

# PROGRAMME & ABSTRACTS



**23rd Cambridge International Manufacturing Symposium**

26 & 27 September 2019 | Cambridge UK

## Shaping the future of global manufacturing supply networks:

Delivering sustainable value for producers and  
consumers through digital platforms



**UNIVERSITY OF  
CAMBRIDGE**

Department of Engineering



Centre for  
International Manufacturing

## Symposium Organisers

The Symposium is organised and hosted by the Centre for International Manufacturing (CIM), one of several Research Centres in Cambridge University's Institute for Manufacturing (IfM), which acts as a focal point for industrial managers and the wider community concerned with international manufacturing issues and problems. The formation of the Centre recognises the importance of these issues in the modern industrial environment alongside the traditional domains of manufacturing strategy and performance measurement, technology management, and product planning and introduction.

## Organising Committee

Dr Jagjit Singh Srail (Chair)  
Dr Paul Christodoulou  
Dr Don Fleet  
Eric Harris  
Dr Ettore Settanni  
Nick Sherwen  
Dr Yongjiang Shi  
Dr Naoum Tsolakis

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# CHAIRMAN'S INTRODUCTION



**The 23rd Cambridge International Manufacturing Symposium will once again bring together industry, academia and policymakers, providing an opportunity for open dialogue and insights into practice and research. This year's Symposium will focus on the theme of 'Shaping the future of global manufacturing supply networks: Delivering sustainable value for producers and consumers through digital platforms'.**

Advanced production and digital technologies are offering new opportunities for more responsive, flexible and potentially more distributed manufacturing located closer to consumers. E-Commerce distribution models are also emerging, as are digital platform businesses that are connecting end-users with producers and service providers.

These developments are significant not just for manufacturers and their supply chains, but also for consumers and society at large. And whilst these technology developments suggest radically different digitalised manufacturing supply chains, technology adoption is far from straightforward, with many pilot applications not progressing to full scale.

Throughout the two days, the Symposium provides an opportunity to share experiences on how firms might better exploit these new opportunities in order to reconceptualise their supply chain operations and escape the pilot purgatory of experimentation without exploitation. At a strategic level for example, how do firms choose which technologies to focus on? As manufacturing supply chains becoming extended operating right through to end users, what strategic partnerships are required? And how do companies acquire or develop the right skills? Do supply chains of the future require different governance arrangements as they leverage new information flows and will they require industry, academia and regulators to work more closely together?

Whilst exemplar 'Lighthouse' applications are now emerging, widespread adoption remains limited. So is this supply chain transformation driven by advanced manufacturing and digital technologies more hype than reality? Our invited industry speakers suggest otherwise and will be addressing real-world applications that are making a difference in their organisations. As per our usual format, we have some outstanding senior industrial speakers on the first day of our Symposium, from **Caterpillar, Electrolux, IKEA, Microsoft, Unilever, and Wehkamp** who will presenting exemplar initiatives from their manufacturing supply chain operations and thoughts on future developments.

We are also delighted to have leading academic keynotes to kick-off day 2, sharing insights on two important developments related to the Symposium theme, the emergence of digital platform businesses that connect producers with consumers, and how manufacturing technologies might support circular economy business models. Professor Geoffrey G. Parker (Thayer School of Engineering, Dartmouth College, USA) will be sharing recent developments in digital platform businesses and how manufacturing organisations might consider such transformations. Professor Lenny Koh (Founder and Director of the Advanced Resource Efficiency Centre (AREC), University of Sheffield, UK) will be sharing her research on resource-efficient supply chains. Academic keynote talks will be followed by parallel tracks on the topics relating to our main research themes.

I am sure you will enjoy the engaging yet informal atmosphere of our rather unique academic-practitioner-policy community, one that has developed its own modus operandi in shaping the forward research agenda. As part of this continued exchange of ideas we are very much looking forward to welcoming you to the 2019 Cambridge International Manufacturing Symposium.

**Dr Jagjit Singh Srail**

Symposium Chair

Head of Centre for International Manufacturing

University of Cambridge, Institute for Manufacturing

## AGENDA | THURSDAY 26 SEPTEMBER

- 09.00 Registration and refreshments
- 09.30 Welcome and introduction**  
Dr Jagjit Singh Srail, Head, Centre for International Manufacturing  
IfM, University of Cambridge
- 09.45 Digital Order-to-delivery: Transformation of an entire multi-tier supply network**  
Haydn Powell, Global Supply Chain Strategy Manager  
Caterpillar
- 10.30 *Refreshments*
- 11.00 IKEA Industry 4.0: From development to pilot**  
Per Berggren, Industrial Strategies  
IKEA Industry AB
- 11.45 Developing advanced e-commerce fulfilment systems for best-in-class customer experience**  
Maarten Tibosch, COO  
wehkamp.nl
- 12.30 *Lunch and networking*
- 13.45 Factory of the future with AI**  
Sophia Velastegui, General Manager in AI Products + Search  
Microsoft
- 14.30 Global operations optimisation: Footprint, automation and digitalisation**  
Frank Wagner, Formerly SVP Global Manufacturing Operations  
Electrolux
- 15.15 *Refreshments*
- 15.45 Supply chain transformation in Unilever**  
Biswaranjan Sen, Executive Vice President Supply Chain,  
Supply Chain Digital Transformation and Engineering and Planning  
Unilever
- 16.30 Plenary session on future research challenges**
- 17.15 Wrap up and close of session
- 19.00 Symposium Dinner at Corpus Christi College

## AGENDA | FRIDAY 27 SEPTEMBER

08.30 Registration and refreshments

**09.00 Reshaping the supply chain through digital platforms – Implications for firms, consumers and society**

Professor Geoffrey G. Parker

Thayer School of Engineering, Dartmouth, USA

**09.45 Designing and manufacturing for sustainability: SCEnAT Life Cycle Platform**

Professor Lenny Koh, Founder and Director of the Advanced Resource Efficiency Centre (AREC)

University of Sheffield, UK

10.30 *Refreshments*

**11.00 RESEARCH THEMES | SESSION ONE**

Digital Manufacturing Networks

Sustainability

Value Chains and Business Models

12.30 *Lunch*

**13.15 RESEARCH THEMES | SESSION TWO**

Supply Network Design

Agri-food Track I

Mergers and Acquisitions

14.45 *Refreshments*

**15.00 RESEARCH THEMES | SESSION THREE**

Technology and Innovation

Agri-food Track II

Risk and Complexity

16.30 Close

## Digital Manufacturing Networks

(Chair: Gary Graham)

**Exploring loss hidden in digital scheduling data. A case of chemical production system**

Koichi Murata, Takahiro Ishimoto

**Digital transformation in the automotive supply chain**

Gary Graham, Laird Burns, Patrick Hennelly

**A method for facilitating the design of Industry 4.0 collaborations and its application in the aerospace sector**

Nikolai Kazantsev, Nikolay Mehandjiev, Pedro Sampaio, Iain Duncan Stalker

**Supply chain digital twins: Opportunities and challenges beyond the hype**

Jagjit Singh Srail, Ettore Settanni, Naoum Tsolakis, Parminder Aulakh

## Sustainability

(Chair: Ekaterina Yatskovskaya)

**Consumer driven sustainable supply networks**

Ekaterina Yatskovskaya, Jagjit Singh Srail

**Soft systems as a helping tool in the assessment of sustainable business practices and risks in a socio-economic-environmental context**

Isabel Duarte de Almeida, J. M. Vilas-Boas da Silva

**Towards the end of the resounding sound of silence: How state intervention forces multinational companies (MNC) to rethink their operations management (OM); The case of waste in the food plastic packaging industry**

Yannick Pottier

**Fabricating biomedical implants material: A case study based on process plans and environmental impacts**

Gurvinder Singh, Vikrant Bhakar, Harpreet Singh

## Value Chains and Business Models

(Chair: Naoum Tsolakis)

**Value chain impacts of EU Waste Framework Directive 2018/851 as a result of reporting substances of very high concern from 2021**

Sukhraj S. Takhar, Kapila Liyanage

**New business models as regulation changes: Case of Finland and Russia**

Oskari Lähdeaho, Olli-Pekka Hilmola, Jukka Niiranen

**Business model design elements for electric car service based on digital data enabled sharing platform**

Lasse Metso, Ari Happonen, Ville Ojanen, Matti Rissanen, Timo Kärri

**Design of B2B e-commerce business models: A configuration and design-science perspective**

Alexander Kouptsov, Jagjit Singh Srail

## Supply Network Design

(Chair: Laird Burns)

**Some advanced topics on innovation-focused lean/agile management**

Hiroshi Katayama

**The impact of the Fourth Industrial Revolution in the ownership, location and internalization advantages of firms: an exploratory study**

Evodio Kaltenecker, Lisa Kahle-Piasecki

**Foster inclusive entrepreneurship in BOP areas: The role of asset specificity and supply chain interconnection**

Jian Du, Jie Lu

**Localization or not localization? Evidence from Philips**

Yue Jia, Bin Guo

## Agri-food Track I

(Chair: Naoum Tsolakis)

**Sustainable supply network configurations driven by water scarcity: Example of end-to-end beverage supply chain**

Ekaterina Yatskovskaya, Jagjit Singh Srail, Mukesh Kumar

**Simulation of future groundwater behaviour in Sirhind Canal Tract of Punjab using MODFLOW**

Navdeep Kaur, Samanpreet Kaur

**Management interventions to enhance productivity of wheat and water use in changing climate of Indian Punjab**

Bharat Bhushan Vashisht

**Can Input-Output data inform agri-food supply network reconfiguration? The case of water-intensive crop production in developing economies**

Ettore Settanni, Jagjit Singh Srail, Franz Stephan Lutter

## Mergers and Acquisitions

(Chair: Pavan Manocha)

**Exploring the implications of M&A for global production networks**

Oliver Flaeschner, Torbjörn Netland, Kasra Ferdows, Jagjit Singh Srail

**Analysing the financial sustainability in mergers and acquisitions for Chinese manufacturing firms**

Xiaobo Wu, Ye Hua, Yongjiang Shi

**Exploring circular economy supply chain considerations in Mergers & Acquisitions – How green is the deal? A natural-resource-based view of the U.S. shale oil & gas product-supply chain**

Pavan Manocha, Jagjit Singh Srail

**Exploring visual management and continuous improvement in a manufacturing context: A structured bibliometric analysis**

Lucia Olszewski, Arijit Bhattacharya, Tomás Seosamh Harrington

## Technology and Innovation

(Chair: Ettore Settanni)

### Windows of opportunity: Technology cycles, demand conditions, and strategy

Xiaobo Wu, Yuanyang Teng, Yongjiang Shi, Sasa Ding

### Exploring the feasibility of anchoring innovation by enhancing the linkage between manufacturing research networks and supply chains

Michael Ward, Janet Godsell

### Developing fava beans as a sustainable source of high-quality protein for food supply chains through optimised genetics, farming and processing

Naoum Tsolakis, Thomas Wood, Isabelle Privat, Bénédicte Terrier, Jean-Michel Roturier, Jagjit Singh Srail, Howard Griffiths

## Agri-food Track II

(Chair: Tomás Seosamh Harrington)

### Sub surface drip fertigation in summer moong-maize-wheat cropping system: A novel technique for sustainable water use and higher resource use efficiency

Ajmer Singh Brar, Kuljit Kaur

### Role of Farmer Producers Organizations (FPOs) in Punjab

Puneet Singh Thind

### Digital FPO design: The development of an institutional-socially responsible supply network framework

Tomás Seosamh Harrington, Jagjit Singh Srail

### Environmental Impact Assessment and Supply Chain Mapping of Kinnow Fruit Production – A Case Study of Punjab, India

Vikrant Bhakar, Harpreet Singh, Kiranjot Kaur

## Risk and Complexity

(Chair: Mukesh Kumar)

### A new approach to optimising supply-chain performance using 4 fundamental process types

David Anker, Glenn Chambers

### Application of the concept of supply chain reliability for an availability assessment of inland waterway systems

Johannes M. Gast, Rebecca Wehrle

### Impact of supply chain risk management on organizational performance: Moderating role of supply chain integration

Sabeen Hussain Bhatti, Asif Ali Bhatti



# **SPEAKER**

## BIOGRAPHIES

## SPEAKER BIOGRAPHIES



### **Per Berggren**

*Industrial Strategies, IKEA Industry AB*

Per Berggren is the Industrial Strategy Manager at IKEA Industry. In this function his responsibilities include Manufacturing Strategy, Footprint, M&A, Product development, R&D, Technology, IT, Business Processes and Sustainability. IKEA Industry is IKEA's manufacturing branch operating 40 plants across 10 countries and employing some 20 000 coworkers. Per has experience from SCM and Manufacturing where he has been running operations in a number of countries as well as headed global business units.

Per holds a M.Sc. in Industrial Engineering & Management and is an alumnus of INSEAD and Wharton.



### **Haydn Powell**

*Director, Digital Manufacturing and Supply Management Strategy, Caterpillar*

Haydn Powell, Director, Digital Manufacturing and Supply Management Strategy, Advanced Components and Systems Division, Caterpillar Inc, has over 30 years of experience in manufacturing engineering, operations and supply chain management. He has published over 25 technical papers and is a member of several national and international committees and technical organizations. He is the inventor of a number of patents in inventory management and currently leads the digital manufacturing and supply management strategy for Caterpillar's Advanced Components Manufacturing Division.

Prior to joining Caterpillar Haydn was involved in research and the application of welding and joining process technologies at The Welding Institute (UK) and has over 15 years of experience working in the European automotive industry with Automobiles Citroen, Peugeot, Jaguar Cars and Ford Motor Company. Haydn graduated from the University of Coventry, UK with a bachelor's Degree in Materials Science and held an appointment as Industrial Research Fellow in Materials Management and Logistics Strategy at Cambridge University UK during his tenure at Jaguar Cars.

**Biswaranjan Sen**

*Executive Vice President Supply Chain, Supply Chain Digital Transformation and Engineering and Planning, Unilever*

Biswaranjan Sen, Executive Vice President Supply Chain, Head of Beauty and Personal Care Supply Chain, Supply chain Digital Transformation and Engineering and Planning, Unilever is a Chemical Engineer by training. He joined Unilever in 1991 and has worked in R&D and across various parts of the Supply Chain including manufacturing, planning, logistics, customer service and procurement. He was a member of the Board of Directors of Unilever Indonesia with responsibility for the supply chain between 2009 and 2012.

He has been an Executive Vice President in Unilever since May 2017 and his role currently covers responsibility for the Beauty and Personal Care Supply Chain, Engineering and leading the Transformation team. He was VP Group SC Personal Care before his current appointment and prior to his responsibilities with Personal Care, he was Vice President Procurement Chemicals.

Bish has worked across the world but is now based out of London, UK.

**Maarten Tibosch**

*COO, wehkamp.nl*

Maarten Tibosch, COO, wehkamp.nl has 20 years of working experience in the manufacturing industry fulfilling global operations roles in almost every part of the supply chain. He worked as consultant for PwC developing and implementing SCM and IT solutions for companies like Johnson & Johnson. He lived in Brazil for Philips Consumer Electronics as General Manager Operations & Service Latin America restructuring successfully the supply chain and aftersales service. He worked 9 years for LEGO in Denmark, in his last role as head of Value Chain Innovation and member of corporate management. Within this role he was responsible for the LEGO Group operating model with the strategic objective to drive innovation in operations and secure a lean execution. This included the management of the operations project portfolio and implementation of the required new supply chain capabilities. It allowed LEGO to grow double digits both revenue and profit.

Presently he is the COO of wehkamp.nl. A leading online retailer in the Netherlands. He is as COO responsible for warehouse & distribution, supply chain management, operational excellence, customer service, supplier management and innovation in operations. Next to this he is also engaged in new business development for the group creating network partnerships along the retail value chain leveraging e-fulfillment capabilities, shared supply base, and fintech payment services.



### **Sophia Velastegui**

*General Manager in AI Products + Search, Microsoft*

Sophia Velastegui is the General Manager in AI Products + Search in Microsoft. Her core responsibilities include managing Microsoft AI Product and Search Product portfolio and partnership. She continues to drive strategic initiatives with key partners for shared benefits on their platform and Microsoft AI platform. Ms. Velastegui serves on the World Economic Forum's Global Future Council and as an Industry Strategy Officer leveraging her expertise in AI and emerging technology since 2018. Before joining Microsoft, she served as Doppler Lab's Chief Product Officer where she defined a new product category and created the world 1st smart earbuds that leveraged machine learning to enhance how people experience sound and help people hear better. During her time there, Doppler was the technical advisor to the "OTC Hearing Aid Act of 2017" spearheaded and passed by Senator Warren and Senator Grassley. She headed Google/Nest's Silicon/Architecture Roadmap team where she scaled the organization from startup to growth business unit after Google acquisition. Previously at Apple, she led the "Think Tank" Program Management and Laptop/Special Projects Product group. Prior to Apple, Ms. Velastegui increased her knowledge of technology and product development through a variety of roles at ETM, and Applied Materials. She serves on Georgia Tech's College of Engineering and Create X incubator boards and as a board director on Elwrn and held advisor role for the South Korean President Jae In Moon's Labor dept from candidacy to presidency.

Ms. Velastegui is widely recognized technology and industry leader who advocates diversity in technology and leadership. She has received numerous recognition and awards for her contributions to technology including being recognized by Business Insider's Most Powerful Female Engineers in the World for her work in advance technology at Google and then again for her work in AI at Microsoft. Ms. Velastegui received the prestigious Lumiere Distinguished Leadership Award from the Advanced Imaging Society for innovation and technical impact in advancing entertainment and media industries.



### **Frank Wagner**

*formerly SVP Global Manufacturing Operations at Electrolux*

Frank Wagner, formerly SVP Global Manufacturing Operations at Electrolux, is a global manufacturing executive that has led manufacturing, supply chain and quality globally for three major corporations. His last global role was with Electrolux Corporation where he was the first global leader of manufacturing operations for the \$16B company which consisted of 35 facilities in 13 countries with over 37,000 employees. In this newly formed role, he created a consistent operations structure across this new team including a defined lean program, metrics, optimal plant layouts, and equipment suppliers. After completing the core structure, he engaged the Cambridge IfM team to develop an optimized global manufacturing footprint including core non-core analysis at the product and process levels. He leveraged this new structure to drive significant results including the company's highest ever quality level of 95%, reduced manufacturing energy consumed per product by 47%, and reduced manufacturing cost per product by 25%.

Prior to Electrolux, Frank was the global leader of manufacturing, supply chain, quality and purchasing for the Store Systems Division of NCR. In his previous role, he had the same scope as the leader of the Garrett Turbocharger Division of Honeywell. He began his career with IBM where he started as an engineer and progressed to plant manager in the personal computer division.

Frank holds an MBA from Duke University, and a Masters and Bachelors in Mechanical Engineering from North Carolina State University.



**Professor Geoffrey G Parker**

*Thayer School of Engineering, Dartmouth*

Geoffrey Parker is a professor of engineering at Dartmouth College where he also serves as Director of the Master of Engineering Management Program. In addition, he is a research fellow at MIT's Initiative for the Digital Economy where he leads platform industry research studies and co-chairs the annual MIT Platform Strategy Summit. He received a B.S.E. from Princeton and M.S. and Ph.D. from MIT. Parker has made significant contributions to the field of network economics and strategy as co-developer of the theory of "two-sided" markets. He is co-author of the book "Platform Revolution." His current research includes studies of platform business strategy, data governance, distributed energy resource integration, and electronic healthcare record systems. Parker's research has been funded by grants from the National Science Foundation, the Department of Energy, the states of Louisiana and New York, and numerous corporations. He serves or has served as department editor and associate editor at multiple journals and as a National Science Foundation panelist. Parker is a frequent keynote speaker and advises senior leaders on their organizations' platform strategies. Before attending MIT, he held positions in engineering and finance at GE. Additional information can be found at [ggparker.net](http://ggparker.net), [@g2parker](https://twitter.com/g2parker), and Google Scholar.



**Professor Lenny Koh**

*Founder and Director of the Advanced Resource Efficiency Centre (AREC), University of Sheffield*

Professor Lenny Koh is the Founder and Director of the Advanced Resource Efficiency Centre (AREC) and a senior management of the Energy Institute at The University of Sheffield. Her work contributes to advancing the understanding and resolution of complex supply chain using interdisciplinary approaches crossing supply chain management and information systems domains across industry. Her research is world leading and is recognised for its scientific novelty and has generated significant impacts for society, government and industry from manufacturing to services. This includes the pioneering of digital Cloud based tools (SCEnAT suites) that support transformation of supply chain towards resource efficiency and sustainability; and infusing and digitising supply chain life cycle thinking across sectors, technologies and systems. She is an advisor and on the Board of diverse organisations, such as a Board member of the Sustainability Partnership and BSI on sustainability/resource efficiency. She has established strategic partnerships with industry leaders from automotive to digital sectors on supply chain sustainability and digital transformation, and work closely with the Transport Systems Catapult on intelligent mobility.

# AUTHOR ABSTRACTS

## DIGITAL MANUFACTURING NETWORKS

### EXPLORING LOSS HIDDEN IN DIGITAL SCHEDULING DATA - A CASE OF CHEMICAL PRODUCTION SYSTEM

KOICHI MURATA, TAKAHIRO ISHIMOTO, NIHON UNIVERSITY, JAPAN

In the era of supply chain digitization, the automation of production scheduling is expected in earnest. However, several constraints of supply chain are included in the production planning structure to be automated, and huge losses may remain latent in this structure. The purpose of this study is to clarify the kinds of temporal loss included in this structure and contribute to a more dynamic supply chain innovation.

### DIGITAL TRANSFORMATION IN THE AUTOMOTIVE SUPPLY CHAIN

GARY GRAHAM<sup>A</sup>, LAIRD BURNS<sup>B</sup>, PATRICK HENNELLY<sup>C</sup>, <sup>A</sup>LEEDS UNIVERSITY, UK; <sup>B</sup>UNIVERSITY OF ALABAMA IN HUNTSVILLE, USA; <sup>C</sup>ROYAL COLLEGE OF THE ARTS LONDON, UK

In this paper, we begin the process of developing practice-based research problems and questions concerning supply chain digitalization in the automotive industry. Specifically, our focus is on understanding organizational conditions facilitating supply chain and production digitalisation and its role in performance improvement. Therefore, as a first step we organized a research workshop during last year's Cambridge Center for International Manufacturing (CIM) Symposium with 30 executives representing multiple tiers of the automotive supply chain. The purpose was identifying key themes and patterns amongst these themes, which provides a basis for a practitioner-based, impact led research agenda. We presented the executives with ten digital scenarios developed by CIM, and recorded responses their responses to each scenario in a template of the ten scenarios. Using social network analysis (SNA) we then interrogated the qualitative data to identify: "inter-codal" patterns, linkages and relationships.

### A METHOD FOR FACILITATING THE DESIGN OF INDUSTRY 4.0 COLLABORATIONS AND ITS APPLICATION IN THE AEROSPACE SECTOR

NIKOLAI KAZANTSEV, NIKOLAY MEHANDJIEV, PEDRO SAMPAIO, IAIN DUNCAN STALKER, THE UNIVERSITY OF MANCHESTER, UK

Industry 4.0 envisions quick formation of manufacturing supply chains to ensure rapid reaction to new product requirements and configurations. This paper proposes a method for facilitating the design of collaborative teams which can implement sections of these supply chains by responding to invitations to tender by a manufacturer. The method includes five core design tasks which are applied recursively by partners to construct a collaboration model – (1) decomposing manufacturing goals, (2) team formation to tackle goals, (3) operationalizing goals into manufacturing processes, (4) decomposing processes and (5) defining execution workflows. The application of the method is shown using a case study from the aerospace industry with evidence of its utility in speeding-up collaborations.

### SUPPLY CHAIN DIGITAL TWINS: OPPORTUNITIES AND CHALLENGES BEYOND THE HYPE

JAGJIT SINGH SRAI, ETTORE SETTANNI, NAOUM TSOLAKIS, PARMINDER AULAKH, UNIVERSITY OF CAMBRIDGE, UK

This paper discusses the application of digital twin concepts, prevalent in the factory unit operations environment, to the supply chain context. While the concept of digital twin is relatively recent in the manufacturing context, its application has now emerged within a wider supply chain context. It is unclear in this broader application what might the benefits of such an approach be in terms of operational control, replicability and efficiency. Following a literature review, the attributes of a Digital Twin Supply Chain (DTSC) are defined, highlighting similarities and differences from the traditional factory perspective that places the emphasis on equipment and unit operations. Selected DTSC attributes are then applied within four industry case studies where advanced manufacturing technologies and industrial digitalisation are expected to provide new capability in terms of more distributed made-to-order manufacturing (e.g. in pharmaceuticals supply chains), as well as enhanced visibility, traceability and authentication (e.g. in organic food supply chains).

## SUSTAINABILITY

### CONSUMER DRIVEN SUSTAINABLE SUPPLY NETWORKS

KATYA YATSKOVSKAYA, JAGJIT SINGH SRAI, UNIVERSITY OF CAMBRIDGE, UK

Supply chain sustainability is determined by various factors. Conventional drivers that promote sustainability in supply chains are determined by supply network stakeholders, including investors, regulators, and NGOs. In recent years consumers have been expressing increasing product traceability concerns, particularly in the food industry that has been influenced by food scandals. Consumer purchasing decisions become highly influenced by the environmentally responsible behaviour of the organisation (Crain, 2000). In order to satisfy customer environmental concerns, some organisations have started to adopt environmentally sustainable production and marketing standards (Polonsky et al., 2006). Thus, currently “consumers have a crucial role” (p. 2, Grunert, 2011) in developing sustainable food supply chains. This study explores the relationships between consumer sustainability demands and sustainable supply network design. The work incorporates extensive literature review to propose a conceptual framework. The latter has been tested through multiple case studies.

### SOFT SYSTEMS AS A HELPING TOOL IN THE ASSESSMENT OF SUSTAINABLE BUSINESS PRACTICES AND RISKS IN A SOCIO-ECONOMIC-ENVIRONMENTAL CONTEXT

ISABEL DUARTE DE ALMEIDA<sup>A,B</sup>, J M VILAS-BOAS DA SILVA<sup>B</sup>, <sup>A</sup>UNIVERSIDADE LUSÍADA, (CLISSIS-UL), PORTUGAL;  
<sup>B</sup>INSTITUTO UNIVERSITÁRIO DE LISBOA (ISCTE-IUL), BUSINESS RESEARCH UNIT (BRU-IUL), PORTUGAL

Sustainability indicators (SI) are fundamental instruments in business practices towards evaluation of general sustainability, its inherent risks, or the interaction of socioeconomic perspectives in an environmental sustainability context. The complex nature of the models applied call for a revision of the scientific methodologies used in the production of indicators addressing measurability, fitting them to a different nature of the problem characterised by: (i) multiple, circular, conflictual relations in a web of heterarchical relations; (ii) the social component relevance; (iii) the existence of an observer bias and interest, stakeholders pressure, interaction with the phenomenon and interpretation, establishing unrepeatable situations that can only be analytically discussed in different contexts. Multicriterion alternatives are advocated and one is briefly characterised: the Soft Systems Methodology (SSM). Its advantages are summarised. The logic and impact of SSM in a classical evaluation process based on the need for feedback are also discussed. The conclusion argues in favour of SSM contribution for scientific knowledge, focusing on validity, in comparison with other methodologies utilised in the Economic, Social, and Environmental Impact Assessment of business practices.

### TOWARDS THE END OF THE RESOUNDING SOUND OF SILENCE: HOW STATE INTERVENTION FORCES MULTINATIONAL COMPANIES (MNC) TO RETHINK THEIR OPERATIONS MANAGEMENT (OM); THE CASE OF WASTE IN THE FOOD PLASTIC PACKAGING INDUSTRY

YANNICK POTTIER, NESTLÉ, SWITZERLAND

**Purpose:** the proposed paper departs from the puzzling evidence that International Business (IB) scholars consider Operations Management (OM) as ‘ancillary’, therefore researching little on it (JMTM 2019). It formulates the hypothesis that business innovation via digital supply chains is both a necessity and an opportunity.

**Design/Methodology:** analyse the impact of innovation and regulation policies on the OM of food multinational companies (MNCs) through a case study. Those policies are these: the decision of Saudi Arabia State-owned enterprise (SOE) Saudi Aramco to invest massively into added-value packaging stream via its 2019 acquired SABIC; the decision of China to ban the importation of packaging waste as of 2018; the 2018/852 amending directive of 94/62/EC European Union Packaging and Packaging Waste

**Findings:** the management of plastics packaging waste impacts the OM of MNCs in many ways, sometimes contradictory and uncertain as knowledge builds up. This requires more agile and faster supply chains. Innovation policies of China and of the EU also intend to foster change in OM, and as part of those policies disruptive digital supply chains will arise.

**Originality/Value:** the paper applies to OM a theory borrowed from international studies and international business: The National Systems of Innovation (NSI) theory



## SUSTAINABILITY (CONTINUED)

### **FABRICATING BIOMEDICAL IMPLANTS MATERIAL: A CASE STUDY BASED ON PROCESS PLANS AND ENVIRONMENTAL IMPACTS**

GURVINDER SINGH, VIKRANT BHAKAR, HARPREET SINGH, INDIAN INSTITUTE OF TECHNOLOGY ROPAR, INDIA

There is considerable interest in the potential of magnesium alloys to be used as temporary surgical implants. Apart from being biocompatible, another major advantage of using magnesium as a surgical implant is its ability to biodegrade in-situ. This in turn means that the implant need not remain in the body without needing extra surgery to remove it. There have been conventional manufacturing processes for implant fabrication, however for the ease of manufacturing new technologies such as additive manufacturing processes are leading the industry, ignoring the environmental aspect of the entire process. Life cycle assessment is emerging as an influential tool in the evaluation of the environmental impact of manufacturing processes. In order to ensure green manufacturing, the process plan needs to be thoroughly investigated from the environmental perspective. In this study the global production scenario of biomedical implants has been explored taking into account the modern manufacturing techniques and their trade-offs. In order to reap the benefits associated with ease of manufacturing and environmental impact, a life-cycle analysis should be applied for all products and processes. Hence, for a successful quantitative evaluation of a product design, an assessment model needs to be incorporated. This study has assessed the fabrication of implants from the two manufacturing routes along with this an environmental impact assessment of these process plan has been carried out to visualize the environmental impacts. It is observed from the analysis that in terms of implant fabrication and quality of implant both routes are comparable. Whereas, the environmental impacts of both the routes have significant difference. A case of the production of a bone-fixation plate by two different manufacturing routes is illustrated.

## VALUE CHAINS AND BUSINESS MODELS

### VALUE CHAIN IMPACTS OF EU WASTE FRAMEWORK DIRECTIVE 2018/851 AS A RESULT OF REPORTING SUBSTANCES OF VERY HIGH CONCERN FROM 2021

SUKHRAJ S. TAKHAR<sup>A</sup>, KAPILA LIYANAGE<sup>B</sup>, <sup>A</sup>ASSENT COMPLIANCE, CANADA; <sup>B</sup>UNIVERSITY OF DERBY, COLLEGE OF ENGINEERING AND TECHNOLOGY, UK

The EU Waste Framework Directive 2018/851 sets out requirements for producers and importers of products within the EEA, to report data on Substances of Very High Concern (SVHC) content within products into a new central European database to from 5th January 2021. The reporting requirements: (1) support chemical regulations that impose the need on industry to record the use of hazardous chemicals; (2) identification of products entering waste streams containing hazardous chemicals; (3) support circular economy initiatives within the EU. To meet these new reporting requirements industry will need to collect additional information from all supply chain actors, who as duty holders will also be required to report into the new EU SVHC database system. Failure to provide the required information may result in enforcement actions from the authorities, which could see products being restricted from the EEA. The new EU database system will be accessible to industry, regulators, NGOs and the general public. This paper explores the new requirements, together with feedback received from various stakeholders for collection of data and reporting into the new EU database system from 2021.

### NEW BUSINESS MODELS AS REGULATION CHANGES: CASE OF FINLAND AND RUSSIA

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Changes of legislative and contractual environment of international business and trade have their impacts on used and successful business models. In this research, we examine such changes between Finland and Russia as a case study. Research is using qualitative approach, involving relevant companies and experts from the two countries. The empirical research includes 10 semi-structured interviews and a survey for manufacturing and logistics service provider companies located next to Russian border. Three example business models (blockchain-based, platform-based and innovative subcontracting-based) were generated during the semi-structured interview phase and tested in the survey phase. Blockchain was seen as immature technology in terms of perceived benefit for the companies, thus not widely implemented yet. All the proposed business models can be integrated with circular economy, which was found to be a relevant new practice among general growing emphasis on environmental sustainability in the studied companies. Presented models in this research are generalized to industry level and should be used as a reference to create specific company level business models that fit in the unique context of the given company, industry and type of business.

### BUSINESS MODEL DESIGN ELEMENTS FOR ELECTRIC CAR SERVICE BASED ON DIGITAL DATA ENABLED SHARING PLATFORM

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The number of electric cars have seen a steady increase in last few years, most likely due to the actions various countries have been taking to limit combustion engines vehicles access to city centres, changes in taxes based on emissions and changes in emission calculation models. On another hand the change in cost structure related to electric cars, like the price of lithium batteries is one of the high level explaining factors for this change. E.g. for last 8 years, price of li-ion batteries has dropped around 80% (Berckmans et al., 2017). From the market point of view, the traditional car manufacturers have their own service networks, while any new player such as a new electric car manufacturer does not have it. To ease up the situation, a service data platform for electric cars enables new players to enter the market by supporting independent car services to access spare parts, maintenance instructions and training material more flexibly than currently. In this context, the key aspect is how the service network will be organized. The platform enables data-based analytics to optimize service for electric cars and to foresee the spare part needs to help the warehousing, logistics and supply chain side. For the whole service network, some new innovative approaches will also be needed to support the new way to work with the data platform. The target of the paper is to present the design elements of a new business model for electric car service data platform. Data sharing enables new manufacturers to come to the market and independent car services to offer electric car maintenance to customers. Paper presents key partners, key activities, key resources, values, customer relationships, channels, customer segments, cost structure and revenue sharing.

## VALUE CHAINS AND BUSINESS MODELS (CONTINUED)

### **DESIGN OF B2B E-COMMERCE BUSINESS MODELS: A CONFIGURATION AND DESIGN-SCIENCE PERSPECTIVE**

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This paper investigates how configuration theory and design-science approaches inform the design of B2B e-commerce business models. The approaches were believed to provide new insights on the relationship between the business model dimensions and their configuration. The design-science methodology involved conceptualising a business model artefact (i.e. a framework) based on literature, which was refined using an in-depth case study of a pharmaceutical firm that recently went through a B2B e-commerce business model re-design process. Through integration and validation of the artefact's dimensions using the case study, it was found that a pharmaceutical firm's business model can be expressed in terms of four dimensions (value creation, value delivery, value capture, and customer) and that these are linked via a dynamic value proposition that is defined in terms of tangible, intangible, and their respective monetary value flows. It was further found that each business model dimension possess capabilities that influence the configuration of each of the value proposition's flows in terms of five properties (volume, velocity, veracity, variety, value). These insights address the knowledge gap related to classification of value exchanges and their interdependencies within pharmaceutical businesses through a business model perspective. They further provide a foundation for exploring the relationship between the individual business model dimensions and contribute to e-commerce business model literature by highlighting its reconfigurable elements in a detailed and coherent way. For practitioners, the findings provide a set of properties for the (re-)design of the value proposition and facilitate the identification of opportunities for improved value generation by the overall business model based on a binary (configured/not-configured) approach. To the author's best knowledge, this is the first study to view the value proposition concept as a dynamic mechanism that links, and is influenced by, the individual dimensions of a business model.

## SUPPLY NETWORK DESIGN

### SOME ADVANCED TOPICS ON INNOVATION-FOCUSED LEAN/AGILE MANAGEMENT

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Basic concept and technical procedures of lean management has been reinforced since 1930s along with Japanese industrialisation. During this century-long industrial history, various extensions have been carried out to adapt radical changes of business environment such as global competitiveness and even rising anti-globalism, increasing social responsibility, intensifying scale and complexity of management issues, highly developed customer needs, argument on environmental sustainability, etc. The topics being discussed in this paper will be on some innovative activities in the lean context, which are deeply drawn attention among professionals and these are closely related to the last two issues listed in the previous paragraph. Various concepts and terms related to innovation will be summarised and categorised followed by their review as the introductory remarks. Then, following two issues will be focused to discuss. 1) General concept and systematic procedure of leanised product development. For the first issue, the ideas of proactive and reactive approaches will be introduced and discussed, where the former is planning phase-focused approach and the latter is recovery phase-focused style of management and both are very critical factors for product development performance. Essential point to argue is how to manage both styles with fine balance. For the second issue, newly developed matrices-based systematic procedure for relevant product development is proposed, which is under application in various global firms tackling with TPM awards. 2) General discussion on application of green-lean methodology, especially KARAKURI technology, to process development activity. Here, typical patterns of KARAKURI application for process innovation will be summarised with case example. Further, white-box vs. black-box approaches for product development, which mean open-based and closed-based intellectual property managements respectively, and IoT-assisted lean process development through KPI structuration will be discussed.

### THE IMPACT OF THE FOURTH INDUSTRIAL REVOLUTION IN THE OWNERSHIP, LOCATION AND INTERNALIZATION ADVANTAGES OF FIRMS: AN EXPLORATORY STUDY

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The Fourth Industrial Revolution, also called Industry 4.0 or I4.0, creates opportunities for improvement of efficiency and productivity, for the reshoring and redistribution of global manufacturing, and for the creation of new global value chains. As a consequence, Industry 4.0 has the potential to impact the internationalization strategy of global manufacturing firms. In order to analyze the transformations in supply chains enabled by the adoption of the advanced technologies of the Fourth Industrial Revolution, this research discusses how these technologies influence the ownership (O), location (L), and internalization (I) advantages of multinational companies (MNC). This study uses the advantages of the eclectic paradigm as constructs to understand how the internationalization strategies of multinational firms are impacted by the use of digitally-enabled technologies and processes described as the "Manufacturing Renaissance".

### FOSTER INCLUSIVE ENTREPRENEURSHIP IN BOP AREAS: THE ROLE OF ASSET SPECIFICITY AND SUPPLY CHAIN INTERCONNECTION

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Inclusive entrepreneurship has been proven to be an elixir for the inclusive growth in the 'Base of the Pyramid' (BOP) regions. Consequently, governors are trying various ways to direct resources into local region to support inclusive entrepreneurship. Some of these policies worked, while others don't. Why? We argue that, although more resources enhance the chances to start business, it also leads to fierce competition among entrepreneurs, and finally impair the benefits of resource supports. So where to direct the resources to and how to arrange these resources should be carefully thought. Analysis based on data collected from inclusive entrepreneurs in Zhejiang province in China shows that, when the resources are directed to sectors with highly specific assets, the competition will be intensified. On the other hand, if the resources are carefully allocated to different links of an intact supply chain, direct competition among entrepreneurs will be mitigated, so the entrepreneurs will benefit more from the resource supporting plans. This study extends literatures on inclusiveness by offering an operational measurement of inclusiveness, and identifying two boundary conditions that will affect the efficacy of resource supporting plans.

### LOCALIZATION OR NOT LOCALIZATION? —EVIDENCE FROM PHILIPS

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Since multinational enterprises expand their business into emerging markets, they have face new competition from the growing middle-class market, which is good enough market. Should multinational enterprises simply maintain their strategies and products in developed markets, or should they adopt a localization strategy and adapt to this new environment? Based on the grounded theory, our comprehensive case study in three business divisions of Phillips China provides detailed insights into the context and content of localization strategy. We also describe the localization strategy path of different internationalization and provide important implications for global MNEs regarding how to establish competitive advantage to respond to special value segment in developing countries.

Our paper is useful in terms of the contributions it makes to the strategy literature on international business. First, this study provides theoretical insights of the determined context and conditions of localization strategy. Second, this study provides critical insights for managers in MNEs to decide whether to adopt a localization strategy and choose the degree of localization in practice. Finally, this study provides in-depth insight of an important phenomenon, good-enough market, and its potential practice and academic value.

## AGRI-FOOD TRACK I

**SUSTAINABLE SUPPLY NETWORK CONFIGURATIONS DRIVEN BY WATER SCARCITY: EXAMPLE OF END-TO-END BEVERAGE SUPPLY CHAIN**

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Economies around the world are facing disruptive risks from water scarcity resulting in adverse effects on local communities, ecosystems, and industrial growth. Leading corporations and academia have recognised natural resource scarcity is becoming a “critical supply chain risk factor for the foreseeable future” (p.158, Bell et al., 2012), with many firms deploying water scarcity mitigation practices into their corporate sustainability strategies. In this context, the academic community has emphasised urgency and a need for systematic approaches and transformation of corporate water strategies. However, industrial water requirements vary depending on product-production process attributes and supply network structure and thus corporate natural resource scarcity mitigation strategies will depend on specific contexts.

This study explores the relationship between natural resource scarcity driven supply network configurational attributes, mitigation approaches, and capabilities that determines the water scarcity challenges for an organisation. The work proposes a conceptual framework that is further tested in the end-to-end case study of a beverage company.

**SIMULATION OF FUTURE GROUNDWATER BEHAVIOUR IN SIRHIND CANAL TRACT OF PUNJAB USING MODFLOW**

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Groundwater sustainability is one of most serious issue that is poignant to the State of Punjab. The rampant tubewell intensification is resulting in utilization of groundwater at a rate greater than annual recharge rate. In this study, a numerical groundwater flow model (MODFLOW) was employed to simulate flow and groundwater levels in the Sirhind Canal Tract (SCT) of Punjab. The aquifer of this region was discretized into 482 cells comprising of 21 rows and 23 columns, each cell representing 100 km<sup>2</sup> area. In general, the aquifers are unconfined and maximum depth upto 300m was considered. The spatial heterogeneity of the aquifers was captured from lithologs available from 500 observation points spread across the region. The annual groundwater recharge and groundwater abstraction rates were estimated using the norms specified by CGWB. The model was calibrated for aquifer parameters viz. hydraulic conductivity and specific yield, boundary conditions using observed groundwater data for 15 years (1998- 2012) and validated for 5 years (2013-2017). Results showed that groundwater modeling fairly matched the historical groundwater pattern. The groundwater model was applied to predict groundwater level up to year 2030 under four different pumping scenarios: Scenario-I (Maintaining the current pumping and recharge rate for the study period); Scenario-II (Increase in pumping rate according to the historical trend); Scenario- III (Increasing canal water supplies and maintaining current groundwater abstractions) and Scenario-IV (Increasing canal water supplies and altering accordingly altering groundwater abstractions). The study identifies a useful strategy for sustainable groundwater development in the region.

**MANAGEMENT INTERVENTIONS TO ENHANCE PRODUCTIVITY OF WHEAT AND WATER USE IN CHANGING CLIMATE OF INDIAN PUNJAB**

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Indian Punjab is known as grain bowl of India. Water resources here are scarce in conjunction with problems of water table decline. In rice-wheat system though irrigation water requirement of wheat crop is less than rice yet the water deficit (evapotranspiration-(rainfall + surface supply)), responsible for water table decline is more in wheat crop than rice. In rice, transplanted at recommended time, evapotranspiration (ET) is almost equal to the rainfall, while in wheat ET is 3.9 times that of rainfall. It warrants the ET reduction in wheat for amelioration of water table decline in rice-wheat system. For ensuring regional food security, it is important to evaluate temperature variability, its effects on wheat yield and development of management strategies to sustain yield. A gradual or abrupt change in weather parameters especially maximum and minimum temperature compared to the apposite not only during entire growth season but at different stages also may adversely impact growth and yield of wheat. Field and simulation studies undertaken at Ludhiana location of central Punjab have facilitated to understand impact of temperature variability on wheat yield in changing climate; and to identify best management intervention such as planting date, variety and irrigation schedule in relation climate variation to sustain yield as well as to amelioration of ground water decline. It concludes that growing of longer duration varieties in last week of October, medium to longer duration in 1st week of November with adequate irrigation emerged as the best adaptive measure to minimize impact of temperature variability on wheat yield and water use by reducing soil water evaporation (E) component of ET. Reduction in ET is realized by implementing real water saving technologies like scheduling irrigation based on IW/Pan E ratio, diversification of wheat to low ET crops under possible area and reduction in E during the bare period, which would help in amelioration of water table decline in rice-wheat cropping system.

## AGRI-FOOD TRACK I (CONTINUED)

### **CAN INPUT-OUTPUT DATA INFORM AGRI-FOOD SUPPLY NETWORK RECONFIGURATION? THE CASE OF WATER-INTENSIVE CROP PRODUCTION IN DEVELOPING ECONOMIES**

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This paper identifies opportunities to facilitate agri-food supply network reconfiguration, using publicly available input-output data platforms to generate insights into the water intensity of crop production. Making reference to the Indian economy, it is shown that intuitive analytics can be rapidly developed to unravel complex patterns of production and consumption in global value networks, and the spatially-specific pressure exerted on freshwater resources. The potential use of the evidence thus obtained to support alternative crop policy scenarios and agri-food supply network configurations is discussed, with an emphasis on the need to inform a possible transition away from highly specialized cropping patterns.

## MERGERS AND ACQUISITIONS

### EXPLORING THE IMPLICATIONS OF M&A FOR GLOBAL PRODUCTION NETWORKS

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This conceptual paper applies and extends the factory role model to provide a production network view on mergers and acquisitions. We map the production networks of an exemplary buyer and target company to explore the framework's potential implications for M&A. We find that a production network view is able to give useful guidance in post-merger integration, restructuring and divestment decisions. It also allows to highlight potential strategic gains for the global manufacturing activity of the post-merger company. Moreover, it mitigates the risk of trading off strategic manufacturing capabilities against purported cost-synergies and might therefore aid the long-term performance of manufacturers.

### ANALYSING THE FINANCIAL SUSTAINABILITY IN MERGERS AND ACQUISITIONS FOR CHINESE MANUFACTURING FIRMS

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Mergers and acquisitions (M&As) can be a critical approach for latecomer firms to catch up with firms with advanced technologies. However, firms after M&As always have high bankruptcy risks and low profitability due to the great amount of funds they spend on buying firms. Hence, finding a strategy to achieve financial sustainability after M&As becomes important for operation management and financial management. Based on two M&A cases for Chinese automobile manufacturing firms, this paper attempts to examine the reasons influencing the success of M&A and propose a strategy for latecomer firms to achieve financial sustainability when they conduct M&As. Through the financial analysis, it is found that firms tend to ensure higher bankruptcy risks and lower profitability after M&As. Results of the study show that latecomer firms can achieve catch-up and even beyond catch-up through merging a firm with advanced technologies. Besides, the cultural of the merged firms are very important to be considered.

### EXPLORING CIRCULAR ECONOMY SUPPLY CHAIN CONSIDERATIONS IN MERGERS & ACQUISITIONS - HOW GREEN IS THE DEAL? A NATURAL-RESOURCE-BASED VIEW OF THE U.S. SHALE OIL & GAS PRODUCT-SUPPLY CHAIN FOR POWER GENERATION

PAVAN MANOCHA, JAGJIT SINGH SRAI, UNIVERSITY OF CAMBRIDGE, UK

Organisations are challenged with executing the transformation to a circular-regenerative industrial system within the context of their operations and value networks (WBA, 2019), networks which are increasingly fueled by mergers and acquisitions (M&As), and which accounted for US\$3.35 trillion in global deal value in 2018 (Dealogic, 2018). While outcomes from M&As may produce mixed results, merger synergies fundamentally change the Environmental, Social and Governance (ESG) footprint of an organisation and its product-supply chain. These compounding challenges of regenerative development, and ESG product-supply chain due diligence are not adequately explored in the operations management literature, or practically considered during the M&A process (Manocha, Srai and Kumar, 2016). In this paper, we explore the relationship between circular supply chains and M&As, in considering the factors that determine how green is the deal? A case study approach is adopted, drawing upon an exemplar deal within the U.S. shale oil & gas product-supply chain for power generation, where high M&A deal-interest and ESG sustainability considerations exist. The theoretical lens is the Natural-Resource-Based View (NRBV) of the firm (Hart, 1995). An analytical framework, integrating key green deal considerations from the M&A process, and Circular Economy (CE) literature is defined. Findings suggest that circular industrial system considerations represent an under-explored source of M&A value, and a substantive gap of both theoretical and practical relevance.

### EXPLORING VISUAL MANAGEMENT AND CONTINUOUS IMPROVEMENT IN A MANUFACTURING CONTEXT: A STRUCTURED BIBLIOMETRIC ANALYSIS

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Many manufacturing organisations rely on continuous improvement (CI) activities to maintain their competitive position. Here, effective communication is seen as critical in facilitating the alignment of corporate strategy and CI efforts. As many firms increasingly struggle to ensure effective internal communication due to time pressures and the need to continuously adapt strategic information, visual management (VM) can provide a means to support effective information transfer. Therefore, this paper explores the impact of VM on CI within a manufacturing context by first systematically reviewing and summarising the extant literature. A bibliometric analysis reveals that while VM offers great potential to support CI efforts, the field lacks systematic and holistic scholarly examination in a number of areas. For example, the association of CI as a dynamic capability and the impact of digitalisation in connecting VM and CI.



## TECHNOLOGY AND INNOVATION

**WINDOWS OF OPPORTUNITY: TECHNOLOGY CYCLES DEMAND CONDITIONS, AND STRATEGY TENDENCIES**

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This paper conducts a simulation based on mobile phone industry with a dynamic demand patterns and combined with different strategies under different situation. Strategy portfolios are provided in this paper and we proposed that under changing demand situation, latecomer companies should change their catching-up strategy accordingly. The simulation shows that stage-skipping strategy combined together with patch-creating strategy works best under expanding-expanding with fluctuation-fixed demand with fluctuation conditions and if a company want to catch up their incumbent, they have to shift their strategy to path-creating.

**EXPLORING THE FEASIBILITY OF ANCHORING INNOVATION BY ENHANCING THE LINKAGE BETWEEN MANUFACTURING RESEARCH NETWORKS AND SUPPLY CHAINS**

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In recent years the progressive investment in large translational manufacturing research facilities in the UK has exceeded all expectations for industrial involvement and uptake, and has resulted in a model which has influenced others at a global level. One of the reasons for the success of this substantial programme is that much of the strategy has been driven from markets and large OEMs down into day-to-day manufacturing operations. This has the huge advantage that manufacturing developments are catalysed from more general trends in the provision of next generation products, making large scale coordinated activity on technological innovation much more feasible than it would otherwise be. It is however still clear that its impact in the deep supply base is less than might be hoped. This can be seen as an indirect consequence of the top down approach. It raises a key question of whether an investment programme in manufacturing research and innovation alone is sufficient to anchor innovation in the country or region of origin. This paper explores the viability of more complete consideration of supply chains in securing maximum value for money from ongoing investment in manufacturing R&D and innovation.

**DEVELOPING FAVA BEANS AS A SUSTAINABLE SOURCE OF HIGH-QUALITY PROTEIN FOR FOOD SUPPLY CHAINS THROUGH OPTIMISED GENETICS, FARMING AND PROCESSING**

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Consumer preferences for plant proteins as alternatives to animal sources have increased in recent years due to improved nutritional and environmental sustainability benefits. Pulses such as pea and fava bean are excellent sources of plant-based protein (PBP). However, supply inconsistencies and price volatilities deter the development of efficient end-to-end supply networks that meet consumer expectation. Imported soya is the principal source of PBP for food manufacturing but this is associated with various negative factors including deforestation, land-use change and increased carbon emissions, whereas other domestically produced protein-crops such as pea are limited in their application by functionality and off-tastes. Fava bean (*Vicia faba*), a widely grown grain legume crop, represents an excellent source of highly nutritious yet under-utilised plant protein that has potential to be exploited as an alternative to animal-derived proteins. "Favuleux" is a multi-disciplinary innovation project focussed on evaluating and optimising the cultivation, production and prototyping of high-quality fava bean protein extracts, to deliver innovative solutions for the food production industry through integrated PBP supply chain networks. The project will establish the major factors influencing fava bean supply networks enabling Industry to respond to emerging market requirements, interacting directly with end-users to build consumer confidence, and delivering enhanced training to farmers and producers to promote environmental sustainability and improve crop husbandry through resource stewardship.



## AGRI-FOOD TRACK II

### **SUB SURFACE DRIP FERTIGATION IN SUMMER MOONG-MAIZE-WHEAT CROPPING SYSTEM: A NOVEL TECHNIQUE FOR SUSTAINABLE WATER USE AND HIGHER RESOURCE USE EFFICIENCY**

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An experiment was conducted on summer moong-maize-wheat cropping system to find out the water and nutrient efficient sub surface drip irrigation and fertigation schedule during 2016-17 and 2017-18. Treatment comprises combinations of two sub surface drip irrigation (SSD) rate (80 and 60 % ETc) and two fertigation rate [80 and 60 % of recommended dose of fertilizers (RDF)] with an extra control (furrow irrigation and 100 % RDF) to all the three crops. Pooled data revealed that summer moong SSD at 80 % ETc resulted in significantly higher seed yield than 60 % ETc. Similarly, fertigation with 80 % of RDF recorded significantly higher seed yield than 60 % RDF. SSD at 80 % ETc with 80 % RDF recorded 25.7 % higher seed yield than control with saving of 26.9 % irrigation water. In maize SSD at 60 % and 80 % ETc recorded statistically at par grain yield. But fertigation with 80 % RDF recorded significantly higher grain yield than 60 % RDF. SSD at 80 % ETc with fertigation at 80 % RDF recorded 16.7 % higher grain yield of maize than control with saving of 36.5 % irrigation water. In wheat, SSD at 80 % ETc recorded significantly higher grain yield than 60 % ETc. Fertigation with 80 % RDF recorded significantly higher grain yield than 60 % RDF. SSD at 80 % ETc with fertigation 80 % RDF recorded 15.2 % higher grain yield of wheat than control with saving of 25.0 % irrigation water. System productivity (maize equivalent yield) was significantly higher with SSD at 80 % ETc than 60 % ETc. Fertigation with 80 % ETc recorded significantly higher system productivity than 60 % RDF. SSD at 80 % ETc with 80 % RDF recorded 18.4 % higher system productivity than control with saving of 28.6 % irrigation water.

### **ROLE OF FARMER PRODUCERS ORGANIZATIONS (FPOs) IN PUNJAB**

PUNEET SINGH THIND, VEGETABLE GROWERS ASSOCIATION OF INDIA, INDIA

Farmers in India constitute an interesting actor in the economy as they need to purchase their farming inputs in the retail market, but they provide their commodities at the wholesale market. To that end, Farmer Producer Organisation (FPOs) could mobilize farmers through collective action, as producers' group associations, while strengthening their capacity through adopting agriculture best practices. FPOs can access markets without intermediaries to achieve better prices. In turn, access and usage of high-quality inputs and services for intensive agriculture can be ensured to enhance production, productivity and profitability of small farmers. This research compares FPOs to other forms of association and coalition, e.g. Cooperatives. It concludes by developing approaches to the formulation of viable FPOs' business models.

### **DIGITAL FARMER PRODUCERS ORGANIZATION (FPO) DESIGN: THE DEVELOPMENT OF AN INSTITUTIONAL-SOCIALLY RESPONSIBLE SUPPLY NETWORK FRAMEWORK**

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Socially responsible supply networks remains a nascent research area in operations management. This paper examines societal needs, social impacts, and strategic behaviours of farmer-producer organisations (FPOs), and their emerging role in developing socially responsible supply chains in India. The concept of a 'Digital FPO' is also introduced.

While agriculture contributes to c.14% of India's GDP, and remains the source of income for c.60% of households, small and marginal farmers are beset with issues linked to the continued fragmentation of land and difficulties in accessing markets on their own. The concept behind the FPO is that farmers can form collectives that then benefit from economies of scale and enable better bargaining capacity. It is estimated that 4000 FPOs are now in operation across various regions of India (i.e., growth of 2000% in the past five years).

It is argued that societal pressures have increased complexities and presented ambiguous challenges that many (current) environmental and supply chain management techniques may not adequately address. A key issue this research looks to address is how to balance the often conflicting pressures created by the need for sustainable development e.g., overall industry and FPO-level economic performance versus environmental degradation and social disruption (and other unintended consequences).

Previous research on multi-organisational network 'concepts of operation' and supply network 'stages of emergence' in technology commercialisation are extended, to develop an Institutional-Socially Responsible Supply Network framework in order to (i) promote capacity building across FPO networks (ii) establish linkages between FPO networks and markets; (iii) facilitate the adoption of technology matrix interventions; and (iv) provide design criteria for new forms of FPO.

## RISK AND COMPLEXITY

### A NEW APPROACH TO OPTIMISING SUPPLY-CHAIN PERFORMANCE USING 4 FUNDAMENTAL PROCESS TYPES

DAVID ANKER, GLENN CHAMBERS, LIGHTFOOT SOLUTIONS, UK

“Supply-chain complexity” is often in the eyes of the beholder. The authors offer a simpler perspective - introducing an approach, appropriate measurement metrics and methods, that will deliver sustained improvement to supply-chain performance.

The authors posit that all businesses operate up to 4 fundamental process-types. By recognising that what is commonly described as supply-chain mainly comprises 2 (of these 4) process-types, this paper illustrates how a select set of key metrics, and measurement method, enable organisations operating any supply-chain model to continuously improve production processes, inventory levels, throughput time and customer experience.

### APPLICATION OF THE CONCEPT OF SUPPLY CHAIN RELIABILITY FOR AN AVAILABILITY ASSESSMENT OF INLAND WATERWAY SYSTEMS

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The concept of Supply Chain Reliability has received some attention in recent years due to disruptions that affect Supply Chains and endanger business continuity. This paper examines the current state of the literature on Supply Chain Reliability. The literature's underlying concept of Reliability Theory is applied to assess the availability of a restrictive infrastructure network based on empirical failure data in a case study about the West-German canal system. Furthermore, the availability of transport flows inside the system is calculated. The model analyses the state of the canal system regarding transportation flows by calculating its component availability. The model is generalisable for inland waterways and results in a quantitative indicator for the risk assessment of Supply Chain Disruptions and Supply Chain Resilience. This indicator, the reliability value, can be integrated into the Supply Chain Risk Management of affected organisations and used as a parameter of procurement models.

### IMPACT OF SUPPLY CHAIN RISK MANAGEMENT ON ORGANIZATIONAL PERFORMANCE: MODERATING ROLE OF SUPPLY CHAIN INTEGRATION

SABEEN HUSSAIN BHATTIA, ASIF ALI BHATTI, BAHRIA UNIVERSITY ISLAMABAD, PAKISTAN

This study helps to investigate the relationship between supply chain risk management (SCRM) and organizational performance. The study also examined the moderating role of supply chain integration (SCI) between SCRM and operational performance. The research design is quantitative. The methodology adopted in this study is survey – based methodology. It is used on the data collected from public sector organizations of Pakistan. Tool used for data collection is questionnaire. The results of the study indicate that there is a positive relationship of the SCRM with operational efficiency and operational flexibility. And also, it also has direct and indirect positive impact on the organizational performance. Moreover, supply chain integration (SCI) moderates positively the impact of SCRM on OE and OF. It contributes to the existing studies about the SCRM and SCI by explaining and analysing some more aspects of SCRM. It also helps to improve managerial insight for risk management and supply chain integration as well.



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