

IEOM

3rd South American International Conference on
Industrial Engineering and Operations Management

*Assunción,
Paraguay*

July 19-21, 2022

Organizer



Host University



Sponsors and Partners



Organizer



Industrial Engineering and Operations Management Society International

IEOM Society International, 21411 Civic Center Dr., Suite 205, Southfield, Michigan 48076, USA
 Phone: 1-248-450-5660, Email: info@ieomsociety.org

Welcome to the 3rd South American Conference on Industrial Engineering and Operations Management in Paraguay

To All-Conference Attendees:

On behalf of the IEOM Society International, we would like to welcome you to the 3rd South American **International Conference on Industrial Engineering and Operations Management**, July 18-21, 2022, hosted by Asuncion National University, Paraguay. The venue is Holiday Inn & Suites Across from Universal Orlando. This unique international conference provides a forum for academics, researchers, and practitioners from many industries to exchange ideas and share recent developments in the fields of industrial engineering and operations management. This diverse international event provides an opportunity to collaborate and advance the theory and practice of major trends in industrial engineering and operations management. There were more than 450 papers/abstracts submitted from 35 countries. After a thorough peer-review process, more than 320 have been accepted for presentation and publication. The program includes many cutting-edge topics in industrial engineering and operations management.

This conference will address many of the issues concerning the continuous improvement of quality and service. The IEOM Society is delighted to have the following keynote speakers at the 3rd South American Conference:

1. Mr. Sumihiro Takaoka, President, Sumi S.A. President, Japan Paraguay Chamber of Commerce
2. Dr. Heriberto García-Reyes, PhD, Regional Chairman, Industrial Engineering Department, Tecnológico de Monterrey, Monterrey, Mexico
3. Professor Duc Truong Pham, Chance Professor of Engineering, Director of Research, Department of Mechanical Engineering, University of Birmingham, Birmingham B15 2TT United Kingdom
4. Dr. Sérgio Shimura, Federal Institute of Education, Science and Technology of São Paulo, Brazil
5. Claudio Vierci, Director-Presidente, Vierci Development, Paraguay
6. Dr. Clinton AIGBAVBOA, Professor, Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa
7. Jill Hosmer- Jolley PhD, MBA, Neurodiversity Accessibility Consultant, MBA Faculty, California State University, Monterey Bay, Management coaching. DEI. CSR. HR. OB., Monterey, California, USA
8. Alfred Fast, CEO, Fecoprod Ltda. and President, El Instituto de Biotecnología Agrícola (INBIO), Asuncion Paraguay
9. Marco Carvalho, CEO, Matza Education, São Paulo (SP), Brazil
10. Prof. Samuel Wiens Bartel, Profesor, Universitario para Liderazgo y Desarrollo Personal, Paraguay
11. Dr. Mario Chauca, Professor, Ricardo Palma University, Santiago de Surco, Peru
12. Prof. Dr. Marcelo Castier, Dean of the Faculty of Engineering Sciences, UPA – Universidad Paraguayo Alemana / German Paraguayan University, San Lorenzo, Paraguay
13. Michel Baudin, Owner, Takt Times Group, Co-founder, Grokcity, Inc., Palo Alto, California, United States

At this conference, the IEOM Society will hold its 31st Global Engineering Education session. It will feature distinguished speakers who will discuss workforce readiness and engineering education challenges and opportunities. The 30th IEOM Industry Solutions will showcase will also be held and feature major topics including IoT, AI, data analytics, iCloud, cybersecurity, automation, digital manufacturing, MSV, and industry best practices. The 10th IEOM Global Supply Chain and Logistics will address the global logistic challenges due to the pandemic. The first IEOM Global Business Management will focus on business operations improvement. Panel sessions have been planned: Global Engineering Education, Supply Chain, Women in Industry and Academia, Lean Six Sigma and Diversity & Inclusion sponsored by Ford Motor Company.

The IEOM Society would like to express our deep appreciation to our sponsors, university partners, organization partners, exhibitors, authors, reviewers, keynote speakers, panelists, track chairs, advisors, the local committee, and the many volunteers who have given so much of their time and talent to make this unique international conference an overwhelming success.

Our conference host, Asuncion National University, Paraguay, would like to extend a warm welcome to all participants.

Our very best wishes to all of you for a successful and memorable event.



Dr. Jorge Kurita, Conference Chair
Research Faculty
Department of Industrial
Engineering
Asuncion National University,
Paraguay



Dr. Ahad Ali
Conference Co-Chair
Associate Professor and Director
of Industrial Engineering
Programs, Lawrence Tech
University, Michigan, USA
Executive Director, IEOM Society



Prof. Vitor M. Caldana
Conference Program Chair
IFSP – Instituto Federal de
São Paulo
Campus Sorocaba
Sao Paulo, SP, Brazil



Prof. Don Reimer
Program Co-Chair
Director of Membership and
Chapter Development
IEOM Society International
President, The Small Business
Strategy Group, Detroit, USA

Conference Overall Program

Day 1 – July 18 (Tuesday)

Competitions and Technical Presentations – Rooms 1-5

Day 2 – July 19 (Tuesday)

6:00 – 7:45 am Technical Parallel Sessions – Rooms 1-5

8:00 -9:30 am – Plenary, Global Engineering Education and Parallel Sessions – Rooms 1-5

9:30 - 10:00 am - Break

10:00 - 10:20 am - Welcome Address:

10:20 -11:00 am - Keynote Speaker I: (Opening Keynote): Mr. Sumihiro Takaoka, President, Sumi S.A. President, Japan Paraguay Chamber of Commerce - Room 1

11:00 - 11:40 am - Keynote Speaker II: Dr. Heriberto García-Reyes, PhD, Regional Chairman, Industrial Engineering Department, Tecnológico de Monterrey, Monterrey, Mexico -Room 1

11:40 am -12:20 pm -Keynote Speaker III: Professor Duc Truong Pham, Chance Professor of Engineering, Director of Research, Department of Mechanical Engineering, University of Birmingham, Birmingham B15 2TT United Kingdom - (Room 1)

12:20 - 12:40 pm - Keynote Speaker IV: Dr. Sérgio Shimura, Federal Institute of Education, Science and Technology of São Paulo, Brazil - (Room 1)

1:00 - 2:00 pm - Lunch

2:00 - 3:45 pm - Global Engineering Education, WIIA Panel and Technical Parallel Session

4:00 - 5:45 pm - Global Engineering Education Panel and Technical Parallel Session

Day 3 – July 20 (Wednesday)

6:00 – 7:45 am Technical Parallel Sessions – Rooms 1-5

8:00 -9:30 am - Industry Solutions and Parallel Sessions

9:30 - 10:00 am - Break

10:00 - 10:20 am - Conference Chairs Remarks

10:20 -11:00 am - Keynote Speaker V: Claudio Vierci, Director-Presidente, Vierci Development, Paraguay- (Room 1)

11:00 - 11:40 am - Keynote Speaker VI: Dr. Clinton AIGBAVBOA, Professor, Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa-Room 1

11:40 - 12:20 pm - Keynote Speaker VI: Jill Hosmer- Jolley PhD, MBA, Neurodiversity Accessibility Consultant, MBA Faculty, California State University, Monterey Bay, Management coaching. DEI. CSR. HR. OB., Monterey, California, USA- (Room 1)

12:20 - 1:00 pm - Keynote Speaker VIII: Alfred Fast, CEO, Fecoprod Ltda. and President, El Instituto de Biotecnología Agrícola (INBIO), Asuncion Paraguay- (Room 1)

1:00 - 2:00 pm - Lunch

2:00 - 3:45 pm - Industry Solutions and Technical Parallel Sessions

4:00 - 5:45 pm - Industry Solutions Panel and Technical Parallel Sessions

6:00 - 8:30 pm - Diversity and Inclusion Panel sponsored by Ford Motor Company

Day 4 – July 21 (Thursday)

6:00 – 7:45 am Technical Parallel Sessions – Rooms 1-5

8:00 -9:30 am - GSCM and Parallel Sessions

9:30 - 10:00 am - Break

10:00 - 10:20 am - Conference Chairs Remarks

10:20 -11:00 am - Keynote Speaker IX: Marco Carvalho, CEO, Matza Education, São Paulo (SP), Brazil - Room 1

11:00 - 11:40 am - Keynote Speaker X: Prof. Samuel Wiens Bartel, Profesor, Universitario para Liderazgo y Desarrollo Personal, Paraguay - Room 1

11:40 am - 12:20 pm -Keynote Speaker XI: Dr. Mario Chauca, Professor, Ricardo Palma University, Santiago de Surco, Peru - (Room 1)

12:20 - 1:00 pm - Keynote Speaker XII: Prof. Dr. Marcelo Castier, Dean of the Faculty of Engineering Sciences, UPA – Universidad Paraguayo Alemana / German Paraguayan University, San Lorenzo, Paraguay - (Room 1)

1:00 – 1:30 pm Keynote XIII: Michel Baudin, Owner, Takt Times Group, Co-founder, Grokcity, Inc., Palo Alto, California, United States

1:00 - 2:00 pm - Lunch

2:00 - 3:45 pm - GSCM and Technical Parallel Sessions

4:00 - 5:45 pm - GSCM Panel, GBME and Technical Parallel Session

7:00 - 9:00 pm - Conference Virtual Awards Ceremony

Keynote Speakers – Room 1

Tuesday, July 19, 2022

Opening Ceremony: Tuesday, 9:30 – 10:00 am

Welcome Address: Tuesday, 10:30 – 10:20 am

Host University President

Opening Keynote I: Tuesday, 10:20 – 11:10 am



Mr. Sumihiro Takaoka
 President
 Sumi S.A. President
 Japan Paraguay Chamber of Commerce

Keynote II: Tuesday, 11:00 – 11:40 am



Heriberto García-Reyes, PhD
 Regional Chairman
 Industrial Engineering Department
 Tecnológico de Monterrey
 Monterrey, Mexico

Dr. Heriberto Garcia-Reyes is a professor and Regional Chairman of the Industrial Engineering Department. He has been a faculty member at Tecnológico de Monterrey, since 1998. He conducts research about the analysis, design, and improvement of supply chain and production systems that involve the integration of technology, people, and processes. He has published in conference such as IERC, ISERC, Winter Simulation Conference and ASEE annual conference among others. He has successfully completed projects for several enterprises in Mexico such as Nampak, Tubacero, Cemex, Sigma Alimentos, State Government, Gruma, Vitro, Coca-Cola and Sisamex among others. He is coauthor of a book entitled Simulación y Análisis de Sistemas con ProModel and has several technical articles in journals and conferences describing his research accomplishments. Regarding the service to the academia he collaborates as co-chair for the Latin American tack in the IERC 2010 and 2011, also as reviewer for the Journal of Supply Chain Management: an International Journal, Journal of Production Economics and Estudios Gerenciales Journal of Management and Economics for Iberoamerica. He is a member of the technical committee for the CENEVAL exam and member of the industrial engineering technical commission of CACEI.

Keynote III: Tuesday, 11:40 am – 12:20 pm



Professor Duc Truong Pham
 Chance Professor of Engineering
 Director of Research
 Department of Mechanical Engineering
 School of Engineering
 College of Engineering and Physical Sciences
 The University of Birmingham
 Birmingham B15 2TT United Kingdom

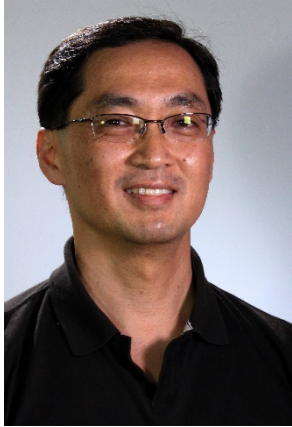
Duc Truong Pham's research covers the fields of mechanical, manufacturing, computer and systems engineering. His academic output includes more than 600 technical papers and 17 books. He has supervised over 100 PhD theses to completion. He has won in excess of £30M in external research grants and contracts. In addition to pursuing and leading research, he has acted as a consultant to several major companies and has been active with knowledge transfer to industry, applying the results of his work to help multinational companies and SMEs generate wealth and create and safeguard jobs.

He has lectured extensively abroad on his research and has delivered more than fifty keynote presentations at international conferences. He was Professeur Invité at École Centrale de Paris, Consulting Professor at HUST (China), Erskine Visiting Fellow at the University of Canterbury (New Zealand), Visiting Professor at the Université Paul Verlaine (France), Visiting Professor at King Saud University (Saudi Arabia), Strategic Scientist at Wuhan University of Technology and Honorary Professor at Xi'an Jiaotong University (China).

He has received several prizes including the Sir Joseph Whitworth prize from the Institution of Mechanical Engineers in 1996 and 2000 and the Institution's Thomas Stephens Group Prize in 2001 and 2003 and Donald Julius Groen Prize in 2004, and the 5th ICMR Best Paper Prize in 2007. He is also a recipient of a Lifetime Achievement Award (2016, World Automation Congress) and a Distinguished International Academic Contribution Award (IEEE SMC Society TC on Enterprise Info Sys and IFIP TC8 WG8.9, 2017)

He is a Fellow of the Royal Academy of Engineering, Learned Society of Wales, Society of Manufacturing Engineers, Institution of Engineering and Technology, and Institution of Mechanical Engineers. He was made an OBE in the 2003 New Year's Honours List for his services to Engineering.

Keynote IV: Tuesday, 12:20 – 1:00 pm



Dr. Sérgio Shimura
 Electronics and Automation Professor
 Instituto Federal Sao Paulo
 Brazil

S. Shimura is an Electronic Engineer from University of Sao Paulo. He holds Doctoral and Msc. Degrees in Electronics Systems and Power Systems respectively from the same institution. He is also Reliasoft's Certified Reliability Professional. He is currently professor at Federal Institute of Sao Paulo (IFSP) teaching electronics and automation and Research and Innovation Coordinator at Sorocaba Campus. His research interests include Artificial Intelligence, IoT and Embedded Systems.

Wednesday, July 20

10:00 – 10:20 am Conference Chair Remarks

Keynote V: Wednesday, 10:20 – 11:00 am



Claudio Vierci
 Director-Presidente
 Vierci Development
 Paraguay

Keynote VI: Wednesday, 11:00 – 11:40 am



Dr. Clinton AIGBAVBOA
 Professor
 Department of Construction Management and Quantity Surveying
 University of Johannesburg
 South Africa

Clinton AIGBAVBOA is a Professor at the Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa. Prof. Aigbavboa is the immediate past Vice Dean of the Faculty of Engineering and Built Environment, University of Johannesburg, South Africa. He has extensive knowledge in practice, research, training and teaching. He is currently the Director of the Construction Industry Development Board Centre of Excellence and the Sustainable Human Settlement and Construction Research Centre at the University of Johannesburg. Prof Aigbavboa has authored and co-authored more than 600 accredited journal articles, conference papers, and book chapters. He is also an author of twelve research books that were published with Springer Nature and CRC Press. Prof Aigbavboa is currently a visiting professor in the School of Civil Engineering of the Shandong University, China, visiting professor, in the Department of Civil Engineering of the University of Nigeria, Nsukka and an International Visiting scholar in the Department of Architecture of the Covenant University, Nigeria. He is also the editor of the Journal of Construction Project Management and Innovation (accredited by the DoHET) and has received national and international recognition in his field of research. He is rated by the South Africa National Research Foundation.

Keynote VII: Wednesday, 11:40 am – 12:20 pm



Jill Hosmer- Jolley PhD, MBA
 Neurodiversity Accessibility Consultant
 MBA Faculty, California State University, Monterey Bay
 Management coaching. DEI. CSR. HR. OB.
 Monterey, California, USA

JILL HOSMER-JOLLEY, MBA, Ph.D., works with organizations to improve outcomes by embracing the strengths of neurodiverse employees, such as creativity and innovation, through improved management practices customized for situational opportunities and structure. Human resources, diversity, inclusion, and neurodiversity are key areas of her research and consulting practice. Previous experience includes 20 years in financial services at Merrill Lynch and Charles Schwab, as a broker in Sunnyvale as well as a regional director for the New England area, managing sales, training, customer service, operations, and people, as well as culture change and career development. Dr. Hosmer-Jolley has 15 excellent years of university teaching and research (Cal State, Rice University, University of California and Yale). In 2008, she began to teach at the university level, focusing on management, human resources, organizational behavior, ethics, and communication. She also works as a technology mentor assisting faculty with online teaching, course development, and integrating technology for student success.

Hosmer-Jolley earned a master's in Business Administration from Simmons College in Boston and a doctorate in Business Administration–Management from Northcentral University in San Diego.

Keynote VIII: Wednesday, July 20, 12:20 – 1:00 pm



Alfred Fast
 CEO, Fecoprod Ltda.
 President, El Instituto de Biotecnología Agrícola (INBIO)
 Asuncion Paraguay

Thursday, July 21

10:00 – 10:20 am Conference Chair Remarks

Keynote IX: Thursday, 10:20 – 11:00 am



Marco Carvalho
 CEO
 Matza Education
 São Paulo (SP), Brazil

Keynote X: Thursday, 11:00 – 11:40 am



Prof. Samuel Wiens Bartel
 Profesor
 Universitario para Liderazgo y Desarrollo Personal
 Paraguay

Keynote XI: Thursday, 11:40 am – 12:20 pm



Dr. Mario Chauca
Professor
Ricardo Palma University
Santiago de Surco
Peru

Dr. Mario Chauca is a professor at Ricardo Palma University, Santiago de Surco, Peru. He teaches at the postgraduate and undergraduate level, with 30 years of experience. He graduated as an Electronic Engineer from Ricardo Palma University in Lima Peru, obtained his Master's Degree in Business Administration with a mention in "Business Management" and his Doctorate in Education from San Luis Gonzaga National University.

Dr. Chauca is an Executive Committee Member of IFEEES and was a Director of the AOTS-Kenshu Kiokay-Peru (2010-2014), member of the technical committees since 2010, invited by the University of Washington IEEE, in 2010 joined the Steering Committee of the IEEE-MWSCAS, and has participated in more than 30 committees in the European Union, Asia, Africa, America and Australia.

Dr. Chauca was participant as speaker and Chair Session at WEE2019-Chennai (India), IEM2019-Toronto (Canada), WEEF2018-Albuquerque (USA), ICIMA2018-Penang (Malaysia), WEEF2017-Kuala Lumpur (Malaysia), CONeGOV2016-Florianopolis (Brazil), ISIT2014,17-Guanajuato (Mexico), MWSCAS2010-Washington (USA), JALIO2009-Mar del Plata (Argentina), CONIELECOMP2007,9,10-Puebla (Mexico), SIE2004-Santa Clara (Cuba). He obtained a scholarship from the AOTS Tokyo (Japan), from the NIPA and Ministry of Science, ICT and Planning of the Future of Korea Seoul (Korea). He is a Consultant in Information and Communication Technologies, he was consultant in the project of United Nations-Inter-American Development Bank-Congress of the Republic of Peru and the Ministry of the Interior of Peru. He is a researcher by RENACYT-CONCYTEC in the Peruvian Government, adviser first award paper CONEIMERA2018, adviser of the First General Award Project for more than 5000 projects in the contest from the Romero Group, adviser for first projects in congress INTERCON, CONEIMERA, and was nominated for the Graña y Montero Prize for Research in Peruvian Engineering. Nominated Peruvian Research Southern Prize 2019 and nominated research award 2018 MEXICO. As author and advisor of papers he has more than 50 letters of acceptance, served organizer of international academic events, editor of proceedings, and advisor to the IEEE chapters at the National University of Callao and the Ricardo Palma University.

Keynote XII: Thursday, July 21, 12:20 – 1:00 pm



Prof. Dr. Marcelo Castier
Dean of the Faculty of Engineering Sciences
UPA – Universidad Paraguayo Alemana / German Paraguayan University
San Lorenzo, Paraguay

Keynote XII: Thursday, July 21, 1:00 – 1:30 pm



Michel Baudin
Owner, Takt Times Group
Co-founder, Grokcity, Inc.
Palo Alto, California
United States

Michel Baudin is an engineer, author, and consultant who graduated from Mines-ParisTech in 1977. His career has taken him from France to Japan, Germany, and finally to the US, where he lives in Palo Alto, California. Michel has taught courses in-house for clients, UC Berkeley, the University of Dayton, the Hong Kong Productivity Council, the University of Buckingham, and training companies in multiple countries.

He has authored four books – Manufacturing Systems Analysis (1990), Lean Assembly (2002), Lean Logistics (2005), and Working with Machines (2007) – and written in refereed journals, professional magazines, and

conference proceedings.

Plenary Speakers

Plenary I

Tuesday, July 19, 8:00 – 9:30 am – Room 1

Session Chair: Anicia Peters, PhD

8:00 – 8:30 am (Tuesday, July 19)



Anicia Peters, PhD

Pro-Vice Chancellor: Research, Innovation and Development, University of Namibia

Chairperson: Namibia Presidential Task Force on the Fourth Industrial Revolution

Deputy Chairperson: Namibia Qualifications Authority (Namibia)

Council member: National Council for Higher Education in Namibia

President: Windhoek ACM SIGCHI local chapter

Anicia Peters is the Pro-Vice Chancellor for Research, Innovation and Development and an Associate Professor of Human Computer Interaction at the University of Namibia. She was also appointed in July 2021 by the President of Namibia as the Chairperson of the 4IR Task Force and has to complete a country assessment and organize the National AI Conference in early 2022. Anicia is further the Technical Programme Committee Chair for ACM CHI 2023 and case studies co-chair for ACM CHI conference 2022. She worked previously at Intuit and Oregon State

University in the United States and pursued her PhD at Iowa State University. She was formerly the Executive Dean for the Faculty of Computing and Informatics at the Namibia University of Science and Technology. She is the co-founder of the AfriCHI conference series (Africa Human Computer Systems Conference) and also a co-inventor of the GenderMag method which detects gender inclusiveness issues in software design/development. In June 2021, she initiated an AI Agriculture Start-Up incubation programme at the University of Namibia. She also implemented the Namibia-India Centre of Excellence in IT focusing on Cybersecurity and Big Data and expanding to AI and co-established an Inclusive Collaborative Tech Innovation Hub. Anicia has received a number of accolades for her work in research and social justice. She established 6 student organisations in the United States and in 2015, she received a Presidential White House Award as co-founder of the ISU Womyn of Colour Network. She further received among others research merit awards from Boeing, Iowa State University and the Rector's medal at the Namibia University of Science and Technology; is one of 10 female African rolemodels for Information Technology; received a Next Einstein Advancing Women in STEM award; 2022 IEOM Distinguished Educator award; was a Google scholar and received a 2020 Google AI Inclusion Research Award. In 2019, she was selected as the UNESCO Chair for Gender and Digital Technologies but relinquished it when she left the Namibia University of Science and Technology. Her research focus is social computing, gamification, e-participation such as digital health, gender and e-government. Anicia published over 80 articles.

8:30 – 9:00 am (Tuesday, July 19)



Dr. Boris Herbas-Torrico

Full Time Professor

Universidad Catolica Boliviana San Pablo Regional Cochabamba

Cercado, Cochabamba, Bolivia

Boris Christian Herbas-Torrico is a professor of industrial engineering at the Bolivian Catholic University in Cochabamba, Bolivia. He is also a researcher at the Exact Sciences and Engineering Research Center (CICEI). He earned his B.S. in Industrial Engineering from the University Mayor of San Simon in Bolivia. In 2007 he was awarded the Monbukagakusho Scholarship from the Japanese Ministry of Education, Culture, Sports, Science, and Technology to graduate studies in Japan. He received a master's and doctoral degree in industrial engineering and management from the Tokyo Institute of Technology (Japan). He has published journal and conference articles in the U.S. Japan, Europe, and South America. He received the 2012 Research Award from the Japanese Society for

Quality Control. Additionally, in 2013 he was awarded the Nikkei Quality Control Literature Prize (Nikkei Keizai Shimbun). Moreover, in 2018, the Bolivian Senate recognized his science and technology contributions to the country. In 2019 he was a visiting researcher at Waseda University (Japan). In 2021 he received the IEOM Society's "Outstanding Professor Award." He has written two books and is an editorial board member for journals and conferences in Bolivia and abroad. His research interests are in the fields of marketing research, consumer behavior, and sustainability.

9:00 – 9:30 am (Tuesday, July 19)



Joseph Akyeampong, PhD

Human Factors Engineering Consultant

Amgen

Fort Lauderdale, Florida, United States

Dr. Joseph Akyeampong is a creative Industrial & Systems engineer who currently works as Human Factors Engineering consultant at Amgen. He has spent his career applying his Human Factors expertise on the development of safe and effective biopharmaceutical combination products (at Amgen), medical devices (at Medtronic and Stryker), and nuclear power plant control rooms (at General Electric and Westinghouse). Notable projects he has worked on include: Amgen combination products including prefilled syringes and autoinjectors; the Stryker Mako robot for orthopedic/joint replacement surgeries; various Medtronic programmable neuromodulation systems; the Westinghouse AP1000; and the GE-Hitachi Economic Simplified Boiling Water Reactor (ESBWR). Dr. Akyeampong received his PhD in Industrial & Systems Engineering from North Carolina A&T State University (USA)

and a Bachelor's in Mechanical Engineering from Kwame Nkrumah University of Science and Technology (Ghana). Dr. Akyeampong is passionate about human factors engineering and technological innovations in general, with strong interests in healthcare.

Plenary II

July 20, Wednesday, 4:00 – 5:30 am – Room 2
Session Chair: Dr. Piera Centobelli

4:00 - 4:30 pm (Tuesday, July 19)

Dr. Nubia Velasco
 Associate professor
 Universidad de los Andes
 Bogota, Colombia

4:30 - 5:00 pm (Tuesday, July 19)

Dr. Piera Centobelli
 Professor of Business Economics and Organization
 Università degli Studi di Napoli Federico II
 Naples, Italy

5:00 - 5:30 pm (Tuesday, July 19)

Plenary III

July 20, Wednesday, 8:00 – 9:30 am – Room 1
Session Chair: Victoria Canela

8:00 am – 8:30 am (Wednesday, July 20)

Rodolfo Sabonge
 Secretario General
 Asociación de Estados del Caribe
 Trinidad and Tobago

8:30 am – 9:00 am (Wednesday, July 20)



Victoria Canela
 Workcell Manager
 Jabil Healthcare
 Santo Domingo, Distrito Nacional, Dominican Republic

Victoria Canela is an Industrial Engineer Graduated (Summa Cume Laude) from the Technological Institute of Santo Domingo (INTEC), with a master's degree on Business Management and Productivity form APEC University. Also, she is recognized by the American Society of Quality as a Certified Quality Engineer. She holds a Green Belt, a Silver Lean Master certification. In addition, Mrs. Canela is certified as a Bullet Proof Manger form Crestcom International.

Victoria has been working on the Medical Devices regulatory Industry for over 10 years, with combine experience on Engineering, Manufacturing operations, Lean Six Sigma and Quality, to achieve the startup of several Manufacturing plans, with New Product Introduction, Machine and Line Transfers and Manufacturing process design using LSS tools and Quality Principles.

She is specialized on Quality Engineering, test method design, validation process and Risk Management. Working for the top companies in the Medical Devices industry, Mrs. Canela coach and lead several teams in achieving more than US\$10MM in savings form several lean initiatives and the reduction of Complaint levels by the implementation of End To End complaint analysis processes.

Victoria is currently the works for one of the Largest Medical Devices contract manufacturers in the world. She is also a part time professor for Technological Institute of Santo Domingo (INTEC), for Materials Science and Engineering for the Engineering Department. In addition, Mrs. Canela is a Consultant for Quality Systems Implementation, LSS and Productivity.

9:00 am – 9:30 am (Wednesday, July 20)



Dave Harry
 Black Belt Trainer / Kata Coach
 President & CEO
 Process Whisperer® Consultants LLC
 Greeneville, TN, USA

David Harry, a.k.a. "The Process Whisperer®", has more than 30 years' experience as a project manager, business process improvement instructor and expert problem solver. Following a successful military career as a Naval Aviator, Dave taught Lean and Six Sigma "Belts" and project management classes for various companies including KPMG Consulting, Northrop Grumman, Rolls-Royce Energy, Arconic, and the University of Tennessee Knoxville. An Expert Trainer at Northrop Grumman, he was Manager of Continuous Improvement at Rolls-Royce Energy and

has been involved with manufacturing and logistics Lean Six Sigma programs across several industries.. He has served on leadership boards of the American Society for Quality and the Institute of Industrial Systems Engineers and the OpEx Society. He has been awarded three Masters-level degrees in management, including from the University of Southern California and the University of Chennai (India). His certifications include PMI Project Management Professional, ASQ Six Sigma Black Belt, Lean Bronze Certification from the SME/Shingo/AME Alliance, Agile Certified Scrum Master and a Certified Baseline Project Management Office (CB-PMO) Consultant. He is a recognized Toyota Kata “Geek” and has attended and presented at several IEOM conferences.

Plenary IV

July 21, Thursday, 8:00 – 9:30 am – Room 1

Session Chair: Steven Sibrel

8:00 – 8:30 am (Thursday, July 21)

Dr. Haree Ramasawmy, RPEM, CEng MIMechE

Associate Professor

University of Mauritius

Réduit, Moka, Mauritius

8:30 – 9:00 am (Thursday, July 21)



Steven Sibrel

Senior Supplier Quality Manager

Harman International

Novi, Michigan, USA

Professional Development Chair and Past Chair – ASQ Greater Detroit

Steve Sibrel is a business process improvement trainer, coach and auditor with over 35 years of experience in the business and manufacturing world. He is currently working as Senior Supplier Quality Manager at Harman International, a manufacturer of audio and infotainment systems for consumer, professional, and automotive industries, with well-known brands such as JBL, Lexicon, Crown, Infinity, Mark Levinson, Becker and Harman-Kardon. Previously he held a number of engineering and management positions in diverse industries at Applied Materials (Semiconductor), NEC (Telecommunications) and Texas Instruments (Military). He has conducted over 200 supplier audits in North America, Europe, and Asia and is a Lead Auditor for ISO/TS16949, ISO9001, ISO13485, ISO17025, and 21CFR820. He has been the Chair for Professional Development for the ASQ Detroit section since 2008. He received the Distinguished Service Award in 2008 and the Leadership Award in 2013 from ASQ. Current ASQ Certifications held are Six Sigma Black Belt, Quality Engineer, Quality Inspector, Quality Auditor, and Manager of Quality/ Organizational Excellence. He is an adjunct faculty member at Macomb Community College. Steve has a BSEE degree from Rose Hulman Institute of Technology and an MSEE degree from Southern Methodist University.

9:00 – 9:30 am (Thursday, July 21)



Dr. Christopher Harris

Associate Professor of Computer Science

University of Northern Colorado

Greeley, Colorado, United States

Dr. Christopher Harris is an Associate Professor of Computer Science in the School of Mathematical Science at the University of Northern Colorado. Previously, he taught at the State University of New York in Oswego and has nearly 20 years of work experience as a technical strategist at companies including the World Bank, Northrop Grumman, Ratheon, E! Entertainment Television, and AT Kearney. He served as the General Manager at Advisa Group, a technology consultancy based in Beijing, China. Professor Harris received his PhD in Information Science at the University of Iowa, an MBA from the Anderson Graduate School of Management at UCLA, his Masters in Computer Science from Virginia Tech, and his Bachelor's in Computer Engineering from the University of South Florida. Professor Harris' research areas include applying machine learning and artificial intelligence to business, agriculture, human resources, and manufacturing, ensuring fairness in machine learning algorithms, and applications involving blockchain and smart contracts.

9:30 – 10:00 am (Thursday, July 21)



Dr. Sergio Salimbeni, Eng, MBA, PhD

Professor & Researcher – Industrial and Management Engineering – Industry 4.0 – Quality 4.0 – PLM4.0

Universidad del Salvador

Buenos Aires, Argentina

Sergio Salimbeni has more than 17 years as Professor and Researcher in Industrial Engineering and Management Sciences at USAL – Universidad del Salvador – Argentina. His research on Industry 4.0 focuses on Quality 4.0 and Smart Products, both in the preparation of human resources and migration to digitalization in manufacturing and service industries. Director of Industry4.0 and Product Development MBA course. He is an Electronic Engineer, with a MBA and PhD in Business Administration, and doctoral candidate for the Industrial Engineering. He has published several articles related to Industry 4.0 maturity models and entry barriers, Simulation, Digital Twins, Digitalisation and Smart Products. He has more than 20 years working on Strategic Management, Quality Management, Business and Product Development, Project Management and Business Process Management, mainly in information and communication technologies, and electronics industries.

Panel Sessions

Electromobility Panel

July 19, 2022, 2:00 – 3:45 pm

Organized by: RELIEVE (Red Latinoamericana de Investigación en Energía y Vehículos) Latinoamerican Research Network in Energy and Vehicles

Moderator



Dr. Nicolas Giraldo-Peralta

Universidad Antonio Nariño
Bogota, Colombia

Mechanical Engineer, M.Sc., Ph.D. in Engineering Sciences (D.Sc.) from Tecnológico de Monterrey – México with a Diploma in Logistics and Supply Chain (MIT GCLOG), 2016, Massachusetts Institute of Technology – MIT – Cambridge, USA. He has participated in scientific research projects on topics such as thermodynamics, fuels, combustion, logistics, and corrosion. Involved in accreditation and administrative processes of engineering programs. He has experience in management, technical advice, and consulting in energy, transportation, vehicles, supply chain, and logistics for public and private entities in Colombia. Advisor to international consulting entities such as GIZ and Atheneum.

Panelists

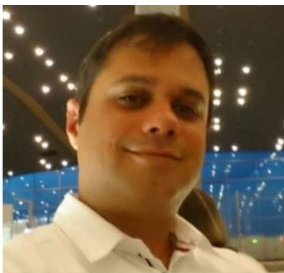


Dr. Daniel Guillermo Cordero Moreno

Research professor
Faculty of Science and Technology
ERGON -Center for Research and Development in Automotive Engineering
University del Azuay
Ecuador

Title: Efficiency tests of electric vehicles in chassis dynamometer

Automotive Mechanics Engineer from the University of Azuay (2007) and Doctor of Engineering Sciences from the Tecnológico de Monterrey (2015). He is currently a professor at the University of Azuay and a member of ERGON, Center for Research and Development in Automotive Engineering. Undergraduate and graduate professor. Work areas: Energy configuration in vehicles, driving cycles, vehicle characterization, vehicle homologation processes.



Dr. Nelson Arzola de la Pena

Full Professor
Faculty of Engineering
Universidad Nacional de Colombia
Bogotá Campus

Title: Experiences in the 2nd National Electric Traction Vehicle Competition

Full Professor of the Department of Mechanical and Mechatronics Engineering of the National University of Colombia (2005 – to date). Coordinator of the Undergraduate Program in Mechanical Engineering (2021 –). Coordinator of the Doctoral Program in Mechanical and Mechatronics Engineering (2017 – 2019). Coordinator of the master's Program in Mechanical Engineering (2007 – 2010). Distinction from the Faculty of Engineering in Meritorious Teaching (years 2010 and 2018). Doctor in Technical Sciences from the Central University of Las Villas, Cuba (2003). Mechanical Engineer from the University of Cienfuegos, Cuba (1997). Author of more than 40 articles in indexed journals, 25 presentations at national and international conferences and two published books. He has participated in five funded research projects in Mechanical Engineering. He has directed 14 Postgraduate Theses and more than 30 Degree Projects. h-index: 11.



Manolín Alcázar, MSc

Ph.D. Candidate
Universidad de Málaga
de Cervantes, 2, 29016 Málaga,
Spain

Title: Motostudent Competition: No fear, race your talent

Manuel Alcázar Vargas received the B.S. degree in mechanical engineering and the M.S. degree in industrial engineering from the University of Jaén, Spain. He is currently pursuing the Ph.D. degree in mechanical engineering with the University of Malaga. He is currently a Researcher of mechanical engineering with the University of Malaga.

His research interests include electric vehicles, moto-student formula, and tire dynamics.

Panel on Women in Industry and Academia

July 19, 2022, 4:00 – 5:45 pm

Panel Chair



Dr. Ximena Córdova Vallejo

Profesora, Colegio de Ciencias e Ingenierías, Politécnico
Universidad San Francisco de Quito
Ecuador

Ximena M. Córdova, Ph.D., was the first woman to graduate in Mathematics from the National Polytechnic School, Quito-Ecuador. She has a Master's in Quality, Management and Productivity and a Master's in Actuarial Sciences from The University of Iowa, Iowa, USA. She holds a Ph.D. in Industrial Engineering from Wichita State University, USA. She was also the first woman to hold the position of Provost at the San Francisco de Quito University (USFQ) until 2020. She has served as a Professor at the San Francisco de Quito University for more than 20 years and was Dean of the School of Engineering of the College of Sciences and Engineering. She is currently a Senior Professor in the Department of Industrial Engineering. She is one of the founders of the project "Women in Science

and Engineering", WISE, to encourage women to study in the areas of science and engineering. She has managed to influence at least 5 female alumni of the USFQ of Industrial Engineering to obtain their Ph.D. in Engineering and for many graduates to continue their four-level studies. Her research is applied to Green Supply Chains through the modeling, analysis and optimization of logistics systems using CO2 emissions as a performance measure and the use of Ecuadorian anthropometry data for the ergonomic design of work spaces.

Panel Speaker I



Maria Carolina Diaz

Business Process Optimization Manager
Spirit Airlines
Miami, Florida, USA

Panel Speaker II



Aracelli Centeno

Senior Process Architect
Registro Nacional de Identificación y Estado Civil (RENIEC)
Peru

Aracelli Centeno has 15 years of experience in project and process management. She have worked in Peruvian business as a company of technology, bank, and the government. Moreover, Aracelli volunteers in International Team Excellence Award (ITEA-ASQ) Judge in US and PMI. She have experience as a Quality Lead Auditor, Project Manager, process consultant and trainer. Her interests are related to process improvement, innovation projects and social development. Aracelli would like to collaborate by establishing social programs that promotes the empowerment for entrepreneurship in around the world and other projects that help to decrease the insecurity and

establish mechanisms to prevent citizens of Identity Theft.

Panel Speaker III



Ph.D (c) Rosa Patricia Larios-Francia

Docente – Investigador
Laboratorio Textil y Confecciones
Carrera de Ingeniería Industrial
Facultad de Ingeniería y Arquitectura
Universidad de Lima
Peru

PhD candidate in Strategic Management with a specialization in Business Management and Sustainability from the Consortium of Universities, Master in Industrial Engineering from the Ricardo Palma University and Industrial Engineer from the University of Lima. With a specialization in innovation from the International High Specialization Programme in Innovation Management at ESAN and La Salle Ramon Llull University in Spain.

Lecturer and Researcher at the University of Lima in the areas of innovation, MSME management, cluster, biodiversity, sustainability, circular economy, humanitarian logistics, technology in the development of new materials and processes in the textile industry, fashion and handicrafts. She has been Director of the Textile Innovation Centre at the University of Lima. Author of scientific articles and books on innovation, sustainability and small and medium-sized enterprises.

With more than twenty years of experience in executive positions in the textile manufacturing sector, specialist in the areas of innovation, design, product development, marketing and operations. International lecturer on business management, innovation management, technology in the textile

industry, sustainability in handicrafts and management of small and medium enterprises.

Member of ISO/TMBG/SAG_ESG Strategic Advisory Group on Environmental, social, governance (ESG) ecosystem; ISO/TC 133 Clothing sizing systems-size designation, size measurement methods and digital fittings; ISO/TC 279/WG1 Innovation Management system. Currently president of the Technical Committee for Standardization - INACAL for Research, Technological Development and Innovation Management. Secretary of the SC-CTN Apparel. Member of the NTCs on MSMEs Management, Textiles and Clothing, and Quality Management and Assurance.

Member of the Latin American Association of Technology and Innovation Management - ALTEC. Member of the Peruvian Association of Textile Technicians - APTT. Member of the Sustainable Fashion Cluster.

Panel Speaker IV

Panel on Lean Six Sigma

July 20, 2022, 2:00 – 3:45 pm

Panel Chair



Dr. Imran Ahmad Rana

Management and Analytics Professional Trainer, Coach, Consultant and Practitioner
TCL, Lahore
Pakistan

Panel Speaker I



Dave Harry

Black Belt Trainer / Kata Coach
President & CEO
Process Whisperer® Consultants LLC
Greenville, TN, USA

David Harry, a.k.a. "The Process Whisperer®", has more than 30 years' experience as a project manager, business process improvement instructor and expert problem solver. Following a successful military career as a Naval Aviator, Dave taught Lean and Six Sigma "Belts" and project management classes for various companies including KPMG Consulting, Northrop Grumman, Rolls-Royce Energy, Arconic, and the University of Tennessee Knoxville. An Expert Trainer at Northrop Grumman, he was Manager of Continuous Improvement at Rolls-Royce Energy and

has been involved with manufacturing and logistics Lean Six Sigma programs across several industries.. He has served on leadership boards of the American Society for Quality and the Institute of Industrial Systems Engineers and the OpEx Society. He has been awarded three Masters-level degrees in management, including from the University of Southern California and the University of Chennai (India). His certifications include PMI Project Management Professional, ASQ Six Sigma Black Belt, Lean Bronze Certification from the SME/Shingo/AME Alliance, Agile Certified Scrum Master and a Certified Baseline Project Management Office (CB-PMO) Consultant. He is a recognized Toyota Kata "Geek" and has attended and presented at several IEOM conferences.

Panel Speaker II



Javier Enríquez

PM Consultant
IT, Mining & Construction
Lima, Peru

Panel Speaker III

Panel on “The Impact of Extra Curriculum Activities in Professional Performance”

July 20, 2022, 4:00 – 5:45 pm

Panel Chair



Dr. Fernando Gonzalez Aleu
Associate Professor
Universidad de Monterrey (UDEM)
Mexico

Fernando Gonzalez Aleu is an Associate Professor at the Universidad de Monterrey (UDEM) in Mexico. He received a BS in Mechanical and Management Engineering at UDEM, a MS at ITESM in 1999, and both an MS and PhD in Industrial and Systems Engineering from Virginia Tech in 2015 and 2016, respectively. His research focuses on the applications of continuous improvement projects. Prior industry experience includes 15 years implementing quality systems, environmental systems, and management systems. He is member of the Institute of Industrial and Systems Engineers, the American Society for Engineering Management, and the American Society for Quality.

Panel Speaker I

Panel Speaker II

Panel Speaker III

Diversity & Inclusion Panel sponsored by Ford Motor Company

July 21, 2022, 2:00 – 3:45 pm

Panel Chair



Professor Donald M. Reimer
President, The Small Business Strategy Group
Detroit, Michigan, USA
Adjunct Faculty – A. Leon Linton Department of Mechanical Engineering
Lawrence Technological University
Southfield, Michigan, USA

Donald M. Reimer is an adjunct faculty at the A. Leon Linton Department of Mechanical Engineering in College of Engineering at Lawrence Tech in Southfield, Michigan. He coordinates the Certificate of Entrepreneurial Engineering Skills. Mr. Reimer holds a Bachelor of Science degree in Industrial Management from Lawrence Technological University and a Master of Arts degree in Political Science from University of Detroit/Mercy. He is a Certified Management Consultant with over 35 years of experience in working with closely-held businesses. He has taught courses in entrepreneurship, strategic management, corporate entrepreneurship and innovation for engineers. Mr. Reimer is a member of the Lawrence Tech Kern Campus Committee, Coordinator of the Lawrence Tech Innovation Encounter. He is faculty Advisor of the Collegiate Entrepreneurs' Organization. Mr. Reimer serves as a Kern Fellow of The Kern Family Foundation, Co-Direct of the Coleman Fellows Program, member of the National Collegiate Entrepreneurs' Organization Faculty Advisory Council and is a member of the American Society of Engineering Education.

He has operated his own consulting company – The Small Business Strategy Group for 23 years. He published numerous articles on small business, entrepreneurship and strategic thinking. He has received several awards and recognition by local, state and federal agencies for his work in entrepreneurship and minority business development. Mr. Reimer served as member of the Minority Economic Development Committee of New Detroit. Mr. Reimer is member of the Small Business Advisory Council of the Detroit Regional Chamber of Commerce. Mr. Reimer is a member of Advisory Board of the Milwaukee Junction Small Business Assistance Center. He is also a member of the Applied Innovation Alliance. Mr. Reimer serves as a KEEN Fellow for The Kern Family Foundation and is a member of United States Association of Small Business and Entrepreneurship.

Panel Speaker I

Prof. Vitor Mendes Caldana

Federal Institute of Sao Paulo (IFSP) – Sorocaba Campus
Sorocaba, Sao Paulo, Brazil

Began the academic career with a technician course in Electronics from Liceu de Artes e Ofícios (1999) followed by an undergraduate degree in Electronic Engineering from Universidade Presbiteriana Mackenzie in 2004. In 2016, finished the Masters course in Industrial Engineering with the Quality of Engineering Education and its Relation to Regional Development as his area of research. As a technical profession, from 1999 until 2016, started in Caltronic Automação Industrial, a service-based company in Brazil that represents American and European automation equipment for the printing industry, and finished as Service and Projects Manager, serving not only Brazil but the whole of South America with services performed also in USA and China. During the professional career took several courses in USA and Europe to Automation and dedicated equipment maintenance. In 2016 left the company for full-time dedication to IFSP. In 2014 began his teaching career in FIEB as a substitute teacher for the Technical Course of Electronics. In 2016 moved to IFSP to start the electronics Technical Course in the city of Sorocaba and has been

engaged with this project since. In this 4,5 years taught a variety of courses in electronics. In 2018 began his Research Group in Industry 4.0 and is currently working with colleagues in this research area as well as the project for the PhD.

Panel Speaker II



Professor Eldon G. Caldwell Marin, Ph.D., Sc.D, Dr.Ed. – IEOM President-Elect
 Professor, Industrial Engineering Department
 Engineering School
 University of Costa Rica
 San Jose, Costa Rica

Eldon Caldwell is full professor/Cathedraticus of the University of Costa Rica, Central America; member of the IEOM Society Academy of Fellows and member of the IEOM Society Global Council. Also, he has been recognized by the IEOM Society with the “Outstanding Service Award” for his career of over 30 years as an educator, researcher and promoter of development of industrial engineering and as “Distinguished Professor” by IEEE

Computer Society, USA.

Dr. Caldwell earned his B.Sc. and Master degree in Industrial Engineering at University of Costa Rica and he earned a Master degree in Service Marketing, as well in Financial Analysis at Interamerican University of Puerto Rico; M.Sc. Health Management Systems at UNED, Costa Rica and a M.Sc. Operations Management at ITESM, México. Finally, he earned three doctoral degrees: 1-Ph.D. in C.Sc. / Industrial Engineering, Autonomous University of Central America; 2- Ph.D. (Sc.D.) in Robotics and Automation, University of Alicante, Spain; and 3-Ph.D. (Dr. Ed.) in Education at the University of Costa Rica, developing the “Theory of Socio-educational Exergy-Anergy and Entropy”.

He is author of many scientific articles and two books: “Marketing of Social Products & Services”, UCR Publications; and “Lean Manufacturing: Fundamentals and techniques for cycle time reduction”, Kaikaku Ins. Press, USA.

Dr. Caldwell served as Director of Industrial Engineering Department at Engineering School of University of Costa Rica, Operations Manager at MASECA, CA; Lean Manufacturing Project Manager at Eaton Corp. Costa Rica, General Manager at Quirós & Cia-Bandag Inc. and General Manager at Lean Systems Intl., USA. He has more than 30 years of experience as advisor and consultant in Operations Management, Lean Manufacturing and Lean Logistics at Interamerican Bank for Development, WHO, UN, World Wide Bank, Coca-Cola, Ministry of Health, Costa Rica, Honduras, Panamá, Costa Rican Institute for Electricity, RTC- Perú, Young Electrical Signs, Nevada, USA, AirCare Inc., Reno, Nevada, Plan International-Honduras, Bournes Co., DOLE Co. and many others. In addition, Dr. Caldwell currently serves as Director of the Central America Robotics and Industry 4.0 Challenge Contest (ROBOTIFEST) and General Manager at Kaikaku Institute Latin America.

Panel Speaker III



Dr. Jorge Kurita
 Professor and Research Director
 Universidad Nacional de Asuncion
 Paraguay

Dr. Jorge Kurita attended Universidad Nacional de Asuncion in Paraguay, where he got his BS in Electromechanical Engineering. After graduation, he spent some time in academia working as faculty. During this tenure, he taught courses on heat transfer, fluid mechanics, and physics. In 2004 Dr. Kurita was granted the Fulbright scholarship to attend a graduate program on Mechanical Engineering at Michigan Technological University. He has finished his MS and then continued with a doctorate program. NASA and the NSF funded his doctorate research. Dr. Kurita’s contribution to his field was well-published in several papers from high-impact journals. From 2011 Dr. Kurita worked as a development engineer II in the competitive automotive industry, Filtran LLC, located in Des Plaines, Illinois. As an experimental researcher, his experience helped Filtran develop special testing techniques never implemented before on filtration systems. In addition, Dr. Kurita worked in the CAE group, contributing to developing simulation techniques to help build state-of-the-art filtration systems. Dr. Kurita participated in developing OEM filters; some

of them obtained awards from Jatco and GM. From 2016 Dr. Kurita is back to his alma mater as an assistant professor in Universidad Nacional de Asuncion. Later the same year, he is appointed to lead the research department of the School of Engineering. In 2017 he was appointed to be the Mechanical Engineering Department head at Universidad Nacional de Asuncion. In August of the same year, Dr. Kurita is awarded the “Distinguished Citizen by the City Council of Asunción” for his contributions to education in Paraguay’s space sector. And in December of the same year, he was mentioned as “Outstanding Protagonist of 2017” by the newspaper Ultima Hora.

Submissions Received from Countries and Territories

1. Australia	11. Indonesia	21. Philippines	30. Trinidad and Tobago
2. Bolivia	12. Iraq	22. Portugal	31. Turkey
3. Brazil	13. Jamaica	23. Saudi Arabia	32. UK
4. Chile	14. Mexico	24. South Africa	33. United Arab Emirates
5. Colombia	15. Morocco	25. Spain	34. United States
6. Cuba	16. Namibia	26. Sri Lanka	
7. Ecuador	17. Nigeria	27. Sweden	
8. Finland	18. Pakistan	28. Taiwan	
9. Hungary	19. Paraguay	29. Thailand	
10. India	20. Peru		

An Economic Analysis of the Roles of Metal Industries in the National Economy: The Case of Japan

Ubaidillah Zuhdi

Faculty of Business Economics and Digital Technology
Universitas Nahdlatul Ulama Surabaya
Surabaya, East Java, Indonesia
ubaidillah.zuhdi@unusa.ac.id

Yohan Kurniawan

Faculty of Language Studies and Human Development
Universiti Malaysia Kelantan
Bachok, Kelantan, Malaysia
yohan@umk.edu.my

**Rizqi Putri Nourma Budiarti, Riyan Sisawan Putra, Hidayatul Khusnah,
Mohamad Rijal Iskandar Zhulqurnain, and Agung Firmansyah**

Faculty of Business Economics and Digital Technology
Universitas Nahdlatul Ulama Surabaya
Surabaya, East Java, Indonesia
rizqi.putri.nb@unusa.ac.id, riyan_sisiawan@unusa.ac.id, hidayatul.khusnah@unusa.ac.id,
rjial.iskandar@unusa.ac.id, agungfirmansyah009.mj20@student.unusa.ac.id

Abstract

This study aims to analyze the roles of metal industries in the Japanese national economy. This study applies Input-Output (IO) analysis as an analysis instrument. More specifically, this study employs the parts of IO analysis, namely simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis devices. The analysis period of this study is from 1985 through 2005. In this study, the analyzed industries are non-ferrous metals, non-ferrous metal products, metal products for construction and architecture, and other metal products. The results display that, by using both multipliers, the analyzed metal industries did not include in the top five Japanese industries from 1985 through 2005. By using both indices, one can argue that the quadrant change on the analysis period was experienced by non-ferrous metals and other metal products industries. Interestingly, both industries experienced the change in 2000. On the other hand, the remaining industries did not experience the quadrant movement from 1985 through 2005. In other words, the industries showed consistency in terms of the quadrant position on the analysis period.

Keywords

Metal Industries, National Economy, IO Analysis, Quadrant.

1. Introduction

The industrial sectors are significant aspects from the point of view of a national economy. Their contributions can be detected not only on the micro part, but also on the macro part of a country. Also, their imperative roles can be seen both in developed and developing countries. One of the industries that worth to be discussed in this matter is the metal industry.

There are many previous studies that explain the metal aspect. For example, Jahns et al. (2021) analyze the metal-dusting behavior of additively manufactured binary Ni-Cu alloys with 30 and 50 wt% Cu, respectively, and the technical Monel Alloy 400 with a Cu content of 30 wt% under metal dusting circumstances. Touileb et al. (2022)

investigate the impacts on the hot cracking vulnerability of fluoride powders such as CaF₂, NaF, and LiF; and metal powders such as Mn, Ti, Nb, and mixed Ti-Nb placed on the 316L stainless steel during the Tungsten Inert Gas (TIG) welding process.

On the other hand, Jamari et al. (2022) analyze three dissimilar metallic materials for application in metal-on-metal bearing of total hip implant in terms of contact pressure. The materials are cobalt chromium molybdenum or CoCrMo, stainless steel 316L or SS 316L, and titanium alloy or Ti6Al4V. Jarfors et al. (2022) analyze the in-process behaviour of a production slurry utilizing an engineering approach to estimate the properties. In their study, a method to measure the rheological properties of a semi-solid metal slurry is tested and found capable of making meaningful measurements. Kroupová et al. (2022) present the possibility of making cast porous metals or metallic foams in a low-tech way by the use of conventional foundry technologies, namely the common procedures and resources. Meanwhile, by means of differential thermal analysis, X-ray diffractometer, scanning electron microscopy, energy-dispersive spectrometer, etc., Wu et al. (2022) investigate systematically the impact of Ga content on the melting temperature, wettability, microstructure, and mechanical properties of low-silver 12AgCuZnSn-2In-0.15Pr cadmium-free filler metal.

Based on the aforementioned previous studies, one can claim that the study to analyze the economic aspects of the metal industry in a particular country is still needed. This study is done to fulfill the gap. One of the devices in conducting the analysis is Input-Output (IO) analysis, the tool in investigating the connections of industrial sectors in one or more nations. The importance and originality of this study is that it explores the roles of the metal industry by applying several calculation approaches from IO analysis which focus on the Japanese national economy.

This study aims to analyze the roles of metal industries in the national economy of Japan. This study uses IO analysis as an analysis instrument. More specifically, this study employs the parts of IO analysis, namely simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis devices. The period of analysis of this study is from 1985 through 2005.

The rest of this paper is elucidated as follows. Section 2 describes the methodology of this study. Section 3 explains the results of calculations. Also, the discussions for the results can be viewed on this section. The next section, section 4, clarifies the conclusions of this study and proposed further studies.

2. Methodology

The methodology of this study is clarified as follows. The first step is to describe the data used. This study employs Japanese IO tables for 1985, 1990, 1995, 2000, and 2005 as data. Initially, the tables consist of 84, 91, 93, 104, and 108 industries, respectively. After performing the adjustment procedure, the tables have 78 industries. Those industries are presented in Appendix. The second step is to show the Japanese metal industries used in this study. Table 1 clarifies those industries.

Table 1. Japanese Metal Industries Used in This Study

Sector Number	Sector Name
38	Non-ferrous metals
39	Non-ferrous metal products
40	Metal products for construction and architecture
41	Other metal products

The third step is to complete the calculations by employing simple output multiplier and simple household income multiplier. Miller and Blair (2009) elucidate the equations of both multipliers as follows:

$$m_{oj} = i = 1n_{lij} \quad (1)$$

$$m_{hj} = i = 1n_{an} + 1l_{ij}. \quad (2)$$

The former model describes the simple output multiplier while the latter one explains the simple household income multiplier. More specifically, $m(o)_j$, $m(h)_j$, $a_{n+1,j}$, n , and l_{ij} are simple output multiplier for sector j , simple household income multiplier for sector j , the coefficients of labor-input, the number of industrial sectors, and a sector-to-sector multipliers matrix, respectively.

The next step is to conduct the calculations in order to investigate the characteristics of Japanese industries on the period of analysis, especially the Japanese metal industries. The approaches used in the calculations are index of the power of dispersion and index of the sensitivity of dispersion. The former index is applied to inspect the strength of one specific industry in influencing entire industries. A larger influence is associated with the higher index value. The detail of the index is elucidated by Ministry of Internal Affairs and Communications Japan (n.d.) as follows:

$$\text{Index of the power of dispersion by sector} = b^*jB. \quad (3)$$

The numerator is each sum of columns in the table of inverse matrix coefficients while the denominator clarifies the mean value of the entire vertical sum in the table of inverse matrix coefficients. More specifically, the equations of numerator and denominator are described as follows:

$$b^*j = \sum_i b_{ij} \quad (4)$$

$$B = \frac{1}{n} \sum_j b^*j = \frac{1}{n} \sum_j \sum_i b_{ij} \quad (5)$$

Further, b_{ij} and n are the value of Leontief inverse from sector i to sector j and number of industrial sectors, respectively. The latter index is employed to investigate the sensitivity of the particular industrial sector to external influences. A larger sensitivity is associated with the greater index value. More specifically, one specific industrial sector is called more sensitive to the effects from the external aspects if it has a higher index value. The detail of the index is clarified by Ministry of Internal Affairs and Communications Japan (n.d.) as follows:

$$\text{Index of the sensitivity of dispersion by sector} = bi^*B. \quad (6)$$

In this index, the numerator is each sum of rows in the table of inverse matrix coefficients while the denominator explains the mean value of the entire horizontal sum in the table of inverse matrix coefficients. Further, the equations of the numerator and denominator of the index are elucidated as follows:

$$bi^* = \sum_j b_{ij} \quad (7)$$

$$B = \frac{1}{n} \sum_i bi^* = \frac{1}{n} \sum_i \sum_j b_{ij} \quad (8)$$

In order to get a compatibility sense with the previous index, equation (7) is slightly transformed from the original source. More specifically, the part describing the number of industrial sectors, n , is added into the equation. As with the previous explanation, b_{ij} is the Leontief inverse value from sector i to sector j . Conclusions of the study and suggested further research are clarified on the last step.

3. Results and Analysis

Tables 2, 3, 4, 5, and 6 display the top five Japanese industrial sectors viewed from the value of simple output multiplier in 1985, 1990, 1995, 2000, and 2005, respectively. Miller and Blair (2009) clarify that an output multiplier for sector j is the total value of production in all industrial sectors of the economy that is essential in order to achieve a currency's worth of final demand for the output of sector j . They also explain that, for the simple output multiplier, the total value of production is coming from the household's exogenous model.

Analyzed metal industries are not included in the tables. By using this outcome, one can argue that the industries did not make an attractive impression to the economy of Japan during the analysis period through an additional final demand. The other interesting fact from the multiplier is the industry number 36, steel products, can be viewed in the tables. This fact clarifies the consistency of the industry in attracting the Japanese economy from 1985 through 2005.

The same phenomenon can be detected on sector 65, self-transport by private cars. The other interesting phenomenon is that sector number 47, motor vehicles and repair of motor vehicles, inhabits the first position in almost all tables. For example, the sector occupies the first rank in table 4 with the value is 3.063. This result elucidates that in order to satisfy a year's worth of final demand for the sector's output in 1995, all Japanese industries required to produce the products of which the total value was ¥3.063.

Table 2. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1985 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	36	Steel products	3.456
2	65	Self-transport by private cars	3.283
3	23	Synthetic resins	3.266
4	22	Chemical basic and intermediate products	3.197
5	35	Pig iron and crude steel	3.183

Table 3. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1990 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.104
2	36	Steel products	3.097
3	65	Self-transport by private cars	2.852
4	35	Pig iron and crude steel	2.850
5	23	Synthetic resins	2.805

Table 4. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 1995 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.063
2	36	Steel products	2.887
3	65	Self-transport by private cars	2.748
4	11	Feeds and organic fertilizer, n.e.c.	2.717
5	35	Pig iron and crude steel	2.672

Table 5. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 2000 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.112
2	36	Steel products	2.967
3	23	Synthetic resins	2.916
4	22	Chemical basic and intermediate products	2.882
5	65	Self-transport by private cars	2.820

Table 6. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Output Multiplier, 2005 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Output Multiplier
1	47	Motor vehicles and repair of motor vehicles	3.449

2	23	Synthetic resins	3.302
3	22	Chemical basic and intermediate products	3.296
4	36	Steel products	3.237
5	65	Self-transport by private cars	2.952

Figures 1, 2, 3, and 4 display the simple output multiplier values of discussed industrial sectors on the analysis period. Generally, those industrial sectors have the same pattern based on the figures, namely decreasing-increasing pattern. A small difference could be seen in the non-ferrous metals sector in 2000. More specifically, compared with other discussed industrial sectors, the simple output multiplier value of the sector in 2000 was larger than the one in 1995.

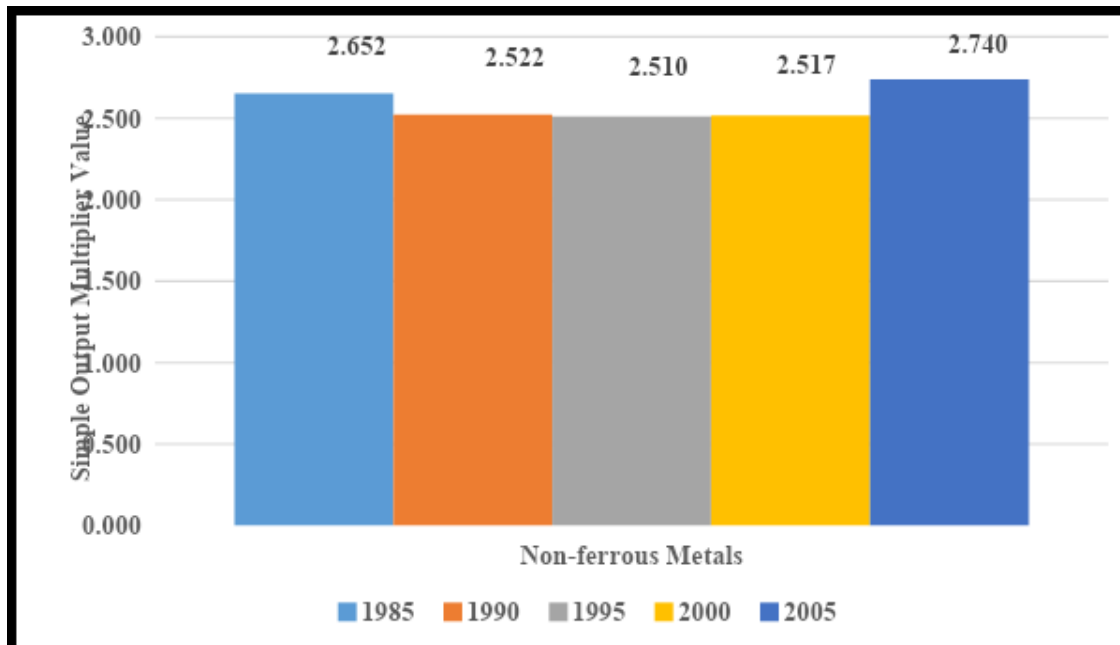


Figure 1. The Simple Output Multiplier Values of the Non-ferrous Metals Sector, 1985-2005

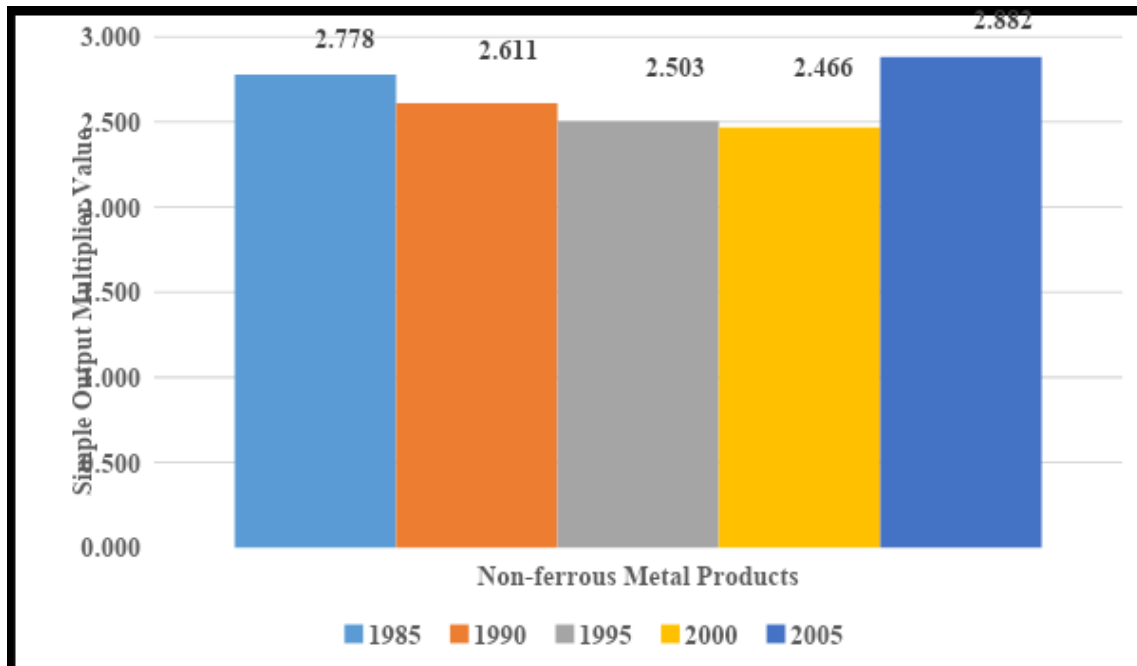


Figure 2. The Simple Output Multiplier Values of the Non-ferrous Metal Products Sector, 1985-2005

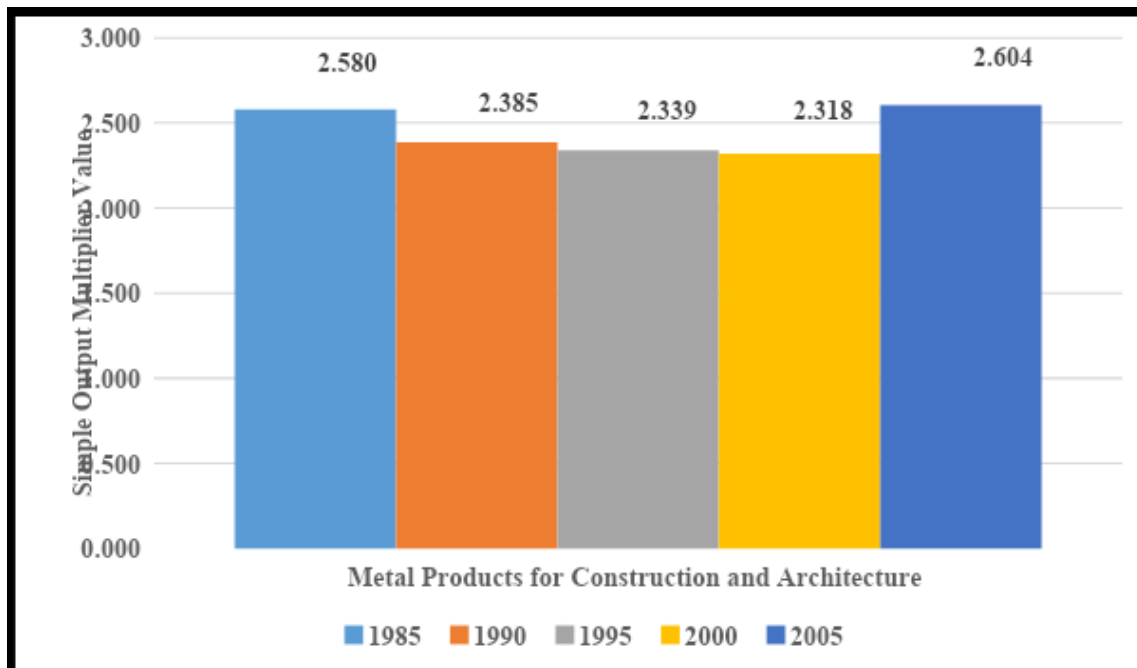


Figure 3. The Simple Output Multiplier Values of the Metal Products for Construction and Architecture Sector, 1985-2005

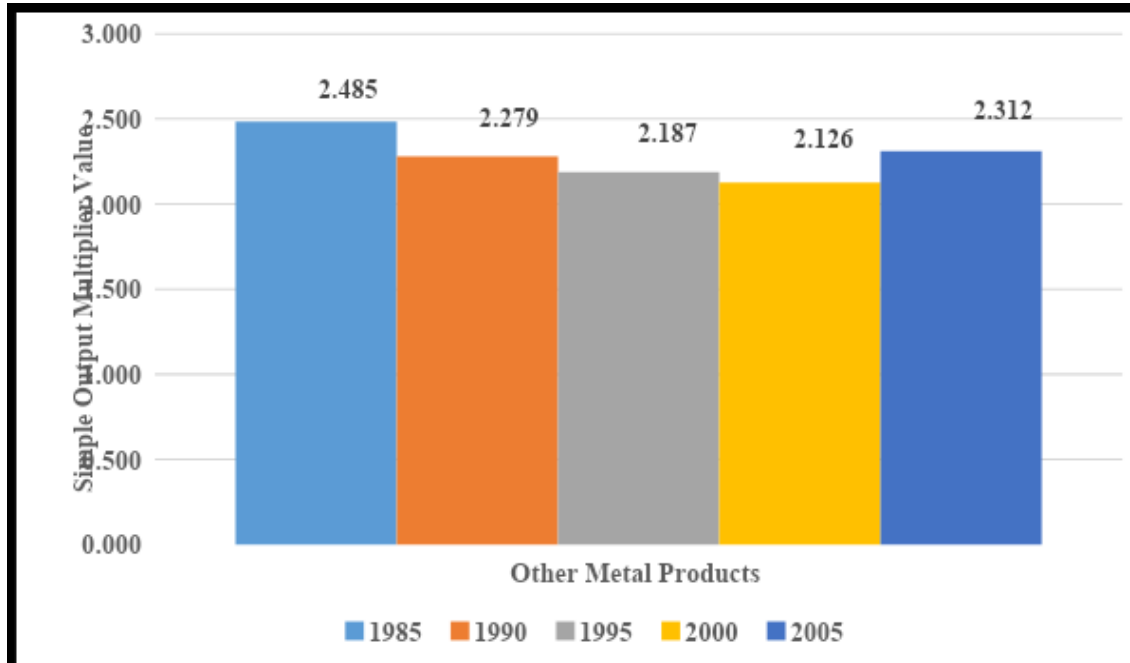


Figure 4. The Simple Output Multiplier Values of the Other Metal Products Sector, 1985-2005

Tables 7, 8, 9, 10, and 11 show the top five Japanese industrial sectors viewed from the values of simple household income multipliers in 1985, 1990, 1995, 2000, and 2005, respectively. Miller and Blair (2009) state that the multiplier is used to elucidate the economic impacts of new final demand as measured by new households' income by using the household's exogenous model. The contents of the tables are not the same with the ones of the tables of the previous multiplier.

Table 7. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1985 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	63	Railway	0.848
2	73	Education	0.836
3	64	Road transport (except transport by private cars)	0.736
4	58	Waste management service	0.719
5	72	Public administration and activities not elsewhere classified	0.691

Table 8. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1990 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.833
2	58	Waste management service	0.739
3	64	Road transport (except transport by private cars)	0.720
4	72	Public administration and activities not elsewhere classified	0.719
5	76	Other public services	0.709

Table 9. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 1995 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.838
2	72	Public administration and activities not elsewhere classified	0.723
3	76	Other public services	0.721
4	64	Road transport (except transport by private cars)	0.720
5	74	Research	0.706

Table 10. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 2000 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.795
2	74	Research	0.715
3	76	Other public services	0.712
4	64	Road transport (except transport by private cars)	0.709
5	75	Medical service, health and social security	0.688

Table 11. Top Five Japanese Industrial Sectors Viewed from the Value of Simple Household Income Multiplier, 2005 (Source: Zuhdi et al. (2021))

No.	Sector Number	Sector Name	Simple Household Income Multiplier
1	73	Education	0.780
2	76	Other public services	0.716
3	64	Road transport (except transport by private cars)	0.684
4	75	Medical service, health and social security	0.676
5	74	Research	0.658

One of the interesting facts from the second multiplier is two industries included in the tables, namely road transport (except transport by private cars) and education. In 1995, the values of those industrial sectors were 0.720 and 0.838, respectively. These values indicate that, in 1995, an additional yen of final demand for the industries would make ¥0.720 and ¥0.838 of new household incomes, respectively, when all direct and indirect impacts were transformed into yen estimates of incomes. The other interesting point is that the analyzed metal industries are not included in the tables. This circumstance is the same with the condition on the previous multiplier.

Figures 5, 6, 7, and 8 explain the simple household income multiplier values of discussed industries on the period of analysis. From the point of view of the multiplier, the industries had no specific pattern from 1985 through 2005. The industry with the most complex pattern on the analysis period was the non-ferrous metal products. On the other hand, the industry that had the simplest pattern from 1985 through 2005 was the other metal products.

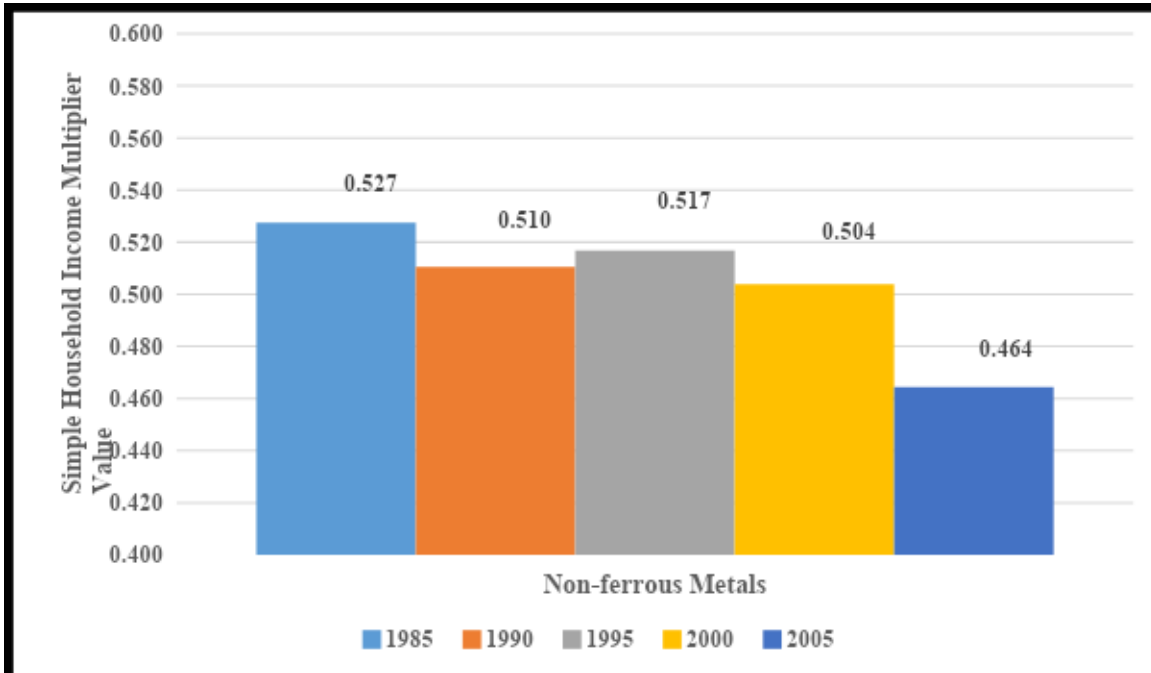


Figure 5. The Simple Household Income Multiplier Values of the Non-ferrous Metals Sector, 1985-2005

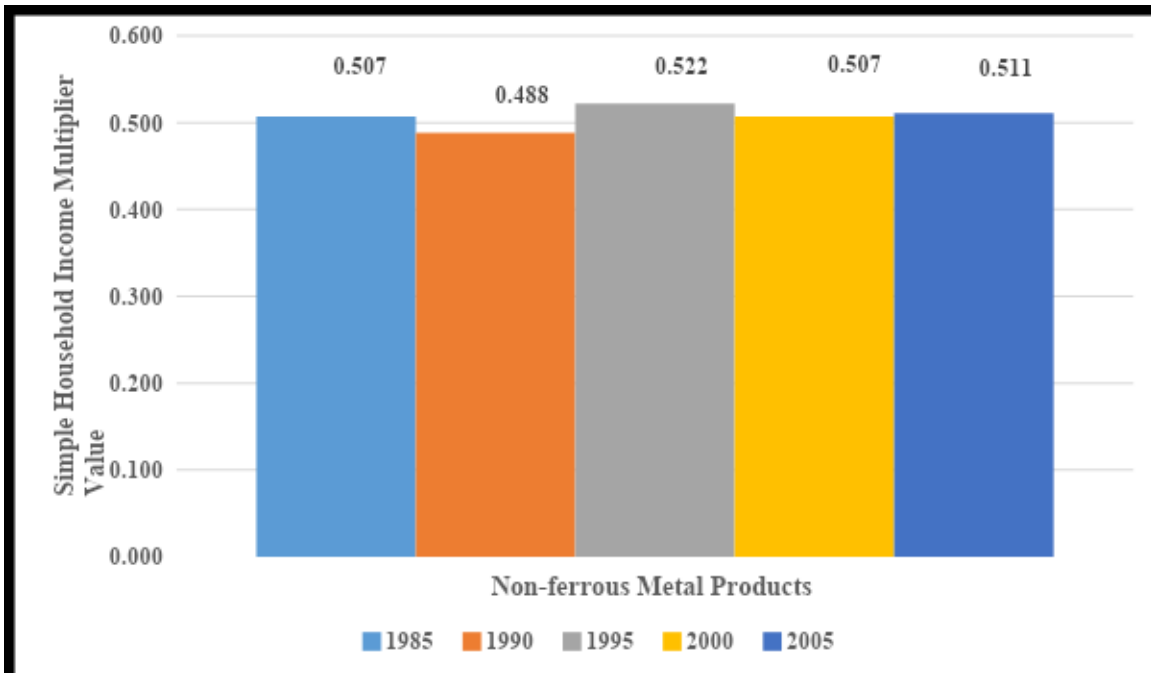


Figure 6. The Simple Household Income Multiplier Values of the Non-ferrous Metal Products Sector, 1985-2005

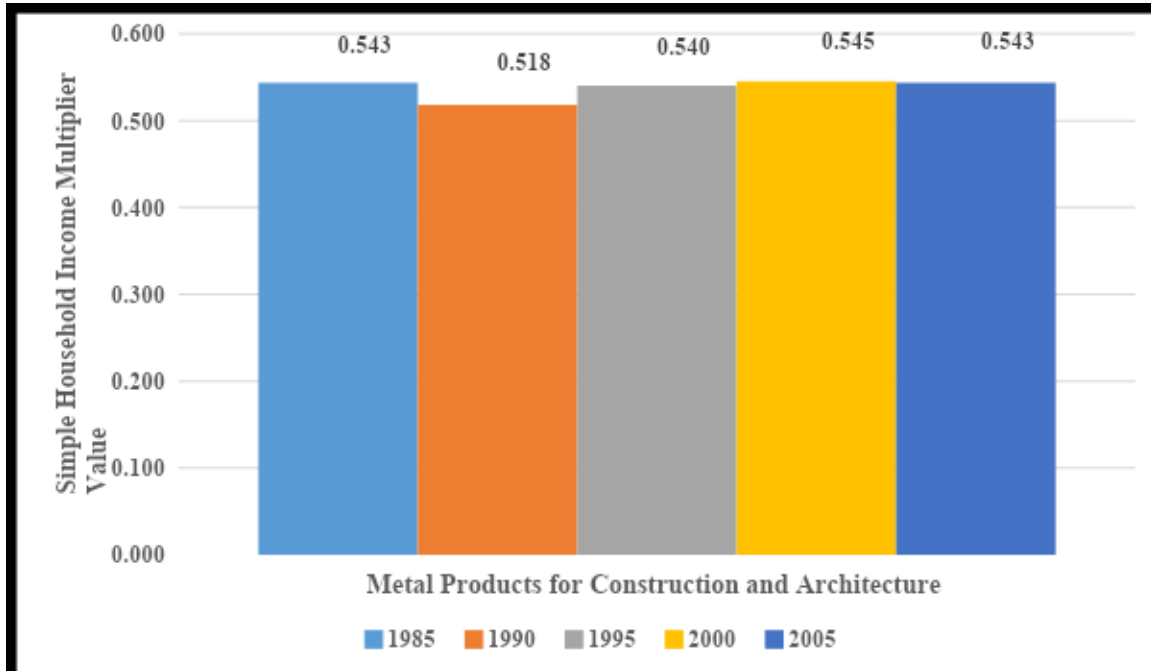


Figure 7. The Simple Household Income Multiplier Values of the Metal Products for Construction and Architecture Sector, 1985-2005

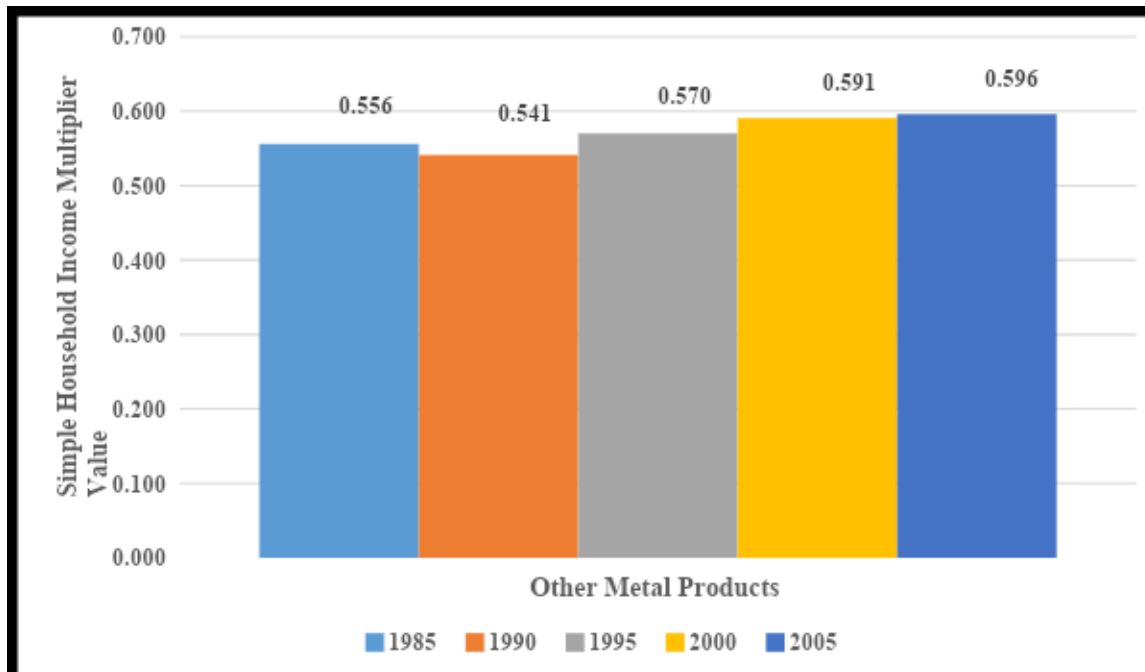


Figure 8. The Simple Household Income Multiplier Values of the Other Metal Products Sector, 1985-2005

Table 12 recaps the quadrants of discussed industries in the analysis period. The quadrants are generated from the combination of both indices used in this study, namely the index of the power of dispersion and the index of the sensitivity of dispersion. Further, four quadrants appear from the combination.

Each quadrant has unique features. More specifically, quadrant I is a position where the values of both indices are more than one. In other words, the industries that lie in this quadrant are those most impacted by the external aspects as well as have strong impressions on the entire industries. The opposite phenomena can be seen in the industries which lie in quadrant III. On the other hand, quadrant II is a position where the value of the index of the power of dispersion is less than one while the value of the other index is more than one. One can say that the industries that lie in this quadrant are those which have weak stimuluses on the entire industries, but they get high effects from the changes of external aspects. The opposite features are owned by the industrial sectors which lie in quadrant IV.

Table 12. The Quadrants of Japanese Metal Industries, 1985-2005

Sector Number	Sector Name	Quadrant				
		1985	1990	1995	2000	2005
38	Non-ferrous metals	I	I	I	IV	I
39	Non-ferrous metal products	IV	IV	IV	IV	IV
40	Metal products for construction and architecture	IV	IV	IV	IV	IV
41	Other metal products	I	I	I	II	I

Based on the information in Table 12, one can argue that the quadrant movement in the analysis period was experienced by non-ferrous metals and other metal products sectors. Interestingly, both sectors experienced the movement in 2000. On the other hand, the remaining sectors did not experience the quadrant change from 1985 through 2005. In other words, the sectors showed consistency in terms of the quadrant position on the period of analysis.

4. Conclusions and Further Research

This study explores the roles of Japanese metal industries in the Japanese national economy by using IO analysis. More specifically, this study employs simple output multiplier, simple household income multiplier, index of the power of dispersion, and index of the sensitivity of dispersion as analysis apparatuses. The period of analysis of this study is 1985-2005. The analyzed Japanese metal industries in this study are non-ferrous metals, non-ferrous metal products, metal products for construction and architecture, and other metal products.

The results show that, by using both multipliers, the analyzed metal industries were not included in the top five Japanese industrial sectors from 1985 through 2005. By using both indices, one can claim that the quadrant movement on the analysis period was experienced by non-ferrous metals and other metal products industries. Interestingly, both industries experienced the movement in 2000. On the other hand, the remaining industries did not experience the quadrant alteration from 1985 through 2005. In other words, the industries showed consistency in terms of the quadrant location on the period of analysis.

The understanding regarding the roles of Japanese metal industries in affecting the Japanese national economy during the period of analysis is obtained from the current study. However, the study would gain a broader insight about the roles if the study could apply the longer analysis period. Therefore, as one of the further studies, the study proposes the same analysis by using the longer period of analysis, such as from 1985 through 2015. One of the vital aspects that must be considered when conducting the proposed further study is the prices and industrial sectors used on the analyzed IO tables should be the same.

The other recommended further research from the study is to do an international comparison using the same approaches. The comparison can be focused on developed-developed, developed-developing, or developing-developing nations. The comparison might explore the roles of the metal industries of compared countries so the similarities and differences among those regarding the industrial sectors can be examined. One of the examples in this matter is the comparison between Japan and Indonesia.

Acknowledgements

The authors would like to thank Universitas Nahdlatul Ulama Surabaya for providing the research funding.

Appendix

The Japanese Industries (Source: Zuhdi et al. (2014) with Slight Modifications)

Sector Number	Sector Name
1	Crop cultivation
2	Livestock
3	Agricultural services
4	Forestry
5	Fisheries
6	Metallic ores
7	Non-metallic ores
8	Coal mining, crude petroleum, and natural gas
9	Foods
10	Beverage
11	Feeds and organic fertilizer, n.e.c.
12	Tobacco
13	Textile products
14	Wearing apparel and other textile products
15	Timber and wooden products
16	Furniture and fixtures
17	Pulp and paper
18	Paper products
19	Publishing and printing
20	Chemical fertilizer
21	Basic industrial inorganic chemicals
22	Chemical basic and intermediate products
23	Synthetic resins
24	Synthetic fibers
25	Final chemical products, n.e.c.
26	Petroleum refinery products
27	Coal products
28	Plastic products
29	Rubber products
30	Leather, fur skins, and miscellaneous leather products
31	Glass and glass products
32	Cement and cement products
33	Pottery, china, and earthenware
34	Other ceramic, stone, and clay products
35	Pig iron and crude steel
36	Steel products
37	Steel castings and forgings, and other steel products
38	Non-ferrous metals

39	Non-ferrous metal products
40	Metal products for construction and architecture
41	Other metal products
42	General industrial machinery
43	Special industrial machinery
44	Other general machines
45	Machinery for office and service industry
46	Electrical appliance
47	Motor vehicles and repair of motor vehicles
48	Ships and repair of ships
49	Other transportation equipment and repair of transportation equipment
50	Precision instruments
51	Miscellaneous manufacturing products
52	Building construction
53	Repair of construction
54	Civil
55	Electricity
56	Gas and heat supply
57	Water supply
58	Waste management service
59	Commerce
60	Finance and insurance
61	Real estate agencies and rental services
62	House rent
63	Railway
64	Road transport (except transport by private cars)
65	Self-transport by private cars
66	Water transport
67	Air transport
68	Storage facility service
69	Services relating to transport
70	Communication
71	Broadcasting
72	Public administration and activities not elsewhere classified
73	Education
74	Research
75	Medical service, health, and social security
76	Other public services
77	Business and office supplies
78	Personal services

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Biographies

Ubaidillah Zuhdi is an Assistant Professor at the Faculty of Business Economics and Digital Technology, Universitas Nahdlatul Ulama Surabaya. Currently, he is the Dean of the faculty. He earned his Doctorate degree from the Department of Industrial Administration, Tokyo University of Science. Previously, he was an Assistant Professor at the Faculty of Management and Economics, Gdansk University of Technology. He has published many journal papers. His research interests include (1) the economic analyses of the sectors of Information and Communication Technology (ICT), creative industry, livestock, agriculture, energy, and fishery, (2) applied economics, (3) policy analysis, (4) IO analysis, and (5) mathematical modeling.

Yohan Kurniawan is an Associate Professor at the Faculty of Language Studies and Human Development, Universiti Malaysia Kelantan. He obtained his master's and Ph.D. degrees in Psychology from Universiti Kebangsaan Malaysia. His main area of interest is Experimental Psychology with its applications in Clinical, Cognitive, and Parapsychology Psychology. He has a deep interest in Cultural Psychology, especially Javanese Culture. He has long experience in the Social Entrepreneurship program called Social Enterprise for Economic Development (SEED).

Rizqi Putri Nourma Budiarti is a Lecturer at the Department of Information Systems, Faculty of Business Economics and Digital Technology, Universitas Nahdlatul Ulama Surabaya. She currently serves as the Editor-in-Chief of the Applied Technology and Computing Science Journal. She obtained her master's degree in Engineering from the Multimedia Intelligent Network Department, Institut Teknologi Sepuluh Nopember. Her research interests include (1) machine learning, (2) data mining, (3) virtual reality, (4) networking, and (5) big data.

Riyan Sisiawan Putra is a Lecturer at the Department of Management, Faculty of Business Economics and Digital Technology, Universitas Nahdlatul Ulama Surabaya. Currently, he is the Head of the department. His Undergraduate degree was taken at Airlangga University, as well as his master's degree. He is taking the Doctoral program at the same university. He is a member of the Indonesian Management Forum (FMI). His fields of study are Human Resource Management and Entrepreneurship.

Hidayatul Khusnah is a lecturer at the Faculty of Business Economics and Digital Technology, Universitas Nahdlatul Ulama Surabaya. She has published many research articles. Her research interests include (1) management accounting, (2) behavioral accounting, (3) financial accounting, and (4) business management.

Mohamad Rijal Iskandar Zhulqurnain is a lecturer in the Department of Management at Universitas Nahdlatul Ulama Surabaya, Indonesia. He earned his Bachelor of Management from Airlangga University, Indonesia and Master of Commerce in Business Management and Organization from Macquarie University Sydney, Australia. During his last year of study in 2020, he received an award mentioned as the “best achievement in Managing Customer Relationship” from the Department of Marketing, Macquarie Business School. He has contributed into several research projects such as the Strategic Management handbook with Airlangga University and the social research regarding the effects of socioeconomic status on cognitive brain function in Southeast Asian countries. He also became part of the business and entrepreneurial student development team in Universitas Nahdlatul Ulama Surabaya.

Agung Firmansyah is currently an undergraduate student at the Faculty of Business Economics and Digital Technology, Universitas Nahdlatul Ulama Surabaya.