Academic Profile

R K Amit

Department of Management Studies

Indian Institute of Technology Madras, Chennai 600 036

Email: rkamit@iitm.ac.in

June 5, 2023

Contents

1 Teaching Profile

At IIT Madras, I have been teaching courses on game theory, operations management, decision theory, statistics, and economics at undergraduate and graduate level. Apart from teaching core concepts, I emphasize on the integration of the concepts with contemporary business and technology interfaces. The course outlines are appended in §1.1. The list of the courses is

1. **MS 3540 Introduction to Game Theory** This is 3-credit undergraduate course, designed by me. The main focus is on understanding fundamental solution concepts of noncooperative and cooperative game theory, along with applications in business and technology.

2. **MS 5025 Game Theory for Business** This is a 2-credit MBA elective course. The course focuses on business applications of game theory, and enables a manager to understand rational behavior in multiagent settings. The course is taught in an interactive manner using a variety of business examples, in-class simulations and role-play exercises, and online exercises.

3. **MS 5230 Operations Management** This is a core MBA 2-credit course. I co-teach this course, and covers topics like forecasting, aggregate planning, materials requirement planning, and quality control.

4. **MS 7038 The Future of Manufacturing Business** This a core 2-credit course taught to the VLMP[1] students since 2018. This is a unique course that focuses on deciphering the role of disruptive technologies in changing the business of manufacturing.

5. **MS 9612 Manufacturing & Service Operations** This is a core 2-credit course offered for Executive MBA. I co-teach this course, and covers topics like forecasting, aggregate planning, inventory management, and quality control.

6. **MS 9651 Global Risk Management** This is a 2-credit elective course offered for Executive MBA since 2019. I co-teach this course, and focus on understanding and sensing risks in global supply chain, and their mitigation. This course is highly relevant in the context of increasing supply chain vulnerabilities due to COVID-19.

7. **MS 7210 Topics in Decision Theory** A research-level 2-credit course, designed by me. The main focus is on discuss normative and descriptive theories of decision making. The course uses recent research papers to link the theories of decision making with applications in operations management.

8. **MS 6031 Data Analysis for Research** This is a core research-level 2-credit course. The focus is on teaching core concepts of statistical data analysis, and developing statistical wisdom.

9. **MS 5235 Operations Forensics** This is a 2-credit course designed by me for techMBA/MBA/Research. This course on Operations forensics adds to this tradition by understanding the operations of an organization from an external viewpoint. Three dimensions of operations forensics—operational indicators, operational due diligence, and operational turnarounds—will be discussed in the course.

10. **MS 5987 Digital Operations and Technology** This is a MBA 2-credit course designed by me for MBA/Research. Recent advances in digital technologies like additive manufacturing, platforms, blockchains, machine intelligence, and Internet-of-things have significantly impacted products, processes, and business models. This course provides an overview of digital technologies and their interface with operations management.

I also designed a course **The Future of Manufacturing Business: Role of Digital Technologies**, jointly with Dr. U. Chandrasekhar, Wipro 3D. This course has been offered on NPTEL platform (https://nptel.ac.in/courses/110/106/110106146/) since 2020, and more than 2000 participants enrolled for the course in 2020. The objective of the course is to understand future of modern manufacturing, in the context of advancements in metal additive manufacturing and delineate the consequential technology-dominated business models.

[1] VLMP: Visionary Leadership in Manufacturing Program

I also taught the following courses at IIT Madras and IIT Kanpur.

1. MS 3510 Fundamentals of Operations Research (UG course, co-taught with Professor Arshinder Kaur)
2. MS 5010 Macroeconomics (core MBA course, taught at IIT Madras)
3. MS 5110 Microeconomics (core MBA course, taught at IIT Madras)
4. MS 5350 Business Research Methods (core MBA course, taught at IIT Madras)
5. MS 6014 Operations Management in Multiagent Settings (research level course, taught at IIT Madras. Designed by me)
6. MS 7080 Research Methodology (co-taught with Professor Saji Mathew at IIT Madras)
7. MS 8300 Mathematics for Operations (research level course, taught at IIT Madras. Co-designed with Professors Usha Mohan and Rahul Marathe)
8. MS 9613 Managerial Economics (Executive MBA core course)
9. MS 6510V Computer Integrated Manufacturing (VLMP course)
10. MBA 606 Economic Analysis for Management (core MBA course, taught at IIT Kanpur)
11. MBA 651 Quantitative Methods for Decision Making (core MBA course, taught at IIT Kanpur)
12. IME 636 Introduction to Game Theory (research level course, taught at IIT Kanpur. I received the *Academic Senate citation for teaching excellence as an instructor* for this course)

1.1 Course Outlines

1.1.1 MS 3540 Introduction to Game Theory

Game theory is a mathematical theory that deals with conflict situations. A conflict situation (game) is a situation in which two or more agents interact and thereby jointly determine the outcome. In such situations, game theory aims to prescribe what each agent in a game should do in order to promote its interests optimally.

In this course, we will focus on the main contributions and applications of game theory. Starting with a detailed description of how to model strategic situations, the course will proceed to basic solution concepts, their refinements, games of incomplete information, repeated games, and cooperative games. Furthermore, for each of these theoretical developments, we will consider a companion set of applications from engineering, management, and economics.

Course Topics

Primitives of Game Theory What is game theory?; Language of game theory—representation, strategies, payoffs, and game trees; Role of Communication; Reasonable outcomes in game theory.

Games in Normal Form Notion of strategy in normal-form games; Two-person zero-sum games and minimax theorem; Reasonable outcomes for games in normal form—Nash equilibrium and Bayesian-Nash equilibrium.

- ♣ Cheap talk in blockchains
- ♣ Designing mechanisms—dominant strategy implementation and auction design
- ♣ Supply chain coordination and procurement
- ♣ Sponsored-search markets
- ♣ Truth-telling mechanisms and data science

Games in Extensive Form Notion of strategy in extensive-form games; Reasonable outcomes for games in extensive form—subgame perfect Nash equilibrium.

- ♣ Time inconsistency and credibility in central banking

♣ Sequential bargaining

Games in Characteristic Form Coalitional games with transferable payoffs; Solution concepts: the core and the Shapley value.

♣ Inventory games

♣ Cooperative location games

♣ Designing matching markets

Main Text: Y. Shoham and K. Leyton-Brown.Multiagent Systems Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press, New York, 2009. http://www.masfoundations.org

Grading The grading for this course will be based on relative performance.

End-Semester Exam: 50%

Assignments: 25

Off-class Quizzes: 25%

♣ stands for applications of game-theoretic concepts
We will use Acadly (https://app.acadly.com/home) as learning management system.

1.1.2 MS 5025 Game Theory for Business

Today's business environment is complex and dynamic and is characterized by interdependence and uncertainty. Managers cannot make decisions in isolation just by taking into account uncertainty as the outcomes of such decisions depend on the action of others. These others could be within the firm—other managers, departments, divisions—or outside the firm such as other firms, governments, regulators, customers, and markets. This interaction with others, which is referred to as *games* could be either competitive or cooperative depending on whether their interests are conflicting or aligned with the manager's interests.

The goal of this course is to enhance a participant's ability to make decisions in complex and interactive environments. Knowledge of game theory will provide students a better understanding of a wide range of problems in such settings. You will learn how to predict when and how your actions will influence the decisions of others and vice versa; this will allow you to exploit such situations to your own benefit. The course will first provide an introduction to the basic concepts and ideas of game theory. The course will be taught in an interactive manner using a variety of business examples, in-class simulations and role-play exercises, and online exercises.

Course Contents

Introduction: What is game theory? What are some common applications of Game Theory in Business? Contracts, Auctions, Bargaining, and Resource sharing; Language of game theory—representation, strategies, payoffs, and game trees; Role of Communication.

Reasonable Outcomes in Game Theory: Notion of strategy; Solving by dominance and backward induction; Focal equilibrium; Nash equilibrium and its refinements; Bayesian equilibrium and Quantal response equilibrium; Solution concepts for coalitional games.

Designing Mechanisms: Fundamentals of mechanism design as game engineering; Dominant strategy implementation and Impossibility results; Designing auctions and bargaining protocols.

Business Applications of Game Theory: Industrial organization games; Contract design in operations management; Managerial incentive design; Cooperative manufacturing and remanufacturing; Designing sponsored search auctions; Truth telling mechanisms in prediction markets and permissioned blockchains; Time inconsistency and credibility in central banking; Location science; Designing matching markets.

Main Text: Y. Shoham and K. Leyton-Brown.Multiagent Systems Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press, New York, 2009. http://www.masfoundations.org

Grading The grading for this course will be based on relative performance.

End-Quarter Exam: 40%

Poster: 40%

Class Participation: 20%

1.1.3 MS 7038 The Future of Manufacturing Business

Manufacturing is one of the key engines of a nation's progress. In recent years, the manufacturing paradigm is changing due to availability of data, improvements in communication, and advances in additive manufacturing. The objective of the course is to understand the business dimensions of modern manufacturing.

Course Contents

Manufacturing Paradigms: What is manufacturing? Significance of manufacturing; Different paradigms—craft production, mass production, mass customization, regionalization & personalized production. Business models for different manufacturing paradigms. Manufacturing and new industrial revolution. Local initiatives in manufacturing: Advanced Manufacturing (US), e-factory (Japan), Industrie 4.0 (Germany), Intelligent Manufacturing (China), Make in India (India).

- ♣ "Globalization and Manufacturing Paradigms". Y. Koren, The Global Manufacturing Revolution, John Wiley & Sons, 2010. Chapter 1.
- ♣ "The Evolution and Future of Manufacturing: A Review". Behzad Esmaeilian, Sara Behdadb, Ben Wang, Journal of Manufacturing Systems, 2016.
- ♣ "The Future of Manufacturing: A New Perspective". Ben Wang, Engineering, 2018.
- ♣ "How Smart, Connected Products Are Transforming Companies". Michael E. Porter and James E. Heppelmann, Harvard Business Review, 2015.
- ♣ "Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business". Marco Iansiti and Karim R. Lakhani, Harvard Business Review, 2014.
- ♣ "The End of Scale". Hemant Taneja, MIT Sloan Management Review, 2018.
- ♣ "Business Models for Additive Manufacturing". Richard A. D'Aveni, Harvard Business Review, 2018.
- ♣ "Operational Excellence". Sunil Gupta, Driving Digital Strategy, Harvard Business Review Press, 2018. Chapter 5.
- ♠ "GE and the Industrial Internet". Karim R. Lakhani, Marco Iansiti, Kerry Herman. Product #: 614032-PDF-ENG.

Economics of Manufacturing: Manufacturing production functions. Mathematics of complementarities. Complementarities in production. Manufacturing and organization. Economic characteristics of additive manufacturing. Impact of additive manufacturing on firms' payoff functions and market structure. Economics of online platforms and their relevance for manufacturing. Economies of Unscale. Revenue management in manufacturing. Market design in manufacturing context—Covisint, Ariba, AutoDX, etc.

- ♣ "The Economics of Modern Manufacturing—Technology, Strategy, and Organization". Paul Milgrom and John Roberts, American Economic Review, Volume 80, 1990.
- ♣ "Economic Implications of 3D printing: Market Structure Models in Light of Additive Manufacturing Revisited". Christian Weller, Robin Kleer, Frank T. Piller, International Journal of Production Economics, Volume 164, 2015.
- ♣ "Economics of Additive Manufacturing for End-Usable Metal Parts". Eleonora Atzeni and Alessandro Salmi, Int J Adv Manufacturing Technology, 2012.

Recent Business Trends in Manufacturing: Cloud manufacturing. Cooperative and responsive manufacturing. Data-driven manufacturing and digital factory. Manufacturing-as-a-Service (MaaS). Open value chain. Flexible production. Human-centered manufacturing. Business models: Crowdsourcing Anything-as-a-Service, Symbiotic ecosystem. Driving and enabling technologies for Factory of Future.

- ♣ "From Cloud Computing to Cloud Manufacturing". Xun Xu, Robotics and Computer-Integrated Manufacturing, 2012.
- ♣ "Innovation Lessons From 3-D Printing". Jeroen P. J. De Jong and Erik De Bruijn, MIT Sloan Management Review, 2013.
- ♣ "Getting Past the Hype About 3-D Printing". Roca et al., MIT Sloan Management Review, 2017.
- ♣ "Mastering the Make-in-India Challenge". Mudambi et al., MIT Sloan Management Review, 2017.
- ♣ "Supply Chains Built for Speed and Customization". Manhmohan Sodhi and Christopher Tang, MIT Sloan Management Review, 2017.
- ♣ "The Biggest Challenges of Data-Driven Manufacturing". Willy C. Shih and Helmuth Ludwig, Harvard Business Review, 2016.
- ♣ "Understanding the Rise of Manufacturing in India". Vijay Govindarajan and Gunjan Bagla, Harvard Business Review, 2015.
- ♣ "Why High-Tech Commoditization Is Accelerating". Willy C. Shih, MIT Sloan Management Review, 2018.
- ♠ "General Electric in 2017: Naming and Claiming the Industrial Internet". Robert E. Siegel, Cameron Lehman. Product #: SM288-PDF-ENG.
- ♠ "Building the Digital Manufacturing Enterprise of the Future at Siemens". Willy Shih. Product #: 616060-PDF-ENG.

Grading The grading for this course will be based on relative performance.

Cases: 20%

Presentations: 20%

Class Discussion and Participation: 10%

Term Paper (Max. 5 students): 30%

End-Term Examination: 20%

♣ indicates readings.
♠ indicates cases.

1.1.4 MS 7210 Topics in Decision Theory

In this course, the emphasis is on gaining a deeper understanding of major concepts, theories, applications, and current research in the area of single-person decision theory. The course revolves around the two main questions—the normative question: How *should* agents make decisions?; and, the descriptive question: How *do* agents make decisions?

The fundamental normative model of decision making is maximization of expected utility or goodness of outcomes. This model serves as the basis of decision analysis used by decision makers in business and government. This normative model of maximization of expected utility involves beliefs and utility in some way. This course revolves around different theories for both of these concepts to understand and explain various normative and descriptive models of decision making. We will also focus on normative and descriptive models of decision making over time.

Main Text I. Gilboa. Theory of Decision Making under Uncertainty. Econometric Society Monographs. Cambridge University Press, 2009.

Course Contents

Preferences and Utility Preference and choice; Utility functions; Existence of Utility functions; Social preferences in utility functions; Hyperbolic and quasi-hyperbolic discounting.

■ "A Brief History of Decision Making", Buchanan and O'Connell (2006), Harvard Business Review.
■ "The Hidden Traps in Decision Making", Hammond, Keeney, and Raiffa (2006), Harvard Business Review.
■ "Economics and Psychology? The case of hyperbolic discounting", Ariel Rubinstein (2005), International Economic Review

Choice under Uncertainty Simple and Compound lotteries; Preference over lotteries; Expected utility theory (EUT); Violations of the EUT—Allais's paradox and Machina's paradox; Behavioral theories—weighted utility, rank-dependent utility.

■ "Decision Bias in the Newsvendor Problem with a Known Demand Distribution: Experimental Evidence", Schweitzer and Cachon (2000), Management Science.

Utility for Money Money lotteries; St. Petersburg-Menger paradox; Measuring risk preferences; Probability premium; Prudence.

■ "The Risk-Averse (and Prudent) Newsboy", Louis Eeckhoudt, Christian Gollier, Harris Schlesinger (1995), Management Science

Prospect Theory and Reference-Dependent Utility Prospect theory; Prospect theory and Allais's paradox; Prospect theory and the "endowment effect"; Reference-Dependent preferences.

■ "Describing decision bias in the newsvendor problem: A prospect theory model", B. Vipin and R K Amit (2019), Omega.

Comparison of Payoff Distributions First Order and Second Order Stochastic Dominance; Hazard rate dominance, Reverse hazard rate dominance; Likelihood ratio dominance.

■ "Optimal shelf-space stocking policy using stochastic dominance under supply-driven demand uncertainty", R K Amit, Peeyush Mehta, Rajeev R Tripathi (2015), European Journal of Operational Research.

Subjective Probability Theory Subjective Probability Expected Utility (SEU) Theorem; Ellsberg's paradox; Ambiguity aversion; Alternatives to SEU—maxmin expected utility; Choquet expected utility; Smooth ambiguity aversion.

■ "A Risk- and Ambiguity-Averse Extension of the Max-Min Newsvendor Order Formula", Qiaoming Han, Donglei Du, Luis F. Zuluaga (2014), Operations Research.

Grading The grading for this course will be based on relative performance.

End Term Exam: 40%

Paper (Team of 2-3 students): 30%

Class Presentations: 20%

Class Participation: 10%

■ stands for readings.

1.1.5 MS 6031 Data Analysis for Research

"Statistics is the discipline concerned with the study of variability, with the study of uncertainty, and with the study of decision-making in the face of uncertainty." (Lindsay et al., 2004). This course focuses on core concepts of statistics and applications in business and applications.

Main Texts

- Morris H. Degroot and Mark J. Schervish, "Probability and Statistics", Addison-Wesley, Fourth Edition, 2002. Reprinted in India by Pearson (*Main Text*).
- Stephen M. Stigler, "The Seven Pillars of Statistical Wisdom", Harvard University Press, 2016.

Grading The grading for this course will be based on relative performance.

End-Quarter Exam: 30%

Assignments: 30%

Class Discussion and Participation: 20%

Paper (Max. 4 students): 20%

Course Contents

Introduction to Statistics What is statistics? Seven pillars of statistical wisdom—Aggregation, Information, Likelihood, Intercomparison, Regression, Design, and Residual.
♣ Bruce G. Lindsay, Jon Kettenring, & David O. Siegmund, "A Report on the Future of Statistics", Statistical Science, 2004.

Review of Probability and Exploratory Data Analysis Numerical summary measures; Graphical summary measures; Exploratory techniques for paired data; Some common probability distributions.
♣ Jonathan A. Schwabish, "An Economist's Guide to Visualizing Data", Journal of Economic Perspectives, 2014.

Sampling Estimating μ and σ; Efficiency of Estimators.

Distributions of Sample Statistics Distribution of s^2 if $x = N(0, \sigma^2)$; Sampling from a finite population; Asymptotic distribution of the median; Bootstraps and Jackknives.

Bayes' Theorem and Maximum Likelihood Estimation

Confidence Intervals and Hypothesis Testing The theory of tests; Likelihood ratio tests.
♣ Naomi Altman & Martin Krzywinski, "Interpreting P values", Nature Methods, 2017.

The Theory of Maximum Likelihood Estimators Efficiency of ML estimators and the minimum variance bounds; Uncertainties in parameters.

Least Squares Fitting in Linear Models Relationship to MLE; Linear estimators; Goodness of fit; Errors in the parameters.

Hypothesis Testing in the Linear Model

♣ stands for readings.

1.1.6 MS 5235 Operations Forensics

Since the publication of seminal book "The Modern Corporation and Private Property" by Berle and Means in 1932, issues at the separation between ownership and control have been at the centre of management science. This course on Operations forensics adds to this tradition by understanding operations of an organisation from an external view point. Three dimensions of operations forensics—operational indicators, operational due diligence, and operational turnarounds—will be discussed in the course.

Readings

Richard Lai. **Operations Forensics**, *MIT Press*, 2013.

Jan A. Van Mieghem and Gad Allon. **Operations Strategy**, Second Edition, *Dynamic Ideas*, 2015.

Additional Readings: Selected recent academic and business articles and cases.

Grading

The grading for this course will be based on relative performance.

End-Quarter Exam: 30%

Class Presentations: 20%

Class Discussions: 20%

Poster Presentation (Group ≤ 3): 30% (presentation, uniqueness, and relevance)

Course Topics

Operations Strategy

Operating system, Three views of Operations, Analysing competitive threat using trade-offs.

- Christensen and Overdorf (2000). Meeting the Challenge of Disruptive Change. Harvard Business Review (HBR).
- Skinner (1969). Manufacturing-missing link in corporate strategy. Harvard Business Review (HBR).
- Stalk, Evans and Shulman (1992). Competing on capabilities: The new rules of corporate strategy. Harvard Business Review (HBR).
- Hayes and Upton (1998). Operations-based strategy. California Management Review.

Operations Forensics: Introduction

What is operations forensics? Understanding the dimensions of operations forensics—operational indicators, operational due diligence, and operational turnarounds. What financial statements may or may not reveal?

- Berman (2005). King of the retail jungle. Fortune.
- Bowman (1984). Content Analysis of Annual Reports for Corporate Strategy and Risk. Interfaces.

Operational Indicators

Indicators of accounting performance. Indicators of disruption. Indicators of Distress. Benford's law.

- Kirby and Stewart (2007). The Institutional Yes: How Amazon's CEO Leads Strategic Change in a Culture Obsessed with Today's Customer. Harvard Business Review (HBR).
- Cusumano, Mylonadis and Rosenbloom (1992). Strategic maneuvering and mass-market dynamics: The triumph of VHS over Beta. Business history review.

Operational Due Diligence

The many facets of operational due diligence. Assessing the customer base. Assessing risks.

- Kaplan (2012). When to Drop an Unprofitable Customer. Harvard Business Review (HBR).
- Spear and Bowen (1999). Decoding the DNA of the Toyota Production System. Harvard Business Review (HBR).
- Smith, Leimkuhler and Darrow (1992). Yield Management at American Airlines. Franz Edelman Award Papers, Interfaces.

Operational Turnarounds

Turning around purchasing. Turning around production. Turning around distribution. Sustaining the turnaround.

- Degraeve and Roodhooft (2001). A Smarter Way to Buy. Harvard Business Review (HBR).
- Fischer, Raman and McClelland (2000). Rocket Science Retailing. Harvard Business Review (HBR).
- Hammer (1990). Reengineering Work: Don't Automate, Obliterate. Harvard Business Review (HBR).
- Geraghty and Johnson (1997). Revenue Management Saves National Car Rental. Franz Edelman Award Papers, Interfaces.

1.1.7 MS 5987 Digital Operations and Technology

Business enterprises strive to match supply with demand in uncertain environments using innovative products, processes, and business models. In operations management, we study such processes and business models. Recent advances in digital technologies like additive manufacturing, platforms, blockchains, machine intelligence, and Internet-of-things have significantly impacted products, processes, and business models. This program provides an overview of digital technologies and their interface with operations management.

Readings

R K Amit, Kulwant Pawar, R P Sundarraj, and Svetan Ratchev, *Advances in Digital Manufacturing*, Springer, 2023. (Selected Chapters)

Amit Sinha, Ednilson Bernardes, Rafael Calderon, and Thorsten Wuest, *Digital Supply Networks: Transform Your Supply Chain and Gain Competitive Advantage with Disruptive Technology and Reimagined Processes*, McGraw-Hill Education, 2020. (Selected Chapters)

Recent papers from leading journals.

Grading

The grading for this course will be based on relative performance.

End-Quarter Exam: 30%

Class Presentations: 20%

Class Discussions: 20%

Poster Presentation (Group ≤ 3): 30% (presentation, uniqueness, and relevance)

Course Topics

Operations Management Paradigms (3 Lectures)

What is "new" in operations and supply chain management? Emerging technologies and business models for operations management.

- Chapter 1 (Sinha et al.)
- Choi et al (2021). Disruptive Technologies and Operations Management in the Industry 4.0 Era and Beyond. Production and Operations Management (POMS).
- Olsen and Tomlin (2020). Industry 4.0: Opportunities and Challenges for Operations Management. Manufacturing & Services Operations Management (MSOM).
- Iansiti and Lakhani (2014). Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business. Harvard Business Review (HBR).

Digital Operations Strategy (3 Lectures)

Enablers of digital operations: people, process, and technology. Advanced technologies: additive manufacturing, blockchains, industrial machine intelligence, industrial internet of things (IIoT), and platforms. Role of hardware and software for digital operations.

- Chapter 3 (Amit et al.)
- Chapter 3, 4, 5 (Sinha et al.)
- Babich and Hillary (2018). Distributed Ledgers and Operations: What Operations Management Researchers Should Know About Blockchain Technology. Manufacturing & Services Operations Management (MSOM).
- Lee et al., Industrial AI and predictive analytics for smart manufacturing systems, Smart Manufacturing, Chapter 5, Elsevier, 2020.

Digital Technologies in Inventory & Capacity Management (6 Lectures)

- Neghab et. al. (2022). An integrated data-driven method using deep learning for a newsvendor problem with unobservable features. European Journal of Operational Research (EJOR).
- Sgarbossa et. al. (2021). Conventional or additive manufacturing for spare parts management: An extensive comparison for Poisson demand. International Journal of Production Engineering (IJPE).
- Boute et. al (2021). Deep reinforcement learning for inventory control: A roadmap. European Journal of Operational Research (EJOR).
- Ban and Rudin (2018). The Big Data Newsvendor: Practical Insights from Machine Learning. Operations Research (OR).
- Notz and Pibernik (2020). Prescriptive Analytics for Flexible Capacity Management. Management Science (MS).
- Chen et al (2020). Retailing with 3D Printing. Production and Operations Management (POMS).

Digital Operations and Business Models (2 Lectures)

- Chapter 5 (Amit et al.)
- Richard D'Aveni (2018). Business models for additive manufacturing. Harvard Business Review (HBR).
- Marshall W. Van Alstyne, Geoffrey G. Parker, and Sangeet Paul Choudary (2016). Pipelines, Platforms, and the New Rules of Strategy. Harvard Business Review (HBR).

2 Research Profile

My research can be divided into three major strands—Operations Management, Sustainability, and Revenue Management. §6 provides details of the research done as part of funded projects. The next three sections provide the summary of my research in these areas.

2.1 Operations Management

2.1.1 Decision-theoretic and Game-theoretic Modeling of Newsvendor Problem

The newvendor model is one of two basic building blocks of inventory theory (other is the Economic Order Quantity (EOQ) model), and has been studied extensively in the literature for modeling many operations and supply chain behavior (Porteus, 2002). Post-assistant professorship, I continued working on decision-theoretic and game-theoretic modeling of newsvendor problem. In this area, our research is motivated by the literature on decision biases observed in the experimental newsvendor settings (Schweitzer and Cachon, 2000), and cooperative newsvendor games (Hartman and Dror, 1996).

Decision-theoretic Modeling The classical newsvendor model assumes that a decision maker (or newsvendor) is risk neutral, faces random exogenous demand, and chooses expected profit maximizing order. A variant of the model in which the newsvendor has an additional ordering opportunity during the selling season is known as *newsvendor problem under recourse option*. The risk-neutral newsvendor models under recourse option predicts that the optimal order quantity is insensitive to the selling price; and, for the risk-averse newsvendor under recourse option, the order quantity decreases with the increasing selling price (Eeckhoudt et al., 1995). This result is counter-intuitive, as it establishes negative relationship between order quantity (supply) and the selling price. There has been increasing focus on behavioral theories of decision making like the prospect theory (Gilboa, 2009). As part of his Ph.D. dissertation, one of my students B. Vipin proposed a prospect-theory based model that explains rational ordering behavior for the newsvendor problem under recourse. **This research is published in *European Journal of Operational Research*** (Vipin and Amit, 2017).

It has been observed in experimental validation of the newsvendor model that the decision makers depart from the normative model predictions, and exhibit decision biases like the *pull-to-center effect* (PTC) (Schweitzer and Cachon, 2000), *asymmetry-in-ordering* (Schweitzer and Cachon, 2000), and *non-linear ordering behavior* (Ockenfels and Selten, 2014). The prospect theory has been used to model the PTC effect (Long and Nasiry, 2014; Uppari and Hasija, 2014), and the asymmetry-in-ordering (Long and

Nasiry, 2014). However, these papers have limitations in explaining all the experimental observations, as well as the behavior at the extreme profit margins. As part of his Ph.D. dissertation, B. Vipin worked on the behavioral modeling of newsvendor problem to improve prediction power of the models, and we proposed a prospect theory model with stochastic-subjective reference point that explains the recent newsvendor laboratory observations. **This research is published in *Omega*** (Vipin and Amit, 2019).

Supply chain coordination using contracts has been one of the major themes of research in operations and supply chain management. With risk-neutral agents in a supply chain, it has be shown that the wholeprice contract is non-coordinating, and coordination can be achieved by the buyback contract (Snyder and Shen, 2019). Using the prospect-theory models of Vipin and Amit (2019), we are working on supply chain contracts with a behavioral retailer, and identifying conditions that ensure coordination also with the wholesale price contracts. **This paper has been accepted for publication in the journal *Computers & Industrial Engineering***.

One of the fundamental assumptions in the classical newsvendor problem is that the demand distribution is known—*decisions under risk*. The literature on experimentally studying decision biases in the newsvendor model assumes decision-making under risk. In many real-life settings, the newsvendor cannot elicit exact information about the demand distribution—*decisions under ambiguity*. I collaborated with Peeyush Mehta and Abhishek Shinde from IIM Calcutta to examine the newsvendor ordering preferences under ambiguity (Karni et al., 2015). Our study is one of the initial experimental research to examine the biases in newsvendor decisions under ambiguity. One of the key findings is the prevalence of "pull-to-center" and 'asymmetry-in-ordering' biases in newsvendor decisions under ambiguity. **This research is published in *International Journal of Production Research*** (Shinde, Mehta, and Amit, 2020).

Game-theoretic Modeling In operations management, matching demand with supply under variability and uncertainty is one of the main objectives. Inventory is one pillar of operations quadrangle to match demand with supply. As holding inventory is expensive for industries, they strive for right amount of inventory at the right place. Using the law of nature that *aggregation reduces variability*, industries that face stochastic demand centralize (or pool) their inventories to leverage risk pooling—centralization of inventory among a group of industries reduces the total cost involved due to dampening of variances in the pooled demand. Examples of inventory centralization are common in industries like fashion retailing, automobile ancillaries, etc. With the advent of technologies like blockchains and market platforms, we are witnessing evolution of cooperation through shared economies. One of the major impact of shared economies has been observed in inventory pooling. For example, Aeroxchange (`https://www.aeroxchange.com`) provides inventory pooling solutions for sellers in the aviation industry.

Coalitional game theory is the preferred modeling methodology to model inventory pooling situations. The multi-firm inventory pooling situations modeled in a coalitional game theory setting are termed as *inventory games*. In the existing literature, the common assumption made for inventory games is that the demand distribution of players and other cost parameters are common knowledge among the players in the coalition. This is not an innocuous assumption in a real world scenario. The participating firms may be competitors, and wish to centralize their inventory together to gain from risk pooling, but they may be reluctant to sharing their demand information to the competitors. One of my M.S. student Aniruda S. (Aniruda, 2014) studied the *core* (stability based solution concept) for inventory games under asymmetric information. I am currently working on other important solution concepts like the *Shapley value* (for fairness) and the *nucleolus* (for minimizing maximum dissatisfaction) for inventory games with asymmetric demand information. **This research is funded by *Science and Engineering Research Board* (SERB) under MATRICS scheme**. §6.1.4 provides the details of the project.

2.1.2 Game Theory for Ambulance Repositioning

The goal of any emergency medical system (EMS) is to provide timely and effective medical assistance to patients in trauma and save their lives. Generally, the performance of an EMS system is measured in terms of the *coverage*, where coverage is defined as the proportion of calls responded within a predefined time (Sudtachat et al., 2016; Zaffar et al., 2016). To cope up with the stochastic nature of the incoming calls and to improve the performance of the system, *dynamic policies* that reposition and dynamically assign the ambulances to any base station are becoming popular (Cady (2002), Williams (2009)). These dynamic policies can be implemented through *compliance tables*. A compliance table maps the available

ambulances to the base stations, i.e. given a certain number of idle ambulances, a compliance table will indicate the ideal base stations to which these ambulances have to be assigned.

Traditionally, in order to develop a compliance table, criticality of each base station is computed, which is defined as the number of calls received for that base station in a given duration, i.e. calls per day. For any number of given idle ambulances n, we locate these n ambulances in the base stations with top n criticality values to develop *criticality-based compliance table*. One possible drawback of such a compliance table is that criticality value does not capture how crucial the base station is for the entire system—it does not account for *positive externality* that a base station may provide to other base stations. For example, a call coming to a base station can be diverted to the next nearest base station due to unavailability of ambulance at the parent base station. In order to compute an efficient compliance table, it is imperative to include positive externality a base station provides in the ambulance network. In other words, the compliance table should map idle ambulances to the base stations that are the most important for the ambulance network. Furthermore, this is akin to the question posed by the ambulance service providers[2], "If we have only one ambulance available, where shall we locate it to improve the coverage?". This is the primary motivation for our work. We proposed to answer this question using the Shapley value,a solution concept from coaltional games, and measures the importance of a player in a coalitional game.

As part of his M.S. dissertation, my student Parthasarathy S. worked on developing the Shapley value-based compliance table for ambulance repositioning to capture the assistance a base station provides to other stations in the ambulance network. Our simulation results show that coverage under the Shapley value based compliance table is statistically significantly greater than under the criticality based compliance table. **This research is under revision for the journal *International Game Theory Review***[3].

Computation of the Shapley value comes under complexity class $\sharp\mathcal{P}$ (Shoham and Leyton-Brown, 2009), so developing a compliance table using the Shapley value is computationally complex. I am currently working with my Ph.D. student Rudramoorti T. on compact representation of the repositioning game to dynamically compute the Shapley value for real time ambulance repositioning. Initial results of this research have been accepted for presentation at SING 16 conference[4].

This research received funding as part of two projects:

1. ***Ambulance Repositioning for Improving Operational Efficiency of Emergency Medical Services* (Exploratory Research Project, IIT Madras)** (refer §6.1.7) for details).

2. ***Shapley Value based Ambulance Repositioning using Spatial-temporal Data* (Department of Science and Technology (DST))** (refer §6.1.5 for details). This project has been identified by NRDMS, DST to address challenges to fight COVID-19.

2.1.3 Advanced Manufacturing

Manufacturing paradigms have significantly evolved from craft manufacturing to personalized manufacturing. In recent years, the nature of technology has been changing. While some of the relevant core technologies have been around for some time, we are now witnessing a unique convergence of various elements such as hardware, software, network, process standards, and manufacturing. One of them is *cloud manufacturing* that melds the concepts of cloud-computing as well as recent advances in new manufacturing processes and innovative materials are disrupting the existing manufacturing knowledge base. For example, additive manufacturing as a direct production process is changing the manufacturing business due to improved material selection, material property, efficiency, and quality (Wang, 2018). Additive manufacturing is changing the linear business models of manufacturing to platform based business models (Rogers et al., 2016). Guo et al. (2015) describe how these advances can be the technology underlying cloud-based manufacturing platforms. *Voodoo manufacturing* (`https://voodoomfg.com`) is an example of additive manufacturing based platform. Ren et al. (2015) define cloud manufacturing as a

[2]Based on our research discussions with GVK-EMRI, who operates ambulance services in many states in India through a free emergency response number "108".

[3]Parathasarathy S. and R K Amit, *The Shapley Value Based Compliance Table For Ambulance Repositioning*, International Game Theory Review, Revise and Resubmit, March 2021.

[4]Paper Titled *Weighted Shapley Value for Ambulance Repositioning*, 16th European Meeting on Game Theory (SING16), Virtual Conference (Host: Universidad de Granada, Spain), June 30-July 2, 2021.

collaborative manufacturing service model—distributed manufacturing resources, software, models, and manufacturing capabilities are interconnected and pooled in cloud manufacturing platform.

Democratization of advances in manufacturing is one of the key focus of these national initiatives. Especially, India, which had lagged in previous technological revolutions, cannot miss the adoption of these advances in manufacturing to grow faster. One enabler of democratization is "cloud manufacturing". Research that studies the adoption of advanced manufacturing systems (and allied areas) is just beginning to emerge (Zhang et al., 2018). I am currently working with a Ph.D. student Balaganesh C., and Professors R. P. Sundarraj (IIT Madras), Kulwant Pawar (University of Nottingham), and Svetan Ratchev (University of Nottingham), as part of a **SPARC**[5] **project titled "Readiness Assessment of Cloud-based Manufacturing Systems"** (refer §6.1.2 for details), to develop a readiness index for cloud manufacturing, especially for MSMEs. Cloud Manufacturing Readiness Index (CMRI) will allow MSMEs to contextualize their cloud manufacturing capability with respect to its cohort group and what it needs to do compete better in the marketplace. As part of this research, we are working on an edited[6] volume titled *Advances in Digital Manufacturing Systems: Technologies, Business Models, and Adoption*, to be published by Springer Nature.

I am collaborating with Arya Bhattacharya (Mahindra University) and Tata Steel on improving performance of blast furnaces using game theory. The performance of the entire steelmaking process chain is dependent crucially on the performance of Blast Furnace. The performance of the blast furnace can be aligned along three directions—*stability*, *quality*, and *productivity*. In the blast furnace, these objectives are conflicting. In this research, we develop a game theoretic framework with agents (controllable process parameters) and objectives (stability, productivity, and product quality) that consistently ensures highest instantaneous feasible levels of stability, productivity, and quality. **This research is funded as a project titled "Development of Real-time, Adaptive Intelligent Mechanisms for Monitoring and Control of Complex Industrial Processes within Industrial IoT Frameworks" by Department of Science and Technology** (refer §6.1.6). **For this invention, we have filed a patent (Patent filed through Tata Steel, Reference no. P||1406||2||2021; Pending)**.

2.2 Sustainability

2.2.1 Recycling

With increasing environmental regulations, End-of-Life Vehicles (ELVs) recycling (or ELV management) is gaining importance. ELV recycling faces multiple challenges such as mixing of materials, uncertainty in the supply stream, volatility in prices of scrap, technological changes, and poor marketability of recycled products (Bellmann and Khare, 2000). Regulated ELV recycling markets ensure an efficient material recovery compared to unregulated markets that are prevalent in emerging economies (Hu and Wen, 2015). Unregulated recycling markets are perfectly competitive markets, and dismantlers' entry and exit decisions are based on profitability that we named as *Dismantlers' Dilemma*. As part of his Ph.D. dissertation, my student Krishna Mohan T. V. analyzed ELV recycling in an unregulated market through a system dynamics model. Using Indian data, the simulation results show that the dismantlers' dilemma leads to lower dismantling capacity that further reduces due to the increase in dismantling costs. **This research is published in *Annals of Operations Research*** (Mohan and Amit, 2020). **This research also received the *Best Paper Award* in the "Operations Track" at the Industrial & Management Engineering Doctoral Colloquium, Indian Institute of Technology Kanpur, India, 2018**. This paper is an outcome of a project titled "Studying Cooperation for Recycling at Auto-Clusters in India" funded by Nissan Research Support Program (refer §6.1.9).

We also extended this research to develop a system dynamics model to analyze dynamic competition between a formal dismantler and few homogeneous informal dismantlers in the ELV recycling markets. The simulation results show that the competition leads to reduced aggregate dismantling capacity due to the exit of informal dismantlers. One of the key findings is vertical integration of vehicle manufacturers and end-of-life management systems will ensure more environmentally sound recycling. This is in tandem with the latest developments in India—"Maruti Suzuki Toyotsu India Private Limited", a joint venture of Maruti Suzuki Limited and Toyota Tsusho is venturing into the recycling market (Economic Times; November 6, 2019). **This research is published in *Sustainable Production and Consumption***

[5] "Scheme for Promotion of Academic and Research Collaboration" Scheme, MHRD, GoI

[6] Editors: R K Amit, R P Sundarraj (IIT Madras) and Kulwant Pawar, Svetan Ratchev (University of Nottingham).

(Krishna Mohan and Amit, 2021). Our research on ELV recycling is highly relevant for understanding risks for sound ELV management, especially in the context of recently announced "Vehicle Scrappage Policy" (Business Today; March 20, 2021).

I also collaboarted with a team from IIT Kanpur comprising J. Ramkumar, B. Vipin, and Brahmesh Joshi on studying the impacts of three policy instruments (i) reduce tax on regulated recyclers, (ii) offer subsidy to regulated recyclers, and (iii) offer subsidy to formal battery remanufactures, on lead-acid battery (LAB) recycling. We developed a system dynamics model to analyze the dynamics of LAB recycling with remanufactures and recyclers in both the formal and the informal sector. Our results show that the first two policies shift the business from the informal to the formal sector with lower lead pollution. An interesting result is that a very high subsidy to the formal sector can lead to the shutting down of both regulated and unregulated recycling sectors. **This research is published in *Resources, Conservation and Recycling*** (Joshi, Vipin, Ramkumar, and Amit, 2021).

In another collaborative research with Arshinder Kaur and Rabindranath Bhattacharya from IIT Madras, we developed a a nonlinear unconstrained model to maximize closed-loop supply chain (including remanufactured products) profitability, considering price-dependent demand. **This research is published in *Journal of Cleaner Production*** (Bhattacharya, Kaur, and Amit, 2018).

2.2.2 Electric Mobility

Due to environmental concerns, electric vehicles (EVs) are gaining prominence. The heart of an EV is the energy storage system, and the popular choice is *lithium ion battery* (LIB) due to high gravimetric energy density (< 250 Wh/kg), volumetric energy density (< 650 Wh/L), power density, good cyclability, high operating voltage (~ 4 V), and low self-discharging compare to other rechargeable systems. Due to high usage of LIBs for mobility and energy storage, there is a burgeoning interest in LIBs across the globe. Bloomberg New Energy Finance (BNEF) forecasted future demand of LIBs as 408 Gigawatt hours (GWh) in 2025 and 1,293 GWh in 2030.

However, there are certain concerns that inhibit the adoption of LIBs for mobility. One challenge is the availability of the key battery materials—Lithium (Li) and Cobalt (Co) are considered *critical materials*. A material is classified as critical if it is highly important for key technologies, with few or no alternatives, and the known resources are limited in size or localized in countries from which supply cannot be guaranteed (Weil and Ziemann, 2014). Olivetti et al. (2017) discuss criticality of Co in LIB supply chain. Increasing battery material prices and concerns of resource availability will increase the research on alternative battery chemistries and recycling. For example, with increasing Cobalt prices, Tesla is moving to low cobalt batteries (Alvarez, 2018). Research is currently pursued on battery chemistries like solid-state, magnesium-sulfur, proton battery, which are easily recyclable or biodegradable (Armand and Tarascon, 2008; Hensley et al., 2012). On the other side, the battery prices are decreasing due to scale effects that will further increase the demand for batteries. Tesla says that the gigafactory is designed to reduce the battery production cost by 30% using the scale economies (Hull, 2016). Lithium ion battery prices have reduced by 73% since 2010, which is mainly due to technology improvements and economies of scale (Curry, 2017). Similarly, advances in recycling technologies may impact the demand of these materials (Gaines, 2014). It is important to understand the dynamics of critical materials for electric mobility to accelerate transition to electric mobility. With this motivation, I started research, with Shankar Venugopal (Mahindra & Mahindra), on modeling battery ecosystem. A concept paper titled *Is this time different for EV battery materials?* was presented at FISITA World Automotive Congress.[7]

I am currently working with a Ph.D. student Bhanu Pratap, along with collaborators Shankar Venugopal (Mahindra & Mahindra) and Krishna Mohan T. V. (IIM Bodh Gaya), on developing system dynamics model for understanding complex dynamics of battery ecosystem. To overcome range anxiety, EV and battery manufacturers are competing to enhance battery capacity that increases LIB cost. One of the main focus is on analyzing trade-off between performance and cost, and its impact on Li prices. Using NMC[8] 622 as battery chemistry, the model incorporates learning effects, and the simulation results indicate low LIB cost per kWh and high LIB demand can be achieved with lower battery capacity and lower battery life. This can be achieved with the business models like mobility-as-a-service (MaaS). This research has been accepted for presentation at the International System Dynamics Conference, July

[7] Shankar Venugopal and R K Amit, *Is this time different for EV battery materials?*, FISITA World Automotive Congress, Chennai, October 2-5, 2018.

[8] The cathode material Lithium Nickel Cobalt Manganese Oxide is abbreviated as NMC.

25-30, 2021[9]. We are extending this research to other chemistries like NMC 811, as well as battery competition.

I also did an industrial consultancy for Societe Generale titled *Understanding Battery Ecosystem* (refer §6.2.3) with the focus on mapping supply chain risks associated with different chemistries in the battery ecosystem.

2.2.3 Water Management

I concluded my collaborative research with Subash S (HSS, IIT Madras) on estimating coping costs of accessing safe water in Chennai. Sustainable Development Goal (SDG) 6.1 is "to achieve universal and equitable access to safe and affordable drinking water for all". This research reinforced the relevance of SDG 6.1. One of the policy implications is that affordability can be enhanced by reducing collection time and increasing reliability of water supply. This can be achieved through piped connections. **This research is published in *Resources, Conservation and Recycling*** (Amit and Sasidharan, 2019). This research was funded by SANDEE (refer §6.1.12).

2.3 Revenue and Pricing Management

Revenue management (RM) refers to the collection of strategies and tactics firms use to scientifically manage demand for their products and services (van Ryzin and Talluri, 2005). It is mainly applied in industries, like the airlines, which have products or services that are perishable, demand is stochastic, and capacity is constrained. The success of RM strategies depends on accurately forecasting demand. Traditional forecasting models in RM assume that the demand for products are independent for separate fare-classes (Littlewood, 2005; Belobaba, 1987, 1989). This assumption does not hold good since the demand for products is dependent on the choices available at the time of purchase. *Discrete-choice models* with two parts: *volume* forecast and *choice* forecast were introduced in airline RM research to account for choices of the customer (van Ryzin, 2005). Fiig et al. (2014) discuss the multiplicative demand model that combines demand volume and customer choice. They assume that the choice probability is independent of departure day. Existing literature does not record any dependent demand model that jointly predicts the demand volume and the customer preferences based on the choices available, and the customers' willingness-to-pay. As part of her dissertation, my Ph.D. student Kavitha Balaiyan proposed models that can jointly predict the demand volume and the customer's choice preferences for a product, based on the options available at the time of purchase. One of major challenge is the estimation of model parameters due to the introduction of choice models (mixed-logit) into the demand model, changes in available options over the booking horizon, and accounting for the willingness-to-pay of the customers in the demand model. We proposed different methods for estimation, and the forecasting models are tested on the data generated by APOS[10] from the real airline data. This work was a collaborative research with a team of SABRE Inc., and is published in ***Journal of Revenue and Pricing Management*** (Balaiyan, Amit, Malik, Luo, and Agarwal, 2019). **This research also received "Best Research Paper Award–First Prize" in the Doctoral Consortium at the XXII Annual International Conference of the Society of Operations Management (SOM 2018)**[11].

Even though airline revenue management techniques have evolved to capture customer-choice behavior, the pricing and allocation decisions continue to be taken independently till date. However, since fares and allocation are related, a single optimization model can address this shortcoming. Using the forecasting models, Ms. Kavitha formulated an optimization model to jointly analyze prices and seat allocation. My M.S. student Aparna Jairam extended the formulation, and developed a joint optimization model that considers both product prices and their respective allocation quantities as decision variables. A sequential optimization technique that divides the model into two decision problems is adopted to deal with the complexity of formulation, and a new heuristic "Elasticity-integrated Pricing and Allocation Heuristic (EPAH)" is proposed that shows consistent increase in revenues, compared to APOS revenues.

[9] Paper Titled: *Modeling the performance and cost dynamics of Lithium-ion Battery for Mobility*, 39th International System Dynamics Conference, Virtual, July 25-30, 2021

[10] Airline Planning and Operations Simulator, an in-house simulation tool developed by SABRE Inc.

[11] Paper titled *Simulation based Estimation for Joint Forecasting Models in Airline Revenue Management*, Doctoral Consortium, XXII Annual International Conference of the Society of Operations Management (SOM 2018), IIM Kozhikode, December 20-22, 2018.

This research was presented at the XXIII Annual International Conference of the Society of Operations Management (SOM 2019)[12].

In recent years, ancillary revenue management is gaining importance. Ancillaries are products that bring additional revenue beyond the sale of tickets by direct sales to passengers or indirectly as a part of the travel experience (Tuzovic et al., 2014). Offering ancillaries allows airlines to keep their ticket prices low while giving customers a personalized experience. Among all sources of ancillary revenue, baggage fee is identified as an essential component since this alone contributes 3.2% of the global airline revenue (**?**). However, there is no consensus in setting the baggage prices across the industry. A customer's excess baggage is charged based on either the number of pieces or the weight and is sometimes route-specific. For his Ph.D. dissertation, my student Prabhupad Bharadwaj, in collaboration with Shao Hung Goh (Singapore Management University), is currently working on optimal baggage pricing. We adopt a linear programming approach to maximize the piece-based revenue, while maintaining a revenue-equivalence between weight and piece-based pricing. Results depict that our model prices are generally aligned with current industry pricing policies, with a higher revenue reported from the model. This method simplifies the complex structure of baggage pricing and proposes a pricing alternative for the industry. This research was presented at AGIFORS Annual Symposium 2020[13] and AGIFORS RM Study Group Meeting, 2021[14]. Another Ph.D. student, Dhandapani S. is working on upgrades-aware overbooking policy. This research aims to determine the optimal number of upgrades and the relationship between show-ups and upgrades, which is a key driver in providing upgrades. The results indicate that while offering upgrades, imposing service level constraints helps maintain airlines' reputation. Furthermore, we find that free upgrades depend on show-ups in both the classes, whereas paid upgrades depend only on show-ups in the higher class. This research has been accepted for presentation at the 25th International Symposium on Logistics (ISL 2021)[15].

I also did an industrial consultancy for Societe Generale titled *Pricing of Cashberry* (refer §6.2.2) on pricing a new product.

2.4 Past Research

My past research can be divided into two major areas—game & decision theory and operations management.

2.4.1 Game & Decision Theory

2.4.1.1 Coalitional Games with Externalities

Traditionally, game theory has been divided into noncooperative games—modeling unit is an individual; and cooperative (or coalitional) games—modeling unit is a coalition. In coalitional games, coalitions are formed of selfish and rational agents; and the set of different coalitions is known as coalition structure. One of the fundamental questions in coalitional games is the stability of a coalition structure. Tradionally, coalitional game theory assumes that the payoff to a coalition is independent of the coalition structure. However, there are situations when payoff to a coalition also depends on the non-members existing in the game. In coalitional game theory, externality is defined as a situation when payoff of a coalition also depends on the coalition structure. Coalitional games with externality are represented as *partition function form* (Thrall and Lucas, 1963). Many extensions of the classical *core* have been proposed in the literature for the partition function form games. However, the core of coalitional games in the presence of externalities can be empty (Funaki and Yamato, 1999; Koczy, 2007). With this motivation, I worked, with Ph.D. student Rajeev Ranjan Tripathi, on a nonempty and stable solution concept for games with externalities. We introduced a payoff division rule, called *equality of satisfaction values* to obtain stable outcome. We show that the division rule is an equivalence relation, and using the fundamental

[12]Paper Titled: *oint optimization of airline pricing and seat allocation under choice-based demand*, XXIII Annual International Conference of the Society of Operations Management (SOM 2019), IIT Kanpur, December 20-21, 2019.

[13]Paper Titled: *Optimal Revenue-Equivalence Baggage Pricing for Airlines*, AGIFORS' 60th Annual Symposium, Virtual, October 20 – 23, 2020.

[14]Paper Titled: *Baggage Pricing Model: An Ancillary Revenue Opportunity*, AGIFORS, Revenue Management SG Meeting, Virtual, May 4-6, 2021.

[15]Paper Titled: *Understanding Upgrades-Aware Overbooking Policy*, 25th International Symposium on Logistics (ISL 2021), Virtual, July 12-13, 2021.

theorem of equivalence relation, we prove that the stable outcome is always nonempty. We named our solution concept: *equivalence nucleolus*. **This research is published in *Operations Research Letters*** (Tripathi and Amit, 2016)).

Another restrictive assumption in the classical cooperative game theory literature is that the payoff to a coalition is deterministic. This assumption is relaxed in a class of games, called the *stochastic cooperative games*. Cooperative game under stochastic payoffs for characteristic function form games was first introduced by Charnes and Granot (1973) as *chance-constrained games*. In many real cases, both externalities and stochasticity of payoffs may exist together. However, the literature on cooperative games is yet to discuss this scenario. To the best of our knowledge, Habis and Csercsik (2014) seems to be the only work on partition function games under stochastic payoffs. They introduce a game, called *partition function game with uncertainty* and propose a stability based solution concept, called *sustainable core* which is an extension of the recursive core (Koczy, 2007) and the weak sequential core (Herings et al., 2006). We extended equivalence nucleolus to this class of games. **This research received the *Best Doctoral Research Paper Award* at the PAN IIM World Management Conference 2016, IIM Ahmedabad**.

2.4.2 Operations Management

2.4.2.1 Shelf-Space Dependent Demand

Retailers use shelf-space as a levers to stimulate demand. In this research, jointly with my Ph.D. student Rajeev Tripathi and Peeyush Mehta from IIM Calcutta, we computed an optimal shelf-stocking policy when demand is shelf-space dependent. We used the concept of stochastic dominance to model the endogenous impact of stocking level on the realized demand. **This research is published in *European Journal of Operational Research*** (Amit et al., 2015).

We also extended this research to multi-agent settings, with the objective of designing *individually rational contracts* to coordinate the supply chain with inventory-level-dependent demand. We considered buyback contracts. A continuum of buyback contracts coordinate the supply chain that may not be individually rational (Cachon and Terwiesch, 2009; Lariviere, 1999). We used the Shapley value from coalitional game theory that ensures fairness and individual rationality in the buyback contract. This is a joint work with Peeyush Mehta, Sanjeev Swami, Kripa Shanker, and L. Devangan; and, published in ***International Journal of Production Economics*** (Devangan, Amit, Mehta, Swami, and Shanker, 2013).

2.4.2.2 Inventory-Dependent Bargaining Models

One of my Ph.D. students, Ramkishore K. R. completed his dissertation on inventory-dependent bargaining mechanisms over the finite and infinite horizon. Following Myerson (1985), we considered four bilateral bargaining mechanisms in static settings—price negotiation, splitting the difference between seller's and buyer's offer, buyer posted price, and seller posted price. We compared these mechanisms in dynamic settings, with consideration of refusal cost. We found that the seller prefers posting prices when the refusal cost is low. Seller is indifferent between buyer posted price and negotiation for the high refusal cost. **This research is published in *International Journal of Operational Research*** (Ramkishore and Amit, 2019).

2.4.2.3 Newsvendor Models

Newsvendor Games under Asymmetric Information Firms, which face stochastic demand, centralize their inventory to take advantage of the reduced cost, due to dampening of variances in the pooled demand (risk pooling). In such inventory pooling situations in a decentralized supply chain, the central question is how to divide this profit among the agents in the coalition such that the coalition is stable. Coalitional game models of this scenario are called the *stochastic inventory games* or the *newsvendor games*. One of my M.S. by Research students, S. Aniruda modeled newsvendor games with asymmetric demand information, and named them *Bayesian Inventory Games* (BIG). In BIG, each player has a finite set of possible demand distribution, thereby yielding a set of possible newsvendor games. Each player has private information of his distribution and Bayesian updated belief over possible demands of other players. As payoff is uncertain, following Samuel and Shoham (2008), we assumed players form contracts

specifying payoff allocation for each newsvendor game. We showed that BIG has non-empty core if the cost parameters are identical for players. We used duality approach and obtain weights over every demand profile possibles within a coalition for all coalitions to define necessary and sufficient condition for non-emptiness of the BIG core. This research was presented at MSOM 2014[16].

My other M.S. student, John Mathew studied noncooperative newsvendor games under asymmetric information. In this research, we aggregated the individual demand forecasts to get the total industry demand. We computed the equilibrium based on a player's belief about the order quantity of the other player. Also we showed the existence of an equilibrium and show its uniqueness under fairly general assumptions. This research was presented as a poster in MSOM 2013[17].

Behavioral Modeling of Newsvendor Problem In a seminal experimental work in the newsvendor problem, Schweitzer and Cachon (2000) observe the *pull-to-center* (PTC) effect—the average order quantity on aggregate level being above (below) the risk-neutral optimal order quantity in the low (high) profit setting. Studies following Schweitzer and Cachon (2000) reinforces the prevalence of the PTC effect (Bolton and Katok, 2008; Bostian et al., 2008; Kremer et al., 2010; Ockenfels and Selten, 2014). One of my Ph.D. students B. Vipin initiated research on prospect-theoretic modeling of newsvendor problem to explain the observed biases (refer §2.1.1 for the results).

2.4.2.4 Relational Contracts

One other interesting research area in supply chain contracts is relational contracting. In a typical supply chain, there are conflicting objectives of multiple agents. These conflicting objectives reduce the overall supply chain performance. Supply chain coordination with contracts has emerged as one of the key strategies to mitigate the inefficiencies due to conflicting objectives. The literature on supply chain coordination is predominantly limited to one-shot contracts; however, Cachon (2003) observes that most supply chain interactions are long term with many opportunities to renegotiate, and most long-term contracts are *incomplete* and *relational*. I published, jointly with Peeyush Mehta, a review paper on relational supply chain contracts (Amit and Mehta, 2010).

One of my M.S. students, Kavitha C. considered relational contracts for truthful forecast sharing between a supplier and multiple retailers. To achieve efficient supply chain performance, forecast information from retailers is of utmost importance to the supplier, as it helps the supplier to plan and build his capacity. As the forecast information is non-verifiable, contracting is mainly incomplete. In this research, we assumed that the forecasts of the retailers are correlated, and conducted a credibility test with multiple reviews to ensure credible punishment to deviating retailers. This ensures truthful sharing of forecast information by the retailers. A revised version of this research has been accepted as book chapter[18].

2.5 Ph.D. Research

In my Ph.D. thesis titled "Topics in Demand Management", I studied the problem of matching the demand with available supply, especially for a scarce resource. Using water as the scarce resource in urban water supply systems, the main focus was to design price-based dynamic contracts that promote rational water use, reflect the opportunity costs of water, and are socially appropriate. One of the major result of the thesis is finite-horizon fair contracts cannot be efficient (published in ***Water Resources Management***: Amit and Ramachandran (2010)). It is shown infinite-horizon contracts achieves economic efficiency and revenue sufficiency (published in ***Urban Water Journal***: Amit and Ramachandran (2012)). One of the important solution concepts in cooperative game theory is the Shapley value. The last part of the thesis focused on exchangeability aspects, and derive the Shapley value

[16] Paper Titled *Modeling of Bayesian Inventory Games and Non-emptiness of their Core* at the Manufacturing and Service Operations management (MSOM) 2014 Conference, Seattle, USA, June, 2014.

[17] Poster Titled *Some Results in the Competitive Newsvendor Model* at the Manufacturing and Service Operations management (MSOM) 2013 Conference at INSEAD, Fontainbleau, France, July 2013.

[18] Kavitha C, R K Amit, B. Vipin, "Truthful Information Sharing in a Multi-Retailer Supply Chain: Role of Review Strategies", *Emerging Frontiers in Operations and Supply Chain Management: Theory and Applications*, B. Vipin, C. Rajendran, Ganesh Janakiraman, Deepu Philip (Editors), Springer Verlag, Singapore, Forthcoming. https://www.springer.com/in/book/9789811627736#aboutBook

using exchangeability (published in ***International Game Theory Review***: Amit and Ramachandran (2013)).

3 Publications

I have been publishing papers in leading journals with my research students and collaborators.

3.1 Journal Publications

1. P Kesavapanikkar, R K Amit, P Ramu, "Product as a service (PaaS) for traditional product companies: an automotive lease practice evaluation", **Journal of Indian Business Research**, 15(1), 40-54, 2023. https://doi.org/10.1108/JIBR-04-2022-0107.

2. D Srinivasan, R K Amit, WC Chiang, "Air cargo revenue management: a state-of-the-art review", **International Journal of Revenue Management**, 13 (3), 144-165, 2023. https://doi.org/10.1504/IJRM.2023.130752.

3. T Rudramoorthi and RK Amit, "Repositioning Game for Ambulance Services", **Transportation Research Record**. 2023. https://doi.org/10.1177/03611981221144294. (Impact Factor: 2.019)

4. Pratap Bhanu and T V Krishna Mohan and R K Amit and Venugopal Shankar, "Factors affecting the market dynamics of lithium-ion battery for electric mobility: a system dynamics perspective", **Journal of Simulation**. 2023. https://doi.org/10.1080/17477778.2022.2150578. (Impact Factor: 2.543)

5. B. Vipin and R K Amit, "Wholesale Price versus Buyback: A Comparison of Contracts in a Supply Chain with a Behavioral Retailer", **Computers & Industrial Engineering**, 162. 2021. https://doi.org/10.1016/j.cie.2021.107689 (Impact Factor: 5.431)

6. Brahmesh Vinayak Joshi, B Vipin, Janakarajan Ramkumar, and R K Amit, "Impact of Policy Instruments on Lead-acid Battery Recycling: A System Dynamics Approach", **Resources, Conservation, & Recycling**, 169, 2021. https://doi.org/10.1016/j.resconrec.2021.105528. (Impact factor: 10.204)

7. T. V. Krishna Mohan and R K Amit, "Modeling Oligopsony Market for End-of-Life Vehicle Recycling", **Sustainable Production and Consumption**, 25, 325-346, 2021. https://doi.org/10.1016/j.spc.2020.09.001. (Impact Factor: 5.032)

8. Abhishek Shinde, Peeyush Mehta, R K Amit, "An experimental investigation of newsvendor decisions under ambiguity", **International Journal of Production Research**, in press, 2020. https://doi.org/10.1080/00207543.2020.1797206. (Impact Factor: 8.568)

9. T. V. Krishna Mohan and R K Amit, "Dismantlers' dilemma in End-of-Life Vehicle Recycling Markets: A System Dynamics Model", **Annals of Operations Research**, 290 (1), 591-619, 2020. https://doi.org/10.1007/s10479-018-2930-z. (Impact Factor: 4.854)

10. K Balaiyan, R K Amit, A K Malik, X Luo, A Agarwal, "Joint Forecasting for Airline pricing and Revenue Management", **Journal of Revenue and Pricing Management**, 18,465–482, 2019. https://doi.org/10.1057/s41272-019-00188-4. (Impact Factor: 0.78)

11. B. Vipin and R K Amit, "Describing Decision Bias in the Newsvendor Problem: A Prospect Theory Model", **Omega**, Volume 82, 132-141, 2019. https://doi.org/10.1016/j.omega.2017.12.008. (Impact Factor: 7.084)

12. R K Amit and S Subash, "Measuring Affordability of Access to Clean Water: A Coping Cost Approach", **Resources, Conservation, & Recycling**, 141, 410-417, 2019. https://doi.org/10.1016/j.resconrec.2018.11.003. (Impact factor: 10.204)

13. R. Bhattacharya, A. Kaur, and R K Amit, "Price Optimization of Multi-stage Remanufacturing in a Closed Loop Supply Chain", **Journal of Cleaner Production**, 186:943-962, June 2018. https://doi.org/10.1016/j.jclepro.2018.02.222. (Impact Factor: 9.297)

14. B. Vipin and R K Amit, "Loss Aversion and Rationality in the Newsvendor Problem under Recourse Option", **European Journal of Operational Research**, 256(1):563-571, 2017. https://doi.org/10.1016/j.ejor.2017.02.012. (Impact Factor: 5.334)

15. K. R. Ramkishore and R K Amit, "Optimal Bargaining Mechanisms with Refusal Cost", **International Journal of Operational Research**, 35 (1), 54-66, 2019. http://dx.doi.org/10.1504/IJOR.2019.099543.

16. Rajeev R. Tripathi and R K Amit, "Equivalence Nucleolus for Coalitional Games with Externalities", **Operations Research Letters**, 44(2): 219-224, 2016. https://doi.org/10.1016/j.orl.2016.01.007. (Impact Factor: 1.154)

17. Arya Kumar Srustidhar Chand and R K Amit, "Capital Rationing under Perfect Information", **Economics Bulletin**, 35(2):878-884, 2015.

18. R K Amit, P. Mehta, and R. R. Tripathi, "Optimal Shelf-Space Stocking Policy using Stochastic Dominance under Supply-driven Demand Uncertainty", **European Journal of Operational Research**, 246(1):339-342, 2015. https://doi.org/10.1016/j.ejor.2015.04.031 (Impact Factor: 5.334)

19. R K Amit and P. Ramachandran, "Aspects of Exchangeability in the Shapley value", **International Game Theory Review**, 15(4), 2013. https://doi.org/10.1142/S0219198913400288.

20. L. Devangan, R K Amit, P. Mehta, S. Swami, and Kripa Shankar, "Individually Rational Buyback Contracts with Inventory Level Dependent Demand", **International Journal of Production Economics**, 142(2):381-387, 2013. https://doi.org/10.1016/j.ijpe.2012.12.014. (Impact Factor: 7.885)

21. R K Amit and P. Ramachandran, "A Relational Contract for Water Demand Management under Market Failure", **Urban Water Journal**, 10(3):209-215, 2012. https://doi.org/10.1080/1573062X.2012.724076. (2019 Impact Factor: 2.081)

22. R K Amit and P. Mehta, "Repeated Contracts for Supply Chain Coordination under Asymmetric Information: A Review and Future Directions", **Technology, Operations and Management**, 1(2): 31-36, 2010.

23. R K Amit and P. Ramachandran, "A Fair Contract for Managing Water Scarcity", **Water Resources Management**, 24(6):1195-1209, 2010. https://doi.org/10.1007/s11269-009-9491-5. (Impact Factor: 3.517)

3.2 Refereed Conference Proceedings

1. Bhanu Pratap, T V Krishna Mohan, R K Amit and Shankar Venugopal, "A Road Map to Sustainable Mobility: Analyzing the Dynamics of Lithium-Ion Battery Recycling", 2021 IEEE Transportation Electrification Conference (ITEC-India), New Delhi, India, 2021.

2. Dhandabani S, R K Amit, Atul Kumar Malik, "Understanding Upgrades-Aware Overbooking policy", International Symposium on Logistics 2021, Virtual Conference, July 12-13, 2021.

3. Bhanu Pratap, T V Krishna Mohan, R K Amit and Shankar Venugopal, "Visualizing the Complex Demand and Supply Dynamics of Critical Battery Materials: A Key Enabler for Realizing the Electric Mobility Vision 2030", 2019 IEEE Transportation Electrification Conference (ITEC-India), Bengaluru, India, December 17-19, 2019.

4. Peeyush Mehta and R K Amit, "Newsvendor Models and Biases under Ambiguity", 9th International Conference on Industrial Engineering and Operations Management, Bangkok, March 5-7, 2019.

5. Shankar Venugopal and R K Amit, "Is this time different for EV battery materials?", FISITA World Automotive Congress,Chennai, October 2-5, 2018.

3.3 Refereed Conference Presentations

1. Bhanu Pratap, T V Krishna Mohan, R K Amit and Shankar Venugopal, "Modeling the performance and cost dynamics of Lithium-ion Battery for Mobility", 39th International System Dynamics Conference, Virtual Conference, July 26-30, 2021 [Paper Presentation].

2. Rudramoorthy T. and R K Amit, "Weighted Shapley Value for Ambulance Repositioning", 16th European Meeting on Game Theory (SING16), Virtual Conference (Host: Universidad de Granada, Spain), June 30-July 2, 2021 [Paper Presentation; Accepted].

3. Prabhpad Bharadwaj, R K Amit, Atul Kumar Malik, Shao Hung Goh, "Baggage Pricing Model: An Ancillary Revenue Opportunity", AGIFORS, Revenue Management SG Meeting, Virtual Conference, May 4-6, 2021 [Paper Presentation; Only presentation from an Asian academic institute].

4. Prabhpad Bharadwaj, R K Amit, Atul Kumar Malik, Shao Hung Goh, "Optimal Revenue-Equivalence Baggage Pricing for Airlines", AGIFORS' 60th Annual Symposium, Virtual Conference, October 20 – 23, 2020 [Paper Presentation].

5. Rudramoorthy T. and R K Amit, "Locating Accident Spots in Ambulance Trajectories", International Workshop on Urban Operations Research 2019, Nanzan University Japan, July 19-21, 2019 [Paper Presentation].

6. T V Krishna Mohan and R K Amit, "Competing for End-of-Life Vehicles: Dismantlers' Strategies in Recycling Markets", 51st Annual Convention of the Operational Research Society of India (ORSI) the International Conference, Indian Institute of Technology Bombay, India, December 16-19, 2018 [Paper Presentation].

7. Kavitha Balaiyan, R K Amit, Xiaodong Luo, Amit Agarwal, "Simulation based Estimation for Joint Forecasting Models in Airline Revenue Management", XXII Annual International Conference of the Society of Operations Management (SOM 2018), IIM Kozhikode, December 20-22, 2018 [Paper Presentation; Awarded *Best Research Paper Award–First Prize* at the Doctoral Consortium].

8. T V Krishna Mohan and R K Amit, "Dismantlers' Dilemma in End-of-Life Vehicle Recycling Markets in Emerging Economies", 10th Annual Alliance for Research on Corporate Sustainability (ARCS) Research Conference, Sloan School of Management, MIT, USA, June 11-13, 2018 [Paper Presentation].

9. Kavitha Balaiyan, R K Amit, Atul Kumar Malik, Xiaodong Luo, "Joint Forecasting for Airline Pricing and Revenue Management", AGIFORS-Revenue Management Study Group meeting, Hong Kong, May 2018 [Paper Presentation].

10. T V Krishna Mohan and R K Amit, "Dismantlers' Dilemma in End-of-Life Vehicle Recycling Markets: Insights from Emerging Economies", Industrial & Management Engineering Doctoral Colloquium, Indian Institute of Technology Kanpur, India, April 7-8, 2018 [Paper Presentation; *Best Paper Award in the "Operations Track"*].

11. T V Krishna Mohan and R K Amit, "Dismantlers' Dilemma in ELV Recycling Markets: A System Dynamics Model", XXIst Annual International Conference of the Society of Operations Management (SOM), Ahmedabad University, India, December 21-23, 2017 [Paper Presentation].

12. Aniruda S, Rajeev R. Tripathi, Vipin B, and R K Amit, "Stable Allocation of Profit in a Bayesian Inventory Game", East Asian Game Theory Conference 2017, Singapore, July 31-Aug 2, 2017 [Paper Presentation].

13. Parthasarathy S. and R K Amit, "Ambulance Relocation policies for improving the operational efficiency of EMS", INFORMS Healthcare 2017, Rotterdam, July 26-28, 2017 [Paper Presentation].

14. Rajeev R. Tripathi and R K Amit, "On the Stability of Coalitions When Externalities and Stochasticity Co-exist", 28th International Conference on Game Theory at Stony Brook, New York, USA, July 17-21, 2017 [Paper Presentation].

15. T V Krishna Mohan and R K Amit, "An Analysis of End-of-Life Vehicle (ELV) Recycling in Emerging Economies", 35th International System Dynamics Conference, Sloan School of Management, MIT, USA, July 16-20, 2017 [Paper Presentation].

16. Rajeev R. Tripathi and R K Amit, "Foresighted Nucleolus for Partition Function Games with Stochastic Payoffs", PAN IIM World Management Conference 2016, IIM Ahmedabad, December 13-15, 2016 [Paper Presentation; *Best Doctoral Research Paper Award*].

17. Vipin B. and R K Amit, "Loss Aversion and Rationality in the Newsvendor Problem under Recourse Option", Manufacturing and Service Operations management (MSOM), June 30 - July 1, 2016, University of Auckland , New Zealand [Paper Presentation].

18. R. R. Tripathi and R K Amit, "Coalitional Games under Externalities and Stochasticity of Payoff", European Meeting on Game Theory (SING 12), University of Southern Denmark, July 11–13, 2016 [Paper Presentation].

19. Ramkishore K. R. and R K Amit, "Optimal Inventory-dependent Bargaining Mechanisms", Manufacturing and Service Operations Management (MSOM) 2015, June 28-30, 2015, Rotman school of management, University of Toronto, Canada [Poster Presentation].

20. Kavitha C. and R K Amit, "Review strategies for truthful forecast information sharing in a multi retailer supply chain". Manufacturing and Service Operations Management (MSOM), Rotman School of Management, University of Toronto, June 28-30 2015, Toronto, Canada [Poster Presentation].

21. Vipin B. and R K Amit, "Decision Bias in the Newsvendor Problem: A Prospect Theory Approach", Manufacturing and Service Operations Management (MSOM), Rotman School of Management, June 28-30, 2015, University of Toronto [Poster Presentation].

22. Vipin B. and R K Amit, "Newsvendor Problem and Pull To Center Effect: A Prospect Theory Approach", 10th Annual Behavioral Operations Conference (BOC), June 24-26, 2015, Cornell University [Paper Presentation].

23. S. Aniruda and R K Amit, "Modeling of Bayesian Inventory Games and Non-emptiness of their Core", Manufacturing and Service Operations management (MSOM) 2014 Conference, Seattle, USA, June, 2014 [Paper Presentation].

24. John Mathew and R K Amit, "Some Results in the Competitive Newsvendor Model", Manufacturing and Service Operations management (MSOM) 2013 Conference, INSEAD, Fontainbleau, France, July 2013 [Poster Presentation].

25. R. R. Tripathi and R K Amit, "Stability of Coalitional Games in Partition Function Form", 9th Spain-Italy-Netherlands Meeting on Game Theory (SING9), Vigo (Spain), July 8-10, 2013 [Paper Presentation].

26. P. Kumar, A. K. Singh, and R K Amit, "Priority Functions in Recurrent Combinatorial Auctions", GAMES 2012—The Fourth World Congress of the Game Theory Society, Istanbul, July 22-26, 2012 [Poster Presentation].

27. N. Karthikram, R. K. Rajagopal, G. Janarthanan, and R K Amit, "Anchoring Bias in Forecast Information Sharing in a Supply Chain", FUR XV—The Fifteenth Biennial International Conference on the Foundations and Applications of Utility, Risk and Decision Theory, Atlanta, June 30-July 03, 2012 [Paper Presentation].

28. R K Amit and P. Ramachandran, "Aspects of Exchangeability in the Shapley value", International Conference on Game Theory, Operations Research and their Applications (GTORA 2012), Indian Statistical Institute, Chennai, January 5-7, 2012 [Paper Presentation].

29. D. Deepak, R K Amit, and P. Mehta, " Efficiency Analysis of Relational Contracts in Three Level Supply Chain", XV Annual International Conference of the Society of Operations Management, IIM Calcutta, December 16-18, 2011 Paper Presentation].

30. R K Amit and P. Ramachandran, "Dynamic Contract for Demand Management in Urban Water Supply Systems", EAERE 2009, Amsterdam, Netherlands, June 24-27 2009 [Paper Presentation].

31. R K Amit and P. Ramachandran, "A Fair and Efficient Dynamic Contract for Demand Management in Water Utilities", AICSOM 2008, IIT Kanpur, India, December 19-21 2008 [Paper Presentation].

32. R K Amit, "Dynamic Contracts for Water Demand Management", Doctoral Symposium, IISc - IBM Research Third Operations Research and Data Analytics Workshop, IISc, Bangalore, India, March 3-4 2008 [Paper Presentation; *Awarded as one of the three commendable presentations*].

33. R K Amit and P. Ramachandran, "Optimal Design of Water Distribution Networks: A Review", ICORAID-2005-ORSI, Bangalore, India, December 27-29 2005 Paper Presentation].

3.4 Books

1. R K Amit, R P Sundarraj, Kulwant Pawar, Svetan Ratchev (Editors), **Advances in Digital Manufacturing Systems: Technologies, Business Models, and Adoption**, Springer Nature Singapore Pte Ltd, 2023. https://link.springer.com/book/10.1007/978-981-19-7071-9

2. R K Amit and Peeyush Mehta, **Game Theory with Applications in Operations Management**, Springer India, Forthcoming. https://www.springer.com/gp/book/9788132239451

3.5 Book Chapters

- Kavitha C, R K Amit, B. Vipin, "Truthful Information Sharing in a Multi-Retailer Supply Chain: Role of Review Strategies", *Emerging Frontiers in Operations and Supply Chain Management: Theory and Applications*, B. Vipin, C. Rajendran, Ganesh Janakiraman, Deepu Philip (Editors), Springer Verlag, Singapore, Forthcoming. https://www.springer.com/in/book/9789811627736#aboutBook

4 Awards and Patents

4.1 Awards

- Paper titled "Simulation based Estimation for Joint Forecasting Models in Airline Revenue Management", with Ph.D. student Ms. Kavitha Balaiyan and collaborators from Sabre, received the *Best Doctoral Research Paper-First Prize* at the Doctoral Consortium, XXII Annual International Conference of the Society of Operations Management (SOM 2018), IIM Kozhikode.

- Paper titled "Dismantlers' Dilemma in End-of-Life Vehicle Recycling Markets: Insights from Emerging Economies", with Ph.D. student T. V. Krishna Mohan, received the *Best Paper Award* in the "Operations Track" at the Industrial & Management Engineering Doctoral Colloquium, Indian Institute of Technology Kanpur, India, 2018.

- Paper titled "Foresighted nucleolus for partition function games with stochastic payoffs", with former Ph.D. student Dr. Rajeev R. Tripathi, received the *Best Doctoral Research Paper Award* at the PAN IIM World Management Conference 2016, IIM Ahmedabad. This paper is based on Dr. Rajeev's Ph.D. dissertation.

- Received the Academic Senate citation for teaching excellence as an instructor for the course "Introduction to Game Theory" (IME 636) taught during Jan-Apr 2010 at IIT Kanpur.

- Awarded as one of the three commendable presentations at the Doctoral Symposium held in conjunction with IISc-IBM Research Third Operations Research and Data Analytics Workshop, Bangalore, March 2008.

4.2 Patents

- Arya K. Bhattacharya (Mahindra University), Sujan Hazra (Tata Steel), Kumar Deepanshu (Tata Steel), Samik Nag (Tata Steel), Artika Agrawal (Mahindra University), R K Amit (IIT Madras), "Perpetual Optimal Performance of Industrial Reactor applying principles of Game Theory", Patent filed through Tata Steel (Reference no. P||1406||2||2021; Pending) (refer §2.1.3 for details).

5 Research Guidance

I have been guiding research students across various research programs. The graduated students (**Ph.D.: 4; M.S. by Research: 6**) had joined academics in the top academic institutes in India, or research-oriented positions in leading business organizations. This section lists the research students guided by me. ★ indicates graduated students. The technical details of their research are summarized in §2.

5.1 Ph.D. Students

1. **Rajeev R. Tripathi ★**
   - Thesis Title: Stability of Coaltional Games with Externalities
   - Status: Graduated (2016)
   - Affiliation: Assistant Professor, Operations Management Group, IIM Bangalore
2. **Vipin B. ★**
   - Thesis Title: Essays on Prospect Theory in Inventory Decisions
   - Status: Graduated (2017)
   - Affiliation: Assistant Professor, Department of Industrial and Management Engineering, IIT Kanpur
3. **Ramkishore K. R. ★**
   - Thesis Title: Topics in Inventory-dependent Bargaining Mechanisms
   - Status: Graduated (2018)
   - Affiliation: Zycus Infotech
4. **Krishna Mohan T.V. ★**
   - Thesis Title: Understanding the Dynamics of End-of-Life Vehicle Recycling Markets
   - Status: Graduated (2019)
   - Affiliation: Assistant Professor, Operations Management, IIM Bodh Gaya
5. **Kavitha B. ★**
   - Thesis Title: Dependent-Demand Forecasting AND Optimization for Airline Pricing and Revenue Management
   - Status: Graduated (2022)
   - Affiliation: Ford Motors
6. **Pradeep P. K.**
   - Thesis Title: Understanding New Product Failures
   - Co-guide: Dr. P. Ramu (Engineering Design, IIT Madras)
   - Status: Ongoing (Joined in July 2016 as an IDRP Part-time Student) (Research Proposal Seminar Completed)
7. **Bhanu Pratap**

- Thesis Title: Understanding Battery Ecosystem for Electric Mobility
- Status: Ongoing (Joined in July 2017) (Research Proposal Seminar Completed)

8. **Rudramoorthi T.**
   - Thesis Title: Compact Representations of Ambulance Repositioning Games
   - Status: Ongoing (Joined in July 2017) (Research Proposal Seminar Completed)
9. **Balaganesh C.**
   - Thesis Title: Readiness Assessment of Digital Manufacturing (Tentative)
   - Co-guide: Professor R P Sundarraj
   - Status: Ongoing (Joined in July 2018) (Comprehensive Examination Completed)
10. **Dhandabani S.**
    - Thesis Title: Topics in Overbooking Policy (Tentative)
    - Status: Ongoing (Joined in July 2018 for MS Program, converted to Ph.D. in January 2020) (Research Proposal Seminar Completed)
11. **Prabhupad Bharadwaj**
    - Thesis Title: Optimal Baggage Pricing (Tentative)
    - Status: Ongoing (Joined in January 2019) (Research Proposal Seminar Completed)
12. **Rajdeep Singh**
    - Thesis Title: Fairness in Combinatorial Procurement Auctions (Tentative)
    - Status: Ongoing (Joined in July 2019 for MS Program, converted to Ph.D. in February 2021)
13. **Atul Kumar Malik**
    - Thesis Title: Multiagent Warehousing Management (Tentative)
    - Status: Ongoing (Joined in January 2020 as a Part-time Student)

5.2 Master of Science (by Research) Students

1. **John Mathew ★**
   - Thesis Title: Topics in Competitive Newsvendor Problem
   - Status: Graduated (2014)
   - Affiliation: KPMG
2. **S. Aniruda ★**
   - Thesis Title: Bayesian Inventory Games
   - Status: Graduated (2015)
   - Affiliation: Amazon Pay
3. **Kavitha C. ★**
   - Thesis Title: Review Strategies for Truthful Forecast Information Sharing in a Multi-Retailer Supply Chain
   - Status: Graduated (2016)
   - Current Affiliation: Cisco Systems
4. **Parthasarathy S. ★**
   - Thesis Title: Analysis of Relocation Policies for Emergency Medical Services

- Status: Graduated (2018)
- Affiliation: Ford Motors

5. **Saman Nihal ★**
   - Thesis Title: Information Privacy Concern and Cloud Contracts: A Study in the Indian Healthcare Industry
   - Co-guide: Dr. Saji Mathew
   - Status: Graduated (2019)
   - Affiliation: McKinsey & Company
6. **Aparna Jayaram ★**
   - Thesis Title: Joint Optimization of Airline Pricing and Seat Allocation for Parallel Flights under Choice-based Demand
   - Status: Graduated (2020)
   - Affiliation: Sabre Inc.
7. **Ajay Kumar Singh ★**
   - Thesis Title: Kalman filter based Estimation of Desired Inventory and Analysis of Production Decision
   - Status: Graduated (2021)
   - Affiliation: Decision Point

5.3 M.Tech. Students (IIT Madras)

1. **Mohammad Khobaid Ahamad (CE19M116) ★**
   - Thesis Title: Blockchain Technology in Supply Chain Management for Mega Road Projects
   - Co-guide: Mr. Sumit Bardhan (L&T)
   - Awarded "Best Project Award for the year 2021"
2. **Nikesh L(CE20M104) ★**
   - Thesis Title: Development of a model to quantify Supply Chain Resilience (SCR) and its application
   - Co-guide: Mr. Sanjay Kumar (L&T)

6 Sponsored Research & Industrial Consultancy

I have been working on numerous projects funded by government funding agencies like Department of Science and Technology (DST), Aeronautics and Research Development Board (ARDB), and industry.

6.1 Sponsored Research Projects

6.1.1 Decision fusion technique for a multisensorial context for ensuing applications in fault diagnostics and decision support systems

Funding Agency	Aeronautics and Research Development Board (ARDB)
Sanctioned Value	₹34,80,000
PI	R K Amit
co-PI	N Arunachalam
Duration	March 2022-March 2025
Status	Ongoing

Summary

This proposal focuses on developing an information fusion architecture for multi-sensor data for fault diagnosis using Dempster-Shafer theory and game theory.

6.1.2 Readiness Assessment of Cloud-based Manufacturing Systems (RACM)

Funding Agency	SPARC[19], MHRD
Sanctioned Value	₹58,46,065
PI	R K Amit (India); Kulwant Pawar (UK)
co-PI	R P Sundarraj (India); Svetan Ratchev (UK)
Duration	June, 2019-September 2023
Status	Ongoing

Summary

Democratization of advances in manufacturing is one of the key focus of these national initiatives like Make in India. One enabler of democratization is "cloud manufacturing". Research that studies the adoption of advanced manufacturing systems (and allied areas) is just beginning to emerge (Zhang et al., 2018). In this project with University of Nottingham, we are working on developing a readiness index for cloud manufacturing, especially for MSMEs. Cloud Manufacturing Readiness Index (CMRI) will allow MSMEs to contextualize their cloud manufacturing capability with respect to its cohort group and what it needs to do compete better in the marketplace. As part of this research, we are working on an edited[20] volume titled *Advances in Digital Manufacturing Systems: Technologies, Business Models, and Adoption*, published by Springer Nature.

6.1.3 Mean-Field Games for Social Distancing during Epidemics

Funding Agency	Exploratory Research, IIT Madras
Sanctioned Value	₹7,10,000
PI	R K Amit
Duration	January, 2021-December, 2021
Status	completed

Summary

Vaccination and alternative control measures, like quarantine and social distancing, are used to control epidemics. These measures are currently used to control COVID-19 pandemic across the globe. Traditionally, the epidemiological models focus on the macro-behavior of population, and assume that an individual's interests are parallel to the interests of the population. However, the efficacy of voluntary vaccination, voluntary quarantine, and social distancing depends on the choices made by rational agents in multiagent settings. For example, in voluntary vaccination, an individual faces *vaccination dilemma*—to vaccinate or not. In this project, we propose to study game-theoretic modeling of social distancing during pandemics using *mean-field games*. Mean-field games are appropriate to model behavior during epidemics, as epidemics are infinite agent problems with each agent decides strategically to influence the density to maximize his/her payoff.

[19] SPARC: Scheme for Promotion of Academic and Research collaboration

[20] Editors: R K Amit, R P Sundarraj (IIT Madras) and Kulwant Pawar, Svetan Ratchev (University of Nottingham).

6.1.4 Solution Concepts for Inventory Games under Asymmetric Information

Funding Agency	Science and Engineering Research Board (SERB)
Sanctioned Value	₹6,60,000
PI	R K Amit
Duration	February, 2020-February, 2023
Status	Completed

Summary

Coalitional game theory is the preferred modeling methodology to model inventory pooling situations. The multi-firm inventory pooling situations modeled in a coalitional game theory setting are termed as *inventory games*. In this project, the objective is to derive important solution concepts like the *Shapley value* (for fairness) and the *nucleolus* (for minimizing maximum dissatisfaction) for inventory games with asymmetric demand information. This research has relevance for designing inventory pooling of humanitarian resources during COVID-19.

6.1.5 Shapley Value based Ambulance Repositioning using Spatial-temporal Data

Funding Agency	Department of Science & Technology (DST)
Sanctioned Value	₹16,85,735
PI	R K Amit
Duration	March, 2019-August, 2021
Status	Completed

Summary

Ambulance demand estimation at different locations, at a different point of time, is critical for the dynamic deployment of the ambulances. In this project, we are working on developing a spatio-temporal model for ambulance. This model can be used along with traffic-flow data to compute the Shapley value for data-driven ambulance repositioning. Furthermore, computation of the Shapley value comes under complexity class $\sharp\mathcal{P}$ (Shoham and Leyton-Brown, 2009), so developing a compliance table using the Shapley value is computationally complex. We are also working on compact representation of the repositioning game to dynamically compute the Shapley value for real time ambulance repositioning. This project has been identified by NRDMS, DST to address challenges to fight COVID-19.

6.1.6 Development of Real-time, Adaptive Intelligent Mechanisms for Monitoring and Control of Complex Industrial Processes within Industrial IoT Frameworks

Funding Agency	Department of science & Technology (DST)
Sanctioned Value (IITM)	₹1,97,000
PI	Arya Bhattacharya (Mahindra University)
co-PI	R K Amit
Duration	December, 2018-December, 2021
Status	Completed

Summary

This project is in collaboration with Tata Steel, and focuses on improving performance of blast furnaces using game theory. The performance of the blast furnace can be aligned along three directions—*stability*, *quality*, and *productivity*; and, these objectives are conflicting. We develop a game theoretic framework that consistently ensures highest instantaneous feasible levels of stability, productivity and quality. For this research, we have filed a patent (Patent filed through Tata Steel, Reference no. P||1406||2||2021; Pending).

6.1.7 Ambulance Repositioning for Improving Operational Efficiency of Emergency Medical Services

Funding Agency	Exploratory Research, IIT Madras
Sanctioned Value	₹6,90,000
PI	R K Amit
Duration	March, 2017-March, 2018
Status	Completed

Summary

To improve operational efficiency, we developed Shapley value-based compliance table that maps the available ambulances to the base stations, i.e. given a certain number of idle ambulances, a compliance table will indicate the ideal base stations to which these ambulances have to be assigned. This approach captures the positive externality a base station provides in the ambulance network. Using data from GVK-EMRI[21], Our simulation results show that coverage under the Shapley value based compliance table is statistically significantly greater than under the criticality based compliance table. This research is under revision for the journal *International Game Theory Review*[22].

6.1.8 Valuation of Privacy in Cloud Contracts

Funding Agency	Indian Council of Social Science Research (ICSSR)
Sanctioned Value	₹4,50,000
PI	R K Amit
co-PI	Saji Mathew
Duration	May, 2016-May, 2018
Status	Completed

Summary

In view of the growing adoption of cloud computing in various Government and business domains, privacy concerns are gaining importance in the healthcare sector. A joint M.S. student with Professor Saji Mathew, Ms. Saman Nihal worked on the project, and developed a framework that addresses the following descriptive question—what are an organization's major privacy concerns when exchanging data on the cloud. Using multi-case study approach, we identified that control and secondary use are the major privacy concerns of an organization. However, awareness of privacy rights and credibility of service providers were found to be antecedents that influence privacy concerns, which in turn is reflected in Cloud contracts. The study has resulted in a theoretical model that was tested using system simulation. The findings from this research will guide the managers on incorporating penalty clauses in Cloud contracts.

[21] GVK-EMRI operates ambulance services in many states in India through a free emergency response number "108".

[22] Parathasarathy S. and R K Amit, "The Shapley Value Based Compliance Table For Ambulance Repositioning", *International Game Theory Review*, Revise and Resubmit, March 2021.

6.1.9 Studying Cooperation for Recycling at Auto-Clusters in India

Funding Agency	Nissan Research Support Program
Sanctioned Value	₹9,02,000
PI	R K Amit
Duration	March, 2015-March, 2017
Status	Completed

Summary

Automobiles are highly recyclable goods. End-of-life vehicle (ELV) recycling include recycling of high-grade steel, aluminum, copper, plastic, and rubber (Mohan Ram, 2012). India lacks an organized mechanism to deal with end of life vehicles. Most of the vehicles are sold as scrap. The unorganized sector is handling the scrap management in a haphazard and unhygienic way, which may lead to health and safety problems and environmental pollution (Mohan Ram, 2012). In this project, we studied the state of automotive recycling in India, understanding the drivers behind automotive recycling in different countries, and developed a system dynamics model that simulates unregulated ELV recycling markets. This research is published in *Annals of Operations Research* (Mohan and Amit, 2020).

As part of the project, we organized a workshop titled *Status and Future of End-of-Life Vehicle (ELV) Recycling in India*, jointly with Renault Nissan Technology and Business Centre India Private Limited (RNTBCI), on November 25, 2016 at IIT Madras. The workshop was attended by participants from government, academia, and industry, and the outcomes were reported in media: To go green, law soon on recycling end of life vehicles; New Indian Express, November 26, 2016 and Workshop on Status and Future of End-of-Life Vehicle (ELV); Kalvimalar, November 30, 2016.

6.1.10 A Decision Support System for Pilot Landing in Adverse Conditions

Funding Agency	Aeronautics Research & Development Board
Sanctioned Value	₹47,04,500
PI	P. Ramu
co-PI	G. Krishnamurthi & R K Amit
Duration	February, 2016-February, 2019
Status	Completed

Summary

Synthetic Vision System (SVS) and Enhanced Vision System (EVS) are one of the solutions for landing during low visibility conditions. For a pilot to make a decision about landing based on the recreated image, the uncertainties need to quantified. For rational decision making based on sensor information, uncertainty and consequences to be integrated. SVS is widely used world over as an advisory system. For it to become operational, the system must have performance, reliability, integrity and safety equivalent or better than current CAT III systems. This project addressed the following with a target of obtaining operational credibility: characterizing image registration uncertainty, propagating this uncertainty to the system level for high reliability, and consequence-based decision making. I contributed mainly to consequence-based decision making.

6.1.11 Buyer's Time Preferences in Electronic Procurement Interactions

Funding Agency	Indian Council of Social Science Research (ICSSR)
Sanctioned Value	₹500,000
PI	R. P. Sundarraj
co-PI	R K Amit
Duration	July, 2013-January, 2016
Status	Completed

Summary

To achieve higher efficiency, organizations are increasingly implementing internet-enabled procurement systems (or e-procurement systems (EPSs)). In EPSs, apart from price, there are other important factors like quality, time, customizability etc. Some of these factors exhibit behavioral issues for the decision maker in EPSs. The current literature does not explicitly consider behavioral trade-offs between these factors. The objective of this research was to develop a behavioral price-time trade-off model to assist decision makers in EPSs. As part of the project, we derived discounting functions that can model impatience of any degree. Our discounting functions will explicitly specify finite-time horizon. Furthermore, we designed experiments to test the usability of our model and the existing models. There are two different ways to test the usability of a model—time taken to complete a given task; and, potential user's perception. We found that, with our simpler model, the time taken to complete the task was lower, effort expectancy was lower, and performance expectancy was higher.

6.1.12 Coping Strategies and Coping Costs for Accessing Safe Water in Chennai, India

Funding Agency	SANDEE[23]
Sanctioned Value	₹11,25,084
PI	R K Amit
co-PI	Subash S.
Duration	September, 2013-September, 2015
Status	Completed

Summary

In this project, we estimated coping costs for accessing safe water in Chennai. Using primary data of 423 households, we estimated the mean coping costs as ₹553 and ₹658 per month for piped and non-piped households, respectively. These costs vary from one percent of income for the high income households to fifteen percent for the low income households. ustainable Development Goal (SDG) 6.1 is "to achieve universal and equitable access to safe and affordable drinking water for all". This research reinforced the relevance of SDG 6.1. One of the policy implications is that affordability can be enhanced by reducing collection time and increasing reliability of water supply. This can be achieved through piped connections. This research is published in *Resources, Conservation and Recycling* (Amit and Sasidharan, 2019).

This research got the coverage in media:

- Feeling the Water Pinch; The New Indian Express, August 19, 2015.
- Poor households spend more on water, says study; The Hindu, September 03, 2015.

[23] South Asian Network for Development and Environmental Economics

6.1.13 Improving Supply Chain Efficiency for Food Security

Funding Agency	Socially Relevant Project, IIT Madras
Sanctioned Value	₹250,000
PI	Usha Mohan
co-PI	R K Amit
Duration	February, 2013-July, 2014
Status	Completed

Summary

India is emerging both as a food supplier and also as a huge consumer market for processed foods as well as for food retail. During the process of the food traveling from the producer to the end user, a large amount of food is wasted due to several reasons. According to industry reports, about 30% of the fruits and vegetables grown in India gets wasted annually. The wastage of food results due to inefficient management of the supply chain. Though there has been enough research done on the pre-harvest stages to improve productivity, there has been very little research done in the area of post harvest. Hence, there is a need to address inefficiencies in food supply chains. In this work, we limited our study of food supply chains to the fresh fruit and vegetables sector. Our focus was to compare the price and wastage in different retail formats of fresh fruit and vegetable supply chains. As a part of our study, we selected five different retail formats for sale of fresh fruits and vegetables in Chennai, India. The prices, demands, and wastage (wherever available) data was collected over a period of six months for six vegetables and fruits over the same period. We observed that, in some retail formats, the price mark-ups are very high. The mark-ups vary with the retail formats and the location of the retail outlets. We had conjectured that high mark-ups lead to high wastage; and found statistically significant relationship between the retail prices and wastage. This is in tandem with the stochastic inventory models—when the mark-ups are high, a profit maximizing retailer orders to maintain high service levels and is not worried about the wastage.

6.2 Industrial Consultancy

6.2.1 Prediction using Data Mining

Client	Jasmin Infotech
PI	R K Amit
Duration	December, 2019-January, 2020
Status	Completed

6.2.2 Pricing of Cashberry

Client	Societe Generale
PI	R K Amit
Duration	October, 2019-December, 2019
Status	Completed

6.2.3 Understanding Battery Ecosystem

Client	Societe Generale
PI	R K Amit
Duration	February, 2019-May, 2019
Status	Completed

7 Professional Service

- **Editor, International Journal of Revenue Management**. https://www.inderscience.com/jhome.php?jcode=ijrm
- **Guest Editor, Special Issue: Sustainable Operations in Manufacturing Enterprise (SOME), Annals of Operations Research** (Springer; 2019 Impact Factor: 2.583; 2019 ABDC Rating: A). Other Editors: Professors Surya Prakash Singh, Malin Song, R. R. K. Sharma, Ron Fisher, Reza Farzipoor Saen. https://doi.org/10.1007/s10479-020-03679-5
- **Editorial Review Panel Member, IIMB Management Review** (Elsevier; 2019 ABDC Rating: B). https://www.journals.elsevier.com/iimb-management-review/editorial-board
- **Adhoc Reviewer** I have been reviewing papers for leading journals, some of them are
  1. European Journal of Operational Research
  2. International Journal of Production Economics
  3. Journal of Operational Research Society
  4. International Journal of Production Research
  5. IEEE Transactions on Automation Science and Engineering
  6. Omega
  7. International Game Theory Review
  8. Resources, Conservation & Recycling
  9. Computers and Operations Research
  10. International Journal of Advanced Manufacturing Technology
- **Ph.D. Thesis Examiner:** IIM Bangalore, IIM Indore, IIT Bombay, IIT Roorkee, IISc Bangalore, and Curtin University. **Thesis Advisory Committee (TAC) Member:** IIM Calcutta.
- **Professional Societies**
  - Treasurer of "Society of Operations Management" (http://www.soc-om.org) since 2014. This is an elected position in the society that promotes activities that help generate, consolidate, and disseminate knowledge in the field of manufacturing and service operations and related areas.
  - Invited Member, Expert Committee on Auto Sector, Tamil Nadu Technology Development Promotion Centre (TNTDPC)
  - Invited Member, Branding & Communication Board, 2021-2022, SAEINDIA
  - Member of the following professional societies:
    - Member, INFORMS
    - Member, Econometric Society
    - Member, Game Theory Society
    - Member, Society of Operations Management, India (Life Member)
    - Member, International Society of Inventory Research (ISIR)
    - Member, AGIFORS

- **Conferences & Workshops Organized**

1. Member, Core Committe, *4th National Conference on Multidisciplinary Design, Analysis, AND Optimization*, Jointly organized by IIT Madras, IISc, Aeronautical Society of India (AeSI), October 7-9, 2021. https://www.ncmdao.org/.
2. Coordinator, *A Workshop on Emerging Trends in Advanced Manufacturing*, organized jointly with the University of Nottingham, IIT Madras, Jan 7-8, 2020. Professor R P Sundarraj was the other coordinator. Attended by more than 80 participants from academia, and industry.
3. Advisory Committee Member, *XXIII Annual International Conference of the Society of Operations Management (SOM 2019)*, IIT Kanpur, Dec 19-21, 2019.
4. Coordinator, National Workshop titled *Status and Future of End-of-Life Vehicle (ELV) Recycling in India*, organized jointly with Renault Nissan Technology and Business Centre India Private Limited (RNTBCI), IIT Madras, November 25, 2016. Attended by more than 100 participants from government, academia, and industry.
5. Technical Committee Member, *E-Business and Supply Chain Competitiveness* (EBSCC 2016), IIT Kharagpur, Feb 12–14, 2016.
6. Conference Co-Chair (Professor Rahul Marathe was the other Co-Chair), *XII Annual International Conference of the Society of Operations Management*, IIT Madras, Dec 20-22, 2013.
7. Local Committee Chair, *International Simulation Conference of India*, IIT Madras, Feb 21–23, 2013.

- **Continuing Education Programs**

1. *Decision Making for Engineering*, Designed for Mahindra & Mahindra, April 2022.
2. *Awareness Program on Blockchain*, Organized for L&T, January 10, 2020.
3. *Supply Chain Excellence in Emerging Economies* (An AICTE Sponsored Program), Department of Management Studies, Indian Institute of Technology Madras, September 12–16, 2015. Role: Co-coordinator. Other coordinators: Professsors Arshinder Kaur and R. P. Sundarraj.
4. *National Workshop on Research Methods*, Department of Management Studies, Indian Institute of Technology Madras, August 20-21, 2011. Role: Co-coordinator. Other coordinator: Professor Saji Mathew.

- **Invited Talks**

1. *Decision Making : Hidden Traps*, Mahindra Technical Academy, Chennai, May 6, 2020.
2. *Mechanism Design for Business*, Ford GDI&A India Guest Lecture Series, Chennai, April 19, 2019.
3. *Fermat meets Shapley—Location Science and Game Theory*, IEOR Day, IIT Bombay, March 30, 2019.
4. *Strategic Materials for Electric Mobility: Challenges and Opportunities*, AFS Tech Symposium, Mahindra Research Valley, Chennai, August 30, 2019.
5. *Reinventing the Bazaar: Platforms*, CII-CTO Forum: Conference on Leading with Disruptive Technologies, Chennai, April 12, 2019.
6. *Adventures in Game Theory*, Mahindra Ecole Central, Hyderabad, July 26, 2018.
7. *Joint Forecasting for Airline Pricing and Revenue Management*, IIM Bangalore, June 29, 2018.
8. *Researching Water Supply in Chennai through Surveys*, British Academy Symposium on Digital Inclusion in the Global South, University of West London, April 16-17, 2018.
9. Invited tutorial *Game Theory in a Modern Economy*, XXI Annual Conference of Society of Operations Management, Ahmedabad University, December 21-23, 2017.
10. *"Getting Together When Others Get Together"—Some Results in Cooperative Games with Externalities*, Department of Mathematics, IIT Madras, September 21, 2017.

11. *Game Theory in Manufacturing*, SAEINDIA Southern Section, Chennai, July 27, 2017.
12. *The Language of Game Theory*, International Conference & Workshop on Game Theory and Optimization (part of NMI), IIT Madras, June 6, 2016.
13. *Economic Applications of Game Theory: Mechanism Design and Auctions*, National Conference on "Remembering Nash", S.P. College, Pune, Febuary 15–16, 2016.
14. *Some Results in Behavioral Operations Management*, Department of Industrial & Management Engineering, IIT Kanpur, October 16, 2014.

- **Articles in Media**

1. Reinventing supply chain models during the pandemic, with Ramachandran S., Forbes India, August, 2020.
2. Covid-19: How much risk can your firm handle? Conduct a scenario analysis, with Ramachandran S., Forbes India, May, 2020.
3. India and the economics of ideas, with Shankar Venugopal, The Hindu Business Line, December 10, 2018.
4. The legacy of John Nash, The Hindu, June 07, 2015. Interviewed to highlight contributions of Nobel Prize winner John Forbes Nash.

- **Research Cited in Media**

1. Workshop on Status and Future of End-of-Life Vehicle (ELV), Kalvimalar, November 30, 2016.
2. To go green, law soon on recycling end of life vehicles, The New Indian Express, November 26, 2016.
3. Poor Forced to Shop for Water in Telangana, The New Indian Express, April 21, 2016.
4. Poor households spend more on water, says study, The Hindu, September 03, 2015.
5. Feeling the Water Pinch, The New Indian Express, August 19, 2015.

8 Service Roles

- **Management Representative, ISO, IIT Madras (2017-2020)** I served as the Management Representative (MR), ISO from July 2017 to August 2020. This is a nominated position by the Director IIT Madras, and the role is to coordinate activities of thirteen sections under QSM-IITM. As MR, ISO, my key contributions are

  – Digitization of documents related to ISO activities from July 2018 onwards on IITM-OwnCloud. This facilitated visibility and easy retrieval of the ISO documents, like the internal and external audit reports, corrective action reports, quality objectives, to the IITM Management and Sections. This initiative assisted ISO activities during COVID-19.

  – Assisted Taramani Guest House (TGH) to be added as the 13th section under QSM-IITM in 2019.

  – Addition of thirty internal auditors, trained for ISO 9001:2015 requirements, for the QSM-IITM activities from various departments/sections of IIT Madras in October 2018.

  – Initiated presenting IITM Workflow data during Management Review Meetings to integrate workflow data with sections' quality objectives.

  I have been an internal auditor, as part of the ISO 9001:2015 requirements of the institute, since 2012.

- **Coordinator, Executive MBA (2017-2019)** I coordinated a new program—Executive MBA (EMBA), along with Professor R P Sundarraj, from July 2017 to December 2019. This program is offered to working professionals, with classes on alternative weekends.

  My role as coordinator of the program spans from strategic—program launch and marketing, curriculum design, competitive positioning, to operational—organizing admission tests on IITM

Moodle, class scheduling. One of the key changes is the focus on virtual classes from the first batch in 2018 (we scheduled one weekend classes as the virtual classes). This experience assisted us when we moved to virtual classes for the all the programs of the Department due to COVID-19.

The first batch of the EMBA students joined in January 2018, and now this is one of the flagship programs of the department with enrolments close to 40 students in each batch since 2018. *The revenue generated from this program is approximately |480 lakhs per year.*

- **Department Representative, Board of Academic Research (2016-2018)** During this tenure, I was a member of the committee constituted by the Board of Academic Research, with Dean (Academic Research) as the convener, to reorganize MS/PhD Ordinances and Regulations.
- **Department Representative, Board of ICSR (2016-2017)**
- **Chairman, Quality Management System of Shaastra (The Tech-Fest of IIT Madras)** I served as the Chairman, Quality Management System of Shaastra (The Tech-Fest of IIT Madras) for each edition of the festival since 2015.
- **Member, Faculty Colloquium Committee (2016-2020)** In 2016, Faculty Association IIT Madras initiated the monthy event "Faculty Colloquium". I was a member of the committee that organized these colloquia by the faculty members of IIT Madras.
- **Coordinator, Placements, Department of Management Studies (2020-2022)** I coordinated placements for MBA and research students of the department, along with Professors Vijayalakshmi V and Rahul Marathe.
- **Coordinator, MBA Admissions (2015-2017)** I coordinated MBA Admissions from 2015 to 2017. My role as the MBA admission coordinator is to design and control the entire admission process—outreach activities, shortlisting criteria, conducting personal interviews at different centres, and results.

  One of the key initiatives, which has been followed for MBA admissions since 2015, is the shortlisting of the candidates using a composite score based on the CAT score, gender, past academic performance, and academic stream.
- **Coodinator, Visionary Leadership in Manufacturing Program (2022 Onwards)** I am currently coordinating Visionary Leadership in Manufacturing Program at IIT Madras.
- **Coodinator, Department Global Engagement (2022 Onwards)** I am currently coordinating Global Engagement office at the Department of Management Studies, IIT Madras.

References

Simon Alvarez. Tesla is leading electric car batteries away from cobalt mining industry, May 7 2018. URL https://www.teslarati.com/tesla-battery-tech-cobalt-mining-industry/.

R K Amit and Peeyush Mehta. Repeated contracts for supply chain coordination: A review and future directions. *Technology Operation Management*, 1(2):31–36, 2010.

R. K. Amit and Parthasarathy Ramachandran. A fair contract for managing water scarcity. *Water Resources Management*, 24:1195–1209, 2010.

R K Amit and Parthasarathy Ramachandran. A relational contract for water demand management under market failure. *Urban Water Journal*, 10(3):209–215, 2012.

R K Amit and Parthasarathy Ramachandran. Aspects of exchangeability in the shapley value. *International Game Theory Review*, 15(04), 2013. ISSN 0219-1989.

R.K. Amit and S. Sasidharan. Measuring affordability of access to clean water: A coping cost approach. *Resources, Conservation and Recycling*, 141, 2019. ISSN 18790658. doi: 10.1016/j.resconrec.2018.11.003.

R.K. Amit, Peeyush Mehta, and Rajeev R. Tripathi. Optimal shelf-space stocking policy using stochastic dominance under supply-driven demand uncertainty. *European Journal of Operational Research*, 246(1):339–342, October 2015. ISSN 0377-2217.

S. Aniruda. Bayesian Inventory Games. *M.S. Thesis, IIT Madras*, 2014.

M. Armand and J.-M. Tarascon. Building better batteries. *Nature*, 451:652, February 2008.

K. Balaiyan, R.K. Amit, A.K. Malik, X. Luo, and A. Agarwal. Joint forecasting for airline pricing and revenue management. *Journal of Revenue and Pricing Management*, 18(6), 2019. ISSN 1477657X. doi: 10.1057/s41272-019-00188-4.

K. Bellmann and A. Khare. Economic issues in recycling end-of-life vehicles. *Technovation*, 20(12):677–690, 2000.

Peter Belobaba. *Air travel demand and airline seat inventory management.* PhD thesis, Massachusetts Institute of Technology, 1987.

Peter P. Belobaba. Application of a probabilistic decision model to airline seat inventory control. *Operations Research*, 37(2):183–197, April 1989.

R. Bhattacharya, A. Kaur, and R.K. Amit. Price optimization of multi-stage remanufacturing in a closed loop supply chain. *Journal of Cleaner Production*, 186, 2018. ISSN 09596526. doi: 10.1016/j.jclepro.2018.02.222.

Gary E. Bolton and Elena Katok. Learning by doing in the newsvendor problem: A laboratory investigation of the role of experience and feedback. *Manufacturing & Service Operations Management*, 10(3):519–538, 2008.

AJ A. Bostian, Charles A. Holt, and Angela M. Smith. Newsvendor pull-to-center effect: Adaptive learning in a laboratory experiment. *Manufacturing & Service Operations Management*, 10(4):590–608, 2008.

G. P. Cachon. Supply chain coordination with contracts. volume 11, chapter 6, pages 229–340. Elsevier, 2003.

G. P. Cachon and C. Terwiesch. *Matching supply with demand : an introduction to operations management.* McGraw-Hill/Irwin, Boston, 2009.

Geoff Cady. 2001 JEMS 200-City Survey. *JEMS: a journal of emergency medical services*, 27(2):46–65, 2002.

A. Charnes and D. Granot. Prior solutions: Extensions of convex nucleus solutions to chance-constrained games. pages 323–332. Proceedings of the Computer Science and Statistics Seventh Symposium at Iowa State University, 1973.

Claire Curry. Lithium-ion battery costs and markets. Technical report, Bloomberg New Energy Finance, 2017.

Lokendra Devangan, R K Amit, Peeyush Mehta, Sanjeev Swami, and Kripa Shanker. Individually rational buyback contracts with inventory level dependent demand. *International Journal of Production Economics*, 142(2):381–387, April 2013. ISSN 0925-5273.

Louis Eeckhoudt, Christian Gollier, and Harris Schlesinger. The Risk-Averse (and Prudent) Newsboy. *Management Science*, 41(5):786–794, 1995.

Thomas Fiig, Roger Härdling, Stefan Pölt, and Craig Hopperstad. Demand forecasting and measuring forecast accuracy in general fare structures. *Journal of Revenue and Pricing Management*, 13(6):413–439, 2014.

Y. Funaki and T. Yamato. The core of an economy with a common pool resource: A partition function approach. *International Journal of Game Theory*, 28:157–171, 1999.

Linda Gaines. The future of automotive lithium-ion battery recycling: Charting a sustainable course. *Sustainable Materials and Technologies*, 1-2(Supplement C):2–7, 2014.

I Gilboa. *Theory of Decision Making under Uncertainty*. Cambridge University Press, New York, 2009.

Liang Guo, Shilong Wang, Ling Kang, and Yang Cao. Agent-based manufacturing service discovery method for cloud manufacturing. *The International Journal of Advanced Manufacturing Technology*, 81(9):2167–2181, 2015. doi: 10.1007/s00170-015-7221-0.

Helga Habis and Dávid Csercsik. Cooperation with externalities and uncertainty. *Networks and Spatial Economics*, 15(1):1–16, 2014.

Bruce C. Hartman and Moshe Dror. Cost allocation in continuous-review inventory models. *Naval Research Logistics*, 43:549–561, 1996.

Russell Hensley, John Newman, and Matt Rogers. Battery technology charges ahead. *McKinsey Quarterly*, July 2012.

P. J. J. Herings, A. Predtetchinski, and A. Perea. The weak sequential core for two-period economies. *International Journal of Game Theory*, 34(1):55–65, 2006. ISSN 1432-1270.

S. Hu and Z. Wen. Why does the informal sector of end-of-life vehicle treatment thrive? a case study of china and lessons for developing countries in motorization process. *Resources, Conservation and Recycling*, 95:91–99, 2015.

Dana Hull. Inside the gigafactory that will decide Tesla's fate, May 6 2016. URL https://www.bloomberg.com/features/2016-inside-tesla-gigafactory/.

Brahmesh Vinayak Joshi, B. Vipin, Janakarajan Ramkumar, and R. K. Amit. Impact of policy instruments on lead-acid battery recycling: A system dynamics approach. *Resources, Conservation and Recycling*, 169:105528, 6 2021. ISSN 18790658. doi: 10.1016/j.resconrec.2021.105528.

Edi Karni, Fabio Maccheroni, and Massimo Marinacci. Ambiguity and Nonexpected Utility. In *Handbook of Game Theory with Economic Applications*, volume 4, pages 901–947. Elsevier B.V., 1 2015. doi: 10.1016/B978-0-444-53766-9.00017-3.

Laslo A. Koczy. A recursive core for partition function game. *Theory and Decision*, 63 (1):41–51, 2007.

Mirko Kremer, Stefan Minner, and Luk N. Van Wassenhove. Do random errors explain newsvendor behavior? *Manufacturing & Service Operations Management*, 12(4):673–681, 2010.

T. V. Krishna Mohan and R. K. Amit. Modeling oligopsony market for end-of-life vehicle recycling. *Sustainable Production and Consumption*, 25:325–346, 1 2021. ISSN 23525509. doi: 10.1016/j.spc.2020.09.001.

M. A. Lariviere. *Supply Chain Contracting and Coordination with Stochastic Demand, in Quantitative Models of Supply Chain Management, S. Tayur, R. Ganeshan, and M. Magazine (Eds.)*. Kluwer Academic Publishers, 1999.

Ken Littlewood. Forecasting and control of passenger bookings. *Journal of Revenue and Pricing Management*, 4 (2):111–123, July 2005. ISSN 14766930.

Xiaoyang Long and Javad Nasiry. Prospect theory explains newsvendor behavior: The role of reference points. *Management Science*, 61(12):3009–3012, 2014.

T. V.Krishna Mohan and R. K. Amit. Dismantlers' dilemma in end-of-life vehicle recycling markets: a system dynamics model. *Annals of Operations Research*, 290(1-2):591–619, 7 2020. ISSN 15729338. doi: 10.1007/s10479-018-2930-z.

N. S. Mohan Ram. Importance of auto recycling, The Hindu BusinessLine, February 26 2012. URL http://www.thehindubusinessline.com/opinion/importance-of-auto-recycling/article2935612.ece(accessedon12-10-2014).

R. B. Myerson. *Game-Theoretic Models of Bargaining*, chapter Analysis of two bargaining problems with incomplete information, pages 115–147. Cambridge University Press, Cambridge, UK, 1985.

Axel Ockenfels and Reinhard Selten. Impulse balance in the newsvendor game. *Games and Economic Behavior*, 86:237–247, 2014.

Elsa A. Olivetti, Gerbrand Ceder, Gabrielle G. Gaustad, and Xinkai Fu. Lithium-ion battery supply chain considerations: Analysis of potential bottlenecks in critical metals. *Joule*, 1(2):229 – 243, 2017. ISSN 2542-4351. doi: https://doi.org/10.1016/j.joule.2017.08.019.

E. L. Porteus. *Foundations of Stochastic Inventory Theory*. Stanford University Press, Stanford, USA, 2002.

K.R. Ramkishore and R.K. Amit. Optimal bargaining mechanisms with refusal cost. *International Journal of Operational Research*, 35(1), 2019. ISSN 17457653. doi: 10.1504/IJOR.2019.099543.

Lei Ren, Lin Zhang, Fei Tao, Chun Zhao, Xudong Chai, and Xinpei Zhao. Cloud manufacturing: from concept to practice. *Enterprise Information Systems*, 9(2):186–209, 02 2015. doi: 10.1080/17517575.2013.839055.

H. Rogers, N. Baricz, and K. Pawar. 3d printing services: classification, supply chain implications and research agenda. *International Journal of Physical Distribution & Logistics Management*, 2016.

I Samuel and Y Shoham. Bayesian coalitional games. *Association for the Advancement of Artificial Intelligence (www.aaai.org)*, 2008.

Maurice E Schweitzer and Gérard P Cachon. Decision bias in the newsvendor problem with a known demand distribution: Experimental evidence. *Management Science*, 46(3):404–420, 2000.

Abhishek Shinde, Peeyush Mehta, and R. K. Amit. An experimental investigation of newsvendor decisions under ambiguity. *International Journal of Production Research*, pages 1–12, 7 2020. ISSN 0020-7543. doi: 10.1080/00207543.2020.1797206.

Y Shoham and K Leyton-Brown. *Multiagent Systems- Algorithmic, Game Theoretic and Logic Foundation*. Cambridge University press, 2009.

Lawrence .V Snyder and Zuo-Jun Max Shen. *Fundamentals of Supply Chain Theory*. Wiley, 7 2019. ISBN 9781119024842. doi: 10.1002/9781119584445.

Kanchala Sudtachat, Maria E Mayorga, and Laura A Mclay. A nested-compliance table policy for emergency medical service systems under relocation. *Omega*, 58:154–168, 2016.

Robert M Thrall and William F Lucas. N-person games in partition function form. *Naval Research Logistics Quarterly*, 10(1):281–298, 1963.

Rajeev R. Tripathi and R.K. Amit. Equivalence nucleolus for coalitional games with externalities. *Operations Research Letters*, 44(2):219–224, March 2016. ISSN 0167-6377.

Sven Tuzovic, Merlin C. Simpson, Volker G. Kuppelwieser, and Jörg Finsterwalder. From 'free' to fee: Acceptability of airline ancillary fees and the effects on customer behavior. *Journal of Retailing and Consumer Services*, 21 (2):98–107, 3 2014. ISSN 09696989. doi: 10.1016/j.jretconser.2013.09.007.

Bhavani Shanker Uppari and Sameer Hasija. On the consistency between prospect theory and the newsvendor pull-to-center effect. *INSEAD working paper 2014/50/DSC/TOM*, 2014.

Garrett J. van Ryzin. Future of revenue management: Models of demand. *Journal of Revenue and Pricing Management*, 4(2):204–210, April 2005. ISSN 1477-657X.

Garrett J. van Ryzin and Kalyan Talluri. An introduction to revenue management. *Tutorials in Operations Research*, 2005. doi: 10.1287/educ.1053.0019.

B Vipin and R K Amit. Loss aversion and rationality in the newsvendor problem under recourse option. *European Journal of Operational Research*, 2017. doi: 10.1016/j.ejor.2017.02.012.

B. Vipin and R.K. Amit. Describing decision bias in the newsvendor problem: A prospect theory model. *Omega*, 82:132–141, 1 2019. ISSN 0305-0483. doi: 10.1016/J.OMEGA.2017.12.008.

Ben Wang. The future of manufacturing: A new perspective. *Engineering*, 4(5):722–728, 2018. doi: https://doi.org/10.1016/j.eng.2018.07.020.

Marcel Weil and Saskia Ziemann. Recycling of traction batteries as a challenge and chance for future lithium availability. In Gianfranco Pistoia, editor, *Lithium-Ion Batteries*, chapter 22, pages 509–528. Elsevier, Amsterdam, 2014.

David M Williams. 2008 JEMS 200-City Survey. *JEMS: a journal of emergency medical services*, 34(2):36–51, 2009.

Muhammad Adeel Zaffar, Hari K. Rajagopalan, Cem Saydam, Maria Mayorga, and Elizabeth Sharer. Coverage, survivability or response time: A comparative study of performance statistics used in ambulance location models via simulation–optimization. *Operations Research for Health Care*, 11:1–12, 12 2016. ISSN 2211-6923. doi: 10.1016/J.ORHC.2016.08.001.

G. Zhang, B. MacCarthy, K. Pawar, and S. Ratchev. Manufacturing in the cloud: Exploring future platform-based manufacturing models. Unpublished Manuscript, 2018.