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

Achieving sustainable development is one of the most challenging problems of our times. Diminishing resources, polluted environment, and rising demands lead to complex challenges. As part of its 2030 agenda for Sustainable Development, the United Nations has identified 17 Sustainable Development Goals (SDGs) with specific targets. Achievement of each goal requires a high level of coordination of governments, corporations and NGOs. Moreover, the problem is continuously evolving. Therefore, pursuing sustainability is akin to steering the planetary system to stay within the sustainability zone defined by ecological, economic, social, technological and legal dimensions. To explore approaches that are likely to be successful, systems dynamics (SD) based integrated planetary models are extremely valuable.

Starting with the goal on Responsible Production and Consumption (Goal 12), we used a global ecological model to investigate a pathway for increased consumption by the developing world. A collapse in the ecological model was observed above a given consumption rate increase, but this could be mitigated by introducing a Circular Economy (CE). However, it was recognised that education/awareness (Goal 4) plays a very important role in many of other 16 SDGs. With this in mind, there is an opportunity to build on our previous research, to look at the role of diffusion of knowledge to speed up the rate at which any specific sustainability goal may be achieved.

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. Agent-based modelling been used in the past to capture theses aspects in dynamic models. However, its application for decision making for sustainable development has been limited. 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 and develop agent-based models to capture the decision making diversity and evolution. The focus will be on capturing factors that affect adoption of recycled and remanufactured goods by consumers as a function of price and product attributes.

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. 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. These systems evolve over time in the presence of uncertainties, and the components adapt dynamically to achieve the desired objectives. 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.

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 modelling
- Experience in data collection, interpretation, and processing, and their integration with models.
- Interest in allied field such as ecology, policy, social sciences, and humanities
- 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.

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)