutes with the photo-voltaic devices industries or research centres will help the developments of new generation of, indigenous, organic-inorganic hybridized solar cell devices for their commercialization. The scientific and non-scientific society will be certainly benefited by the production of new class of photo-voltaic devices. Their commercialization will help the society because of their low toxicity, moderate cost and technologically improved functionality. Moreover, the outcomes of this project will certainly enhance the educational-industry relations towards the make-in-India campaign of Government of India.

#### 5.4 Comment on the estimation when the activities will become self generating

The product of the research project will be commercialized after the optimization, testing and evaluation with the experts available in the research area. We are expecting that the machines, which are already existing or will be purchased from this project, will be generating some revenue from the other researchers (from research institutes/universities/colleges) for material and device testing/consultancy. Moreover, the photo-voltaic devices (produced in this research) can be integrated with the existing solar cell company for commercialization and revenue generation. After the finalization of the duration of this research project, we will plan up gradation of the photo-voltaic devices according to the requirement of scientific society.

#### 5.5 Suggested parameters for monitoring effectiveness of intervention during and after the project

We planned continuous monitoring parameters to test the effectiveness of the products of this research project. For this, we will be testing our research outcomes by sending the results (in terms of research papers / patents) to the high standard international/national journals for evaluation of their technological and economic aspects. The efficiency of the devices will be repeatedly checked (with variable thickness of active layers and charge transport layers) for evaluating their thickness based functionality. All such results will be presented in front of experts available in the field and, moreover, such results will be presented in the international/national conferences for getting comments/suggestions, if any, on our existing results. After completion of the project, the machines and materials will be routinely tested for their effectiveness, efficiency and commercialization.

#### 5.6 Work already done or being done which is nearest to the project in objective scope & methodology, along with the institutions & names of the people involved

The research group of P.I. of this project is actively working for the synthesis and testing of various solar cell, gas sensing, magnetic and optical/catalyst materials and devices. The group members (including the MSc and PhD students) are already preparing the SrVO<sub>3</sub> and other perovskite materials in the university instrumentation centre. The P.I. of this project has received approval of projects from IUAC New Delhi for performing the ion-implantation based experiments. The research group is also applied proposals for using Synchrotron accelerator-based facility (PAL, South Korea) for determining the electronic structure properties of devices before the practical applications of photo-voltaic devices.

  
Signature of PI

## Budget Estimates

1. Project Title	Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity
2. Name of Project Investigator	Aditya Sharma

### (A) Budget Details : Recuring

Head	1st Year	2nd Year	3rd Year	Total
Salaries/Wages	0	0	0	0
Consumable	100000	100000	100000	300000
Travel	10000	10000	10000	30000
Other Costs/ Contingencies	20000	20000	10000	50000
Overheads	15000	15000	15000	45000
<b>Total</b>	<b>145000</b>	<b>145000</b>	<b>135000</b>	<b>425000</b>

### (B) Budget Details : Equipments

Equipment	Make	Quantity	Total Price	Utility	Justification
Solar simulator with electrometer	Sciencetech Inc canada	1	1400000	Photovoltaic Testing. Material and degradation testing. Keithly Model 2450 - Touchscreen for complete current-voltage measurement system used to characterize photovoltaic cell performance.	SciSun solar simulators include a variable aperture component, which allows variation of the output irradiance level without adjusting the power supply. This current-voltage tester works by sampling current at different voltages of the photovoltaic cell with a variable impedance load. This kind of instruments are essential for Solar-cell based research and not available in nearby universities. Therefore, purchasing of this equipment will certainly enhance the research out comes from the students

Total Budget (A+B) = 1825000

### DETAILS OF BUDGET FOR SALARIES/WAGES

Appointment Type	No. of Persons	Monthly Emoluments	1st Year	2nd Year	3rd Year	Total
Full Time	0	0	0	0	0	0
Part Time	0	0	0	0	0	0
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Justification	We need budget for purchasing high quality chemicals (99.99 % pure). Therefore, budget of Rs. 300000/- only has been planned in 3 years in the consumable section. The travelling will be done to reach nearby research centers for conducting research experiments. Other contingencies section, we have planned for buying research books/research articles etc for the students/faculty of the department/university. Overhead charges are nearly 10 percent (or can be decided by HSCSIT).					

*Ashama.*

Signature of PI



**Haryana State Council for Science,  
Innovation and Technology**  
हरियाणा राज्य विज्ञान, नवाचार एवं प्रौद्योगिकी परिषद  
Government of Haryana/हरियाणा सरकार

SPEED POST

No: HSCSIT/R&D/2022/ 2980

Dated: 09/11/2022

To,

Registrar  
Manav Rachna University, Faridabad

**Subject: -** Research & Development Project titled "Development and testing of Ion implantation induced modified charge transport layers in lead deficient perovskite solar cells for enhancing the efficiency/stability and reducing the toxicity." sanctioned to Dr. Aditya Sharma, Asst. Prof. & Asso. Head, Department of Physics, Manav Rachna University Faridabad, during the year 2022-23.

Please refer to the subject cited above.

This is to inform you that the above said R&D project submitted to this office has been approved for funding with the following budget as per detail given below:-

Total Budget/Duration	1 <sup>st</sup> Year Budget (Rs.)	2 <sup>nd</sup> Year Budget (Rs.)	3 <sup>rd</sup> Year Budget (Rs.)
Budget: 1825000/- Duration : 3 Years	15,45,000	1,45,000	1,35,000

Accordingly, the 1<sup>st</sup> year grant amounting to Rs. 15,45,000/- (Fifteen Lacs forty five thousands only) has been transferred in your bank account through NEFT/RTGS vide debit advice no. HSCSIT/2022/2910 dated 07.11.2022 (copy enclosed).

You are requested to ensure that the above R&D project may be carried out as per the terms & conditions of the scheme. Project work must result in publications and Research papers should be published in SCI journals only and each publication must acknowledge HSCSIT, Science and Technology Department, Haryana grant number. All the IPRs of projects funded by the Council will vest with the Haryana Government, in the case of private Universities/Institutions, or Universities/Institutions under the control of a Government, other than Govt. of India/Govt. of Haryana. However, the IPRs may be transferred to the concerned University/Institution on re-payment of the funding received. Proper accounts are maintained in the project, utilization certificates are provided to this office regularly and schedule of the project is strictly adhered to by the PI. The interest

accrued on the grant may be refunded to HSCSIT. The PI will have to submit half yearly and annual progress report to this office in the duration of the project. On completion of 1<sup>st</sup>/2<sup>nd</sup> year the PI will make the presentation before an Expert Group on the progress made in the project vis-a-vis the work plan proposed in the sanctioned project proposal. If the progress is found satisfactory further annual grant will be released. On the completion of project the PI have to submit the detailed project report and make final presentation citing outcomes of the project.

Scientific Engineer (B-I)  
for Secretary, EC

Endst. No. HSCSIT/R&D/2022/2981

Dated: 09/11/2022

A copy of the above is forwarded to Dr. Aditya Sharma, Asst. Prof. & Asso. Head, Department of Physics, Manav Rachna University Faridabad with the request to complete the above said R&D project as per the time schedule, budget earmarked and as per the terms & conditions of the scheme. The project work must result in publications, which should publish Research papers in SCI journals only and each publication must acknowledge HSCSIT, Science and Technology Department, Haryana grant number. The hard copy of reprints of the publications may be submitted to this office. Half yearly progress report and Annual progress report may be sent to this office during the project duration. The interest accrued on the grant may be refunded to HSCSIT. All the IPRs of projects funded by the Council will vest with the Haryana Government, in the case of private Universities/Institutions, or Universities/Institutions under the control of a Government, other than Govt. of India/Govt. of Haryana. However, the IPRs may be transferred to the concerned University/Institution on re-payment of the funding received.

Scientific Engineer (B-I)  
for Secretary, EC

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