IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**The green behind the electric vehicle supply chain: A psychological perspective**	
Project Number	**IMURA1009**	
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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	*Artificial Intelligence and Advanced Computational Modelling*
2	*Circular Economy*
3	*Clean Energy*
4	*Health Sciences*
5	*Smart Materials*
6	*Sustainable Societies*

The research problem

In 2021, more than 300 thousand units of new electric vehicles (EVs) were sold in India (https://vahan.parivahan.gov.in/vahan4dashboard), and in 2022, India's annual gross sale of electric vehicles (EVs) is predicted to touch 1 million units. These statistics indicate that Indian consumers are swiftly adopting EVs in place of traditional fuel engine vehiclesAround 10% of India's total greenhouse gas emissions come from road transportation, a global climate change concern. Widespread adoption of EVs is believed to reduce these emissions. Besides, local air pollution is a glaring public health crisis in urban centers in India. EVs do not have tailpipe emissions, and therefore, consumers anticipate immediate public health benefits with the purchase of EVs.

It is important to note that EVs run on the power supplied by the countries' electricity grids. Therefore, the real effectiveness of EVs in reducing greenhouse gas emissions depends on the particular country's power sector emissions. So, the emission reduction is higher in European countries, which mostly rely on carbon-free sources of electricity generation. In comparison, more than 50% of electricity produced in India is from coal, which is many times more polluting than a BS-6 compliant car, per unit of usable power generated. In addition, the manufacturing of EVs has a higher per-unit carbon footprint than conventional vehicles, mainly from battery production (and disposal/recycling issues). Another sustainability and supply chain challenge for EV manufacturing is a dearth of rare earth material used to produce batteries and electric motors. From an industry perspective, these paradoxes in the eco-friendliness of EVs raise the dilemma of whether to treat EV manufacturing as a social responsibility initiative or a profitability enhancing option.

From a consumer utility perspective, EVs in India come with higher risks, such as relatively high price, limited battery range, uncertain cost performance, and underdeveloped battery charging and vehicle maintenance infrastructure. But, due to the salience of local air pollution, Indian consumers may associate higher personal benefits with EVs and thus may undervalue the utility risks of EVs (Alhakami & Slovic, 1994). In addition, the government offers incentives for the purchase and manufacturing of EVs. The widespread adoption of EVs needs the rapid expansion of India's standardized charging and maintenance infrastructure. Such investment in infrastructure development in a vast geography like India is beyond the capabilities of individual EV manufacturers and thus requires coordination among governments and different manufacturers (Yu et al.). As a result, the future of EV ecosystem in the country depends on the government's policy support to a large extent. Hence, manufacturers' operational decisions also need to factor in the government policy of the day.

Overreliance on public policy can not be a long-term strategy for an Indian manufacturer in a globally competitive industry. Therefore, EV manufacturers need to decide their differentiation strategy to optimize their EV production operations. India is still a cost-sensitive market. Should Indian manufacturers promote EVs primarily for their (1) lifecycle environmental benefits, (2) ease of use, (3) range, or (4) cost performance? Operational planning for each choice will need focussed investments in innovation, capacity, and upstream supply chains.

Alhakami, A. S., & Slovic, P. (1994). A Psychological Study of the Inverse Relationship Between Perceived Risk and Perceived Benefit. *Risk Analysis, 14*(6), 1085-1096. https://doi.org/https://doi.org/10.1111/j.1539-6924.1994.tb00080.x

Yu, J. J., Tang, C. S., Li, M. K., & Shen, Z.-J. M. (in press). Coordinating Installation of Electric Vehicle Charging Stations between Governments and Automakers. *Production and Operations Management,* (n/a). https://doi.org/https://doi.org/10.1111/poms.13564

Project aims

Define the aims of the project

1. To investigate whether Indian consumers anticipate higher environmental benefits from EVs compared to global counterparts due to the salience of local air pollution.
2. To study whether the Indian industry perceives investment in EV manufacturing as a social responsibility apart from a profitability enhancing option (Lyneis & Sterman, 2016).
3. To study the impact of the government's policy on EV demand and manufacturing (Helper et al., 2021).
4. To investigate how the corporate strategy drives the investments and production planning of EV manufacturers (Ward & Duray, 2000) in India.
5. To study the economics of installing EV battery charging services and its role in consumer adoption of EVs.

References:

Lyneis, J., & Sterman, J. (2016). How to Save a Leaky Ship: Capability Traps and the Failure of Win-Win Investments in Sustainability and Social Responsibility. *Academy of Management Discoveries,*

2(1), 7-32. https://doi.org/10.5465/amd.2015.0006

Helper, S., Gray, J. V., Hughes, M. M., & Roman, A. V. (2021). Public policy and operations management. *Journal of Operations Management, 67*(7), 780-802. https://doi.org/https://doi.org/10.1002/joom.1160

Ward, P. T., & Duray, R. (2000). Manufacturing strategy in context: environment, competitive strategy and manufacturing strategy. *Journal of Operations Management, 18*(2), 123-138. https://doi.org/https://doi.org/10.1016/S0272-6963(99)00021-2

What is expected of the student when at IITB and when at Monash?

Highlight how the project will gain from the students stay at IITB and at Monash

The empirical setting is India, with the possibility of a cross-country comparative study with Australia. The research facilities in either place can be used at different stages of research. The student will also benefit from spending time in the department and research program at Monash as well as taking some of the Monash coursework (non-assessed).

The student is expected to devote a large part of their work to connect with industry and consumers, conduct interview and field observations which should inform controlled experiments to test the field-generated hypotheses.

Expected outcomes

Highlight the expected outcomes of the project

A better understanding of EV awareness, motivation and uptake from a consumer, retailer, and manufacturer's perspective, as well as use and post-use considerations, which cuts through the current clutter and marketing noise.

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 project falls squarely within Themes 3 and 6: energy and sustainability

Potential RPCs from IITB and Monash

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

Prof. Snehal Awate, SJMSOM, IIT Bombay: Works in innovation, technology, and strategy area, and has published in top journals in the area.
Prof Graham Currie, Monash Civil Engineering, expert in public transit policy and use, member of public transport research group.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to 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.

A strong background in engineering, supply chain management, marketing and/or psychology, preferably demonstrated by an advanced degree by research in these fields.

Necessary Courses

Name three tentative 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)

Behavioral Operations Management
Logistics and Supply Chain Management
Sustainable Supply Chains

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.

Prof. Sandeep Anand, Depatment of Electrical Engineering, IIT Bombay: has expertise in Electric Vehicles and Circuits for Interfacing Alternate Sources (Solar PV, Battery, Fuel Cells)

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.

Green Chemistry and Renewable Energy, Novel Batteries and Fuel Cells, Transportation and Traffic Engineering and Logistics, Humanities/Management