IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Assessment of circular economy adoption for global sustainability**	
Project Number	**IMURA0906**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address?
*(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*

1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address?
(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

Global challenges related to climate change, over-exploitation of resources, and increasing demands are well acknowledged. As a consequence, achieving sustainable development is one of the most challenging problems of our times. Sustainability has economic, environmental, and social dimensions, and consequently is a very complex problem to address. Circular economy (CE) has been proposed as a way to address some of these challenges. CE includes reuse, recycle, remanufacture and so on. But the implication of CE adoption should be carefully assessed.

Model based decision making is well established in the field of engineering design, management, and operating. Such models, however, cannot capture the multi-disciplinary and multi-scale characteristics that become important for sustainability related issues. They also cannot capture the diversity and evolution in decision making. Therefore, integrated models that capture the dynamics of natural systems are required. Such models are complex in nature and require strong foundations in computational models and software design. Moreover, the diversity of various decision makers also needs to be captured. Agent-based modeling been used in the past to capture theses aspects in dynamic models. The research problem is based on developing agent-based models for decision making in integrated systems for sustainable development specifically in the context of circular economy.

Project aims

Define the aims of the project

This project will use the system dynamics model as the foundation to study the adoption of circular economy in the global context. We will start by considering the problem of the CE studied by Hanumante (2020). The focus will be on how the development of CE may impact positively the reduced demand for goods and negatively the wealth generated by this demand. We will particularly focus on the following two aspect:

1. Considers complex material cycles in circular economy adoption. This will include considering possibilities of downcyling, upcycling, and limited number of uses of material. Also adding additional types of products would also be considered.
2. Developing agent-based model based on the original model to consider the decision making by individual users. In particular modes of behaviour towards recycling will be investigated to discover what behaviours accelerate adoption and which act as a brake. Agents with differing characteristics will be employed to model a real community. The agent-based approach allows the modelling of such complex behaviour, and is therefore preferred over the traditional equation-based approach.

The specific tasks to be undertaken are:

- Develop simulation models of circular economy using Python
- Define agents and their decision rules to capture the socio-economic diversity
- Develop decision making rules regarding adoption of CE
- Perform Monte carlo simulations for various policy initiatives

Expected outcomes

Highlight the expected outcomes of the project including likelihood of patents

We expect to continue to make a strong contribution to the ever increasingly important field of Sustainability and Sustainability Metrics. This will be in the form of publications, Invited Lectures etc. Specifically, the project is expected to lead to following outcome:

- Model framework to perform agent-based simulation

- Likely adoption pathways of CE
- Systematic assessment of policy alternatives to stimulate CE

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

The proposal work will be based on using advanced computational engineering and simulation techniques to solve the problem of sustainable development. While the theoretical and conceptual development will be generic, we will take up specific problems that could be in the area of water, clean energy and/or infrastructure. Therefore, the applications might cover many of the Academy's themes.

Potential RPC members from IITB and Monash

Provide names of the potential research progress committee members (RPC) and describe why they are most suited for the proposed project.

Professor David Brennan (Monash University)
Professor Jayendran Venkateswaran (IIT Bombay)

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

Successful completion of this research will require the following skills:

- Basic training in engineering
- Strong mathematical foundation
- Experience in simulation modeling
- Experience in data collection, interpretation, and processing, and their integration with models.
- Interest in working on inter-disciplinary problems

This is a highly interdisciplinary topic and would require someone to be open to exploring concepts in ecology, humanities, and social sciences in addition to foundation of engineering.

Necessary Courses

List three tentative core courses relevant to the project that the student should complete during his/her coursework at IITB (the student will require to secure 8 point in these courses)

CL701: Computational methods in chemical engineering
IE604: System dynamics modelling and analysis

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Tata Chemicals Ltd.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Data Science, optimisation, algorithms
Systems Analysis and Control
Modelling and Simulation
Miscellaneous / Uncategorised (Sustainability)