

## Editor-in-Chief

*Kai Rannenberg, Goethe University Frankfurt, Germany*

## Editorial Board

TC 1 – Foundations of Computer Science

*Jacques Sakarovitch, Télécom ParisTech, France*

TC 2 – Software: Theory and Practice

*Michael Goedicke, University of Duisburg-Essen, Germany*

TC 3 – Education

*Arthur Tatnall, Victoria University, Melbourne, Australia*

TC 5 – Information Technology Applications

*Erich J. Neuhold, University of Vienna, Austria*

TC 6 – Communication Systems

*Aiko Pras, University of Twente, Enschede, The Netherlands*

TC 7 – System Modeling and Optimization

*Fredi Tröltzsch, TU Berlin, Germany*

TC 8 – Information Systems

*Jan Pries-Heje, Roskilde University, Denmark*

TC 9 – ICT and Society

*Diane Whitehouse, The Castlegate Consultancy, Malton, UK*

TC 10 – Computer Systems Technology

*Ricardo Reis, Federal University of Rio Grande do Sul, Porto Alegre, Brazil*

TC 11 – Security and Privacy Protection in Information Processing Systems

*Steven Furnell, Plymouth University, UK*

TC 12 – Artificial Intelligence

*Ulrich Furbach, University of Koblenz-Landau, Germany*

TC 13 – Human-Computer Interaction

*Marco Winckler, University Paul Sabatier, Toulouse, France*

TC 14 – Entertainment Computing

*Matthias Rauterberg, Eindhoven University of Technology, The Netherlands*

## **IFIP – The International Federation for Information Processing**

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP's aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

*IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.*

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

More information about this series at <http://www.springer.com/series/6102>

Ilkyeong Moon · Gyu M. Lee  
Jinwoo Park · Dimitris Kiritsis  
Gregor von Cieminski (Eds.)


# Advances in Production Management Systems

Production Management for Data-Driven,  
Intelligent, Collaborative, and Sustainable  
Manufacturing

IFIP WG 5.7 International Conference, APMS 2018  
Seoul, Korea, August 26–30, 2018  
Proceedings, Part I


*Editors*

Ilkyeong Moon   
Seoul National University  
Seoul  
Korea

Gyu M. Lee   
Pusan National University  
Busan  
Korea

Jinwoo Park  
Seoul National University  
Seoul  
Korea

Dimitris Kiritsis   
EPFL  
Lausanne  
Switzerland

Gregor von Cieminski   
ZF Hungária Kft  
Eger  
Hungary

ISSN 1868-4238 ISSN 1868-422X (electronic)  
IFIP Advances in Information and Communication Technology  
ISBN 978-3-319-99703-2 ISBN 978-3-319-99704-9 (eBook)  
<https://doi.org/10.1007/978-3-319-99704-9>

Library of Congress Control Number: 2018952244

© IFIP International Federation for Information Processing 2018

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

We have already experienced three major industrial revolutions since the 18th century. These revolutions brought innovation in productivity for industry, the public, and individuals. Surprisingly, another new industrial revolution, the fourth one, has been rapidly approaching us in every sector of industry. Key components of the fourth industrial revolution include big data analysis, artificial intelligence, and virtual and augmented reality. These components also had a huge impact on the manufacturing sector and research on production management. Therefore, the 2018 Advances in Production Management Systems Conference played a leading role in the academic field. The core of our contributions strive to realize smart production management for data-driven, intelligent, collaborative, and sustainable manufacturing. Our topics of interest include Global Supply Chain, Knowledge-Based Production Management, Collaborative Networks, Sustainability and Production Management, Industry 4.0, and Smart City.

We welcomed leading experts from academia, industry, and research institutes from all over the world to the 2018 Advances in Production Management Systems Conference in Seoul, Korea, to exchange ideas, concepts, theories, and experiences. A large international panel of experts reviewed all the papers and selected the best ones to be included in these conference proceedings. In this collection of papers, the authors provide their perspectives along with their concepts and solutions for the challenges that industrial companies are confronted with, to offer great opportunities, new technologies, collaboration, and developments.

The proceedings are organized in two parts:

- Production Management for Data-Driven, Intelligent, Collaborative, and Sustainable Manufacturing (Volume 1)
- Smart Manufacturing for Industry 4.0 (Volume 2)

We hope that our readers will discover valuable new ideas and insights in these proceedings. The conference was supported by the International Federation of Information Processing (IFIP) and was organized by the IFIP Working Group 5.7 on Advances in Production Management Systems, the Korean Institute of Industrial Engineers (KIIE), and the Institute for Industrial Systems Innovation at Seoul National University. We would like to thank all contributors for their research and for their willingness to share ideas and results. We are also indebted to the members of the IFIP Working Group 5.7, the Program Committee members, and Organizing Committee members for their support in the review of the papers. Finally, we appreciate the generous support from both the Korean Federation of Science and Technology

Societies (KOFST) grant funded by the Korean government and Korea Land and Housing Corporation.

August 2018

Ilkyeong Moon  
Gyu M. Lee  
Jinwoo Park  
Dimitris Kiritsis  
Gregor von Cieminski

# Organization

## Honorary Co-chairs

Dimtris Kiritsis  
Jinwoo Park

EPFL, Switzerland  
Seoul National University, Korea

## Conference Chair

Ilkyeong Moon

Seoul National University, Korea

## Advisory Committee

Byung Kyu Choi  
Chi Hyuck Jun  
Kap Hwan Kim  
Tae Eog Lee  
Young Hoon Lee

KAIST, Korea  
POSTEC, Korea  
Pusan National University, Korea  
KAIST, Korea  
Yonsei University, Korea

## Program Co-chairs

Gregor von Cieminski  
Gyu M. Lee

ZF Hungária Kft, Hungary  
Pusan National University, Korea

## Program Committee

Bhaskar Bhandarkar  
Chen-Fu Chien  
Shuo-Yan Chou

Indian Institution of Industrial Engineering, India  
National Tsing Hua University, Taiwan  
National Taiwan University of Science  
and Technology, Taiwan

Xuehao Feng  
Chin-Yin Huang  
Szu-Hao Huang  
Takashi Irohara  
Yasutaka Kainuma  
Harish Kutemate  
Bo Lu  
Hiroaki Matsukawa  
Koichi Nakade  
Izabela Ewa Nielsen  
Taeho Park  
Subrata Saha  
Biswajit Sarkar

Zhejiang University, China  
Tunghai University, Taiwan  
National Chiao Tung University, Taiwan  
Sophia University, Japan  
Tokyo Metropolitan University, Japan  
Indian Institution of Industrial Engineering, India  
Dalian University, China  
Keio University, Japan  
Nagoya Institute of Technology, Japan  
Aalborg University, Denmark  
San Jose State University, USA  
Institute of Engineering and Management, India  
Hanyang University, Korea

Hongfeng Wang Northeastern University, China  
 Ruiyou Zhang Northeastern University, China

### Organizing Committee

Jung Woo Baek	Chosun University, Korea
Tai-Woo Chang	Kyonggi University, Korea
Yoon Seok Chang	Korea Aerospace University, Korea
Taesu Cheong	Korea University, Korea
Hyunbo Cho	POSTECH, Korea
Yong-Chan Choi	KAIST, Korea
Byung Do Chung	Yonsei University, Korea
Kwanghun Chung	Hongik University, Korea
Byung-Hyun Ha	Pusan National University, Korea
Kyu Hwan Han	Seoul National University, Korea
Yoo Suk Hong	Seoul National University, Korea
Young Jae Jang	KAIST, Korea
Bong Ju Jeong	Yonsei University, Korea
Hong-Bae Jun	Hongik University, Korea
Changmuk Kang	Soongsil University, Korea
Yuncheol Kang	Hongik University, Korea
Jun-Gyu Kang	Sungkyul University, Korea
Byung-In Kim	POSTECH, Korea
Byung Soo Kim	Incheon National University, Korea
Dongsoo Kim	Soongsil University, Korea
Duck Young Kim	UNIST, Korea
Hwa-Joong Kim	Inha University, Korea
Chang Seong Ko	Kyungsung University, Korea
Chulung Lee	Korea University, Korea
Dong Ho Lee	Hanyang University, Korea
Kangbok Lee	POSTECH, Korea
Kyungsik Lee	Seoul National University, Korea
Taesik Lee	KAIST, Korea
Dug Hee Moon	Changwon National University, Korea
Sang Do Noh	Sungkyunkwan University, Korea
Kun Soo Park	KAIST, Korea
Kwangyeol Ryu	Pusan National University, Korea
Jong-Ho Shin	Chosun University, Korea
Eun Suk Suh	Seoul National University, Korea

### International Advisory Committee

Ery Yulian Triblas Adesta	International Islamic University Malaysia, Malaysia
Erlend Alfnes	Norwegian University of Science and Technology, Norway
Thecle Alix	IUT Bordeaux Montesquieu, France



Susanne Altendorfer-Kaiser	Montanuniversität Leoben, Austria
Farhad Ameri	Texas State University, USA
Bjørn Andersen	Norwegian University of Science and Technology, Norway
Eiji Arai	Osaka University, Japan
Frédérique Biennier	INSA Lyon, France
Umit S. Bititci	Heriot Watt University, UK
Magali Bosch-Mauchand	Université de Technologie de Compiègne, France
Abdelaziz Bouras	Qatar University, Qatar
Jim Browne	University College Dublin, Ireland
Luis Camarinha-Matos	Universidade Nova de Lisboa, Portugal
Sergio Cavalieri	University of Bergamo, Italy
Stephen Childe	Plymouth University, UK
Hyunbo Cho	Pohang University of Science and Technology, Korea
Gregor von Cieminski	ZF Hungária Kft, Hungary
Catherine Da Cunha	Ecole Centrale de Nantes, France
Frédéric Demoly	Université de Technologie de Belfort-Montbéliard, France
Shengchun Deng	Harbin Institute of Technology, China
Melanie Despeisse	Chalmers University of Technology, Sweden
Alexandre Dolgui	IMT Atlantique Nantes, France
Slavko Dolinšek	University of Ljubljana, Slovenia
Heidi Carin Dreyer	Norwegian University of Science and Technology, Norway
Eero Eloranta	Helsinki University of Technology, Finland
Soumaya El Kadiri	Texelia AG, Switzerland
Christos Emmanouilidis	Cranfield University, UK
Åsa Fasth-Berglund	Chalmers University, Sweden
Jan Frick	University of Stavanger, Norway
Paolo Gaiardelli	University of Bergamo, Italy
Adriana Giret	Universidad Politécnica de Valencia, Spain
Bernard Grabot	INP-ENIT (National Engineering School of Tarbes), France
Samuel Gomes	Belfort-Montbéliard University of Technology, France
Gerhard Gudergan	FIR Research Institute for Operations Management, Germany
Thomas R. Gullledge Jr.	George Mason University, USA
Hironori Hibino	Tokyo University of Science, Japan
Hans-Henrik Hvolby	Aalborg University, Denmark
Dmitry Ivanov	Berlin School of Economics and Law, Germany
Harinder Jagdev	National University of Ireland at Galway, Ireland
John Johansen	Aalborg University, Denmark
Toshiya Kaihara	Kobe University, Japan
Dimitris Kiritsis	Ecole Polytechnique Fédérale de Lausanne, Switzerland

Tomasz Koch	Wroclaw University of Science and Technology, Poland
Pisut Koomsap	Asian Institute of Technology, Thailand
Gül Kremer	Iowa State University, USA
Boonserm Kulvatunyou	National Institute of Standards and Technology, USA
Thomas R. Kurfess	Georgia Institute of Technology, USA
Andrew Kusiak	University of Iowa, USA
Lenka Landryova	Technical University of Ostrava, Czech Republic
Jan-Peter Lechner	First Global Liaison, Germany
Ming K. Lim	Chongqing University, China
Hermann Lödding	Hamburg University of Technology, Germany
Marco Macchi	Politecnico di Milano, Italy
Vidosav D. Majstorovich	University of Belgrade, Serbia
Adolfo Crespo Marquez	University of Seville, Spain
Gökan May	Ecole Polytechnique Fédérale de Lausanne, Switzerland
Jörn Mehnen	Strathclyde University Glasgow, UK
Hajime Mizuyama	Aoyama Gakuin University, Japan
Ilkyeong Moon	Seoul National University, Korea
Dimitris Mourtzis	University of Patras, Greece
Irenilza de Alencar Naas	UNIP Paulista University, Brazil
Masaru Nakano	Keio University, Japan
Torbjörn Netland	ETH Zürich, Switzerland
Gilles Neubert	EMLYON Business School Saint-Etienne, France
Sang Do Noh	Sungkyunkwan University, Korea
Manuel Fradinho	SINTEF, Norway
Duarte de Oliveira	
Jinwoo Park	Seoul National University, Korea
François Pérès	Université de Toulouse, France
Fredrik Persson	Linköping Institute of Technology, Sweden
Selwyn Piramuthu	University of Florida, USA
Alberto Portioli-Staudacher	Politecnico di Milano, Italy
Vittalidas V. Prabhu	Pennsylvania State University, USA
Ricardo José Rabelo	Federal University of Santa Catarina, Brazil
Mario Rapaccini	Florence University, Italy
Joao Gilberto Mendes dos Reis	UNIP Paulista University, Brazil
Ralph Riedel	TU Chemnitz, Germany
Asbjörn Rolstadås	Norwegian University of Science and Technology, Norway
David Romero	Tecnologico de Monterrey University, Mexico
Christoph Roser	Karlsruhe University of Applied Sciences, Germany
Martin Rudberg	Linköping University, Sweden
Thomas E. Ruppli	University of Basel, Switzerland
Krzysztof Santarek	Warsaw University of Technology, Poland

John P. Shewchuk	Virginia Polytechnic Institute and State University, USA
Dan L. Shunk	Arizona State University, USA
Riitta Smeds	Aalto University, Finland
Vijay Srinivasan	National Institute of Standards and Technology, USA
Johan Stahre	Chalmers University, Sweden
Kathryn E. Stecke	University of Texas at Dallas, USA
Kenn Steger-Jensen	Aalborg University, Denmark
Volker Stich	FIR Research Institute for Operations Management, Germany
Richard Lee Storch	University of Washington, USA
Jan Ola Strandhagen	Norwegian University of Science and Technology, Norway
Stanislaw Strzelczak	Warsaw University of Technology, Poland
Shigeki Umeda	Musashi University, Japan
Marco Taisch	Politecnico di Milano, Italy
Kari Tanskanen	Aalto University School of Science, Finland
Ilias Tatsiopoulos	National Technical University of Athens, Greece
Sergio Terzi	Politecnico di Milano, Italy
Klaus-Dieter Thoben	Universität Bremen, Germany
Jacques H. Trienekens	Wageningen University, The Netherlands
Mario Tucci	Università degli Studi di Firenze, Italy
Gündüz Ulusoy	Sabancı University, Turkey
Bruno Vallespir	University of Bordeaux, France
Agostino Villa	Politecnico di Torino, Italy
Hans-Hermann Wiendahl	University of Stuttgart, Germany
Joakim Wikner	Jönköping University, Sweden
Hans Wortmann	Groningen University, The Netherlands
Thorsten Wuest	West Virginia University, USA
Iveta Zolotová	Technical University of Košice, Slovakia

## **Marco Garetti Doctoral Workshop**

### **Co-chairs**

Gyu M. Lee	Pusan National University, Korea
Ralph Riedel	TU Chemnitz, Germany

### **Academic Reviewers and Participants**

Gregor von Cieminski	ZF Hungária Kft, Hungary
Paolo Gaiardelli	University of Bergamo, Italy
Adriana Giret	Universidad Politécnica de Valencia, Spain
Gyu M. Lee	Pusan National University, Korea
Ming K. Lim	Chongqing University, China
Gökan May	Ecole Polytechnique Fédérale de Lausanne, Switzerland

Ralph Riedel	TU Chemnitz, Germany
David Romero	Tecnologico de Monterrey University, Mexico
Stanislaw Strzelczak	Warsaw University of Technology, Poland

### **Sponsors for APMS 2018**

College of Engineering, Seoul National University  
IFIP WG 5.7 Advances in Production Management Systems  
Institute for Industrial Systems Innovation, Seoul National University  
Korea Land & Housing Corporation  
Korean Federation of Science and Technology Societies  
Korean Institute of Industrial Engineers

# Contents – Part I

## Lean and Green Manufacturing

Reverse Logistics Route Selection Using AHP: A Case Study of Electronics Scrap from Pakistan . . . . .	3
<i>Fahad Mushtaq, Muhammad Shafiq, Matteo Mario Savino, Touqeer Khalid, Marialuisa Menanno, and Ali Fahad</i>	
Digital Lean Cyber-Physical Production Systems: The Emergence of Digital Lean Manufacturing and the Significance of Digital Waste . . . . .	11
<i>David Romero, Paolo Gaiardelli, Daryl Powell, Thorsten Wuest, and Matthias Thürer</i>	
Effect of Prioritization on the Waiting Time . . . . .	21
<i>Yannic Jäger and Christoph Roser</i>	
A Small Dice Game for the Kingman Formula . . . . .	27
<i>Christoph Roser and Masaru Nakano</i>	
Towards a Sustainable Innovation Process: Integrating Lean and Sustainability Principles . . . . .	34
<i>Myrna Flores, Doroteja Maklin, Billy Ingram, Matic Golob, Christopher Tucci, and Andrea Hoffmeier</i>	
Mathematical Modelling for Sustainable Agricultural Supply Chain Management Considering Preferences Between Farmers and Retailers . . . . .	43
<i>Takashi Hasuike, Tomoko Kashima, and Shimpei Matsumoto</i>	
Formalising Specific-Energy Consumption Under a Production-Management Form Where Rush Orders Are Added in Time Slots . . . . .	50
<i>Shungo Arai, Hironori Hibino, Takamasa Horikawa, and Makoto Yamaguchi</i>	
Implementation Challenges Affecting the Environmental Improvement Performance in Pharmaceutical Production: Results of a Green Kaizen Pilot . . . . .	58
<i>Seyoum Eshetu Birkie, Martin Kurdve, Monica Bellgran, and Jouni Korhonen</i>	
A Stochastic Programming Model for Multi-commodity Redistribution Planning in Disaster Response . . . . .	67
<i>Xuehong Gao and Gyu M. Lee</i>	

**Operations Management in Engineer-to-Order Manufacturing**

Dual Resource Constrained (DRC) Shops: Literature Review and Analysis. . . 81  
*Matthias Thürer*

Controlling Customer Orders in the ETO/VUCA Contexts . . . . . 87  
*Stanislaw Strzelczak and Viswawikram Viswanathan*

Defining Solution Spaces for Customizations . . . . . 95  
*Nikolas Käkälä and Joakim Wikner*

A Conceptual Framework for Stage Configuration. . . . . 101  
*Bjørn Christensen, Thomas D. Brunoe, and Kjeld Nielsen*

Dynamic Weight Configuration of Dispatching Rule  
 Using Machine Learning . . . . . 110  
*Jong-Ho Shin, Chaekyo Lee, Sangrae Kim, and Jun-Gyu Kang*

Customizations vs. Platforms – A Conceptual Approach to COSI . . . . . 116  
*Jenny Bäckstrand and Martin Lennartsson*

Barriers and Success Factors for Continuous Improvement Efforts  
 in Complex ETO Firms . . . . . 124  
*Emrah Arica, Kristoffer Magerøy, and Marta Therese Mathisen Lall*

Engineering Change Management in the Engineer-to-Order Production  
 Environment: Insights from Two Case Studies . . . . . 131  
*Natalia Iakymenko, Anita Romsdal, Marco Semini,  
 and Jan Ola Strandhagen*

**Product-Service Systems Customer-Driven Innovation  
 and Value Co-creation**

Economic Assessment of PSS Value Networks – An  
 Algorithmic Approach . . . . . 141  
*Khaled Medini, Xavier Boucher, Sophie Peillon, and Hervé Vaillant*

Modularity in Product-Service Systems: Literature Review  
 and Future Research Directions. . . . . 150  
*Maria Støettrup Schioenning Larsen, Ann-Louise Andersen,  
 Kjeld Nielsen, and Thomas Ditlev Brunoe*

Mass Customization as a Productivity Enabler in the  
 Construction Industry . . . . . 159  
*Kim Noergaard Jensen, Kjeld Nielsen, and Thomas Ditlev Brunoe*

How Can Hackathons Accelerate Corporate Innovation? . . . . .	167
<i>Myrna Flores, Matic Golob, Doroteja Maklin, Martin Herrera, Christopher Tucci, Ahmed Al-Ashaab, Leon Williams, Adriana Encinas, Veronica Martinez, Mohamed Zaki, Lourdes Sosa, and Karina Flores Pineda</i>	
Smart Supply Chain – Development of the Equipment Supplier in Global Value Networks . . . . .	176
<i>Martina Schiffer, Michael Luckert, Hans-Hermann Wiendahl, and Benedikt Saretz</i>	
Mass Customization Capability Planning with Additive Manufacturing . . . . .	184
<i>Songi Kim and Bongju Jeong</i>	
Construct a Customized Product Service System Utilizing Multi-agent System . . . . .	193
<i>Cheng-Yen Chang, Chi-Hsuan Tsai, and Ming-Chuan Chu</i>	
The Demand-Pull Approach to Business Model Innovation Through Product-Service Systems: A Case Study . . . . .	201
<i>Martha Orellano, Christine Lambey-Checchin, Khaled Medini, and Gilles Neubert</i>	
<b>Collaborative Networks</b>	
Scenarios for the Development of Platform-Based Networks for Additive Spare Part Production . . . . .	213
<i>Jana Frank, Philipp Jussen, Lennard Holst, and Timo Lütke Meyring</i>	
Embedding Memorable Experience to Customer Journey . . . . .	222
<i>Duangthida Hussadintorn Na Ayutthaya and Pisut Koomsap</i>	
Overcoming Barriers Against Interaction on Innovation Capabilities Within and Between SMEs . . . . .	230
<i>Sara Hajikazemi, Anandasivakumar Ekambaram, Carl Christian Røstad, and Bjørnar Henriksen</i>	
Controllable Production Rate and Quality Improvement in a Two-Echelon Supply Chain Model . . . . .	238
<i>Mitali Sarkar and Byung Do Chung</i>	
Reduction of Decision Complexity as an Enabler for Continuous Production Network Design . . . . .	246
<i>Günther Schuh, Jan-Philipp Prote, Bastian Fränken, Stefan Dany, and Andreas Gützlaff</i>	

Collaborative and Sustainable Network Design in Courier Services . . . . .	254
<i>Ki Ho Chung, Seung Yoon Ko, and Chang Seong Ko</i>	
Measuring Throughput Times in Wood Component Production: A Case Study . . . . .	262
<i>Sven-Vegard Buer, Oladipupo Olaitan, and Jan Ola Strandhagen</i>	
Possibilities and Benefits of Intermediate Care Units in Healthcare Systems from a Logistics Perspective . . . . .	271
<i>Aili Biriita Bertnum, Giuseppe Ismael Fragapane, Marco Semini, and Jan Ola Strandhagen</i>	
<b>Smart Production for Mass Customization</b>	
A New IT Architecture for the Supply Chain of Configurable Products . . . . .	281
<i>Ernst-August Stehr, Jan Reschke, and Volker Stich</i>	
Service Rate Control in Mn/Gn/1 Queue . . . . .	289
<i>Koichi Nakade and Shunta Nishimura</i>	
Understanding Changeability Enablers and Their Impact on Performance in Manufacturing Companies . . . . .	297
<i>Ann-Louise Andersen, Kjeld Nielsen, Thomas D. Brunoe, Jesper K. Larsen, and Christopher Ketelsen</i>	
A Changeable Jig-Less Welding Cell for Subassembly of Construction Machinery . . . . .	305
<i>Mads Bejlegaard, Thomas Ditlev Brunoe, and Kjeld Nielsen</i>	
Challenges in Production and Manufacturing Systems Platform Development for Changeable Manufacturing. . . . .	312
<i>Daniel Grud Hellerup Sorensen, Thomas Ditlev Brunoe, and Kjeld Nielsen</i>	
Modelling for Service Solution of a Closed-Loop Supply Chain with the Presence of Third Party Logistics. . . . .	320
<i>Mitali Sarkar, Rekha Guchhait, and Biswajit Sarkar</i>	
Product-Process Modelling as an Enabler of Manufacturing Changeability . . .	328
<i>Thomas Ditlev Brunoe, Daniel G. H. Sorensen, Mads Bejlegaard, Ann-Louise Andersen, and Kjeld Nielsen</i>	
A Model of Dynamic Scheduling of Restaurant Operations Considering the Order and Timing of Serving Dishes . . . . .	336
<i>Tomomi Nonaka, Terumi Nobutomo, and Hajime Mizuyama</i>	



A Literature-Based Analysis of the Cyber-Physical Systems Under the Lens of Reconfigurability. . . . . 342  
*Napoleone Alessia, Macchi Marco, and Pozzetti Alessandro*

The Platform of Intelligent Manufacturing System Based on Industry 4.0. . . . . 350  
*Jinghui Yang, Guorong Huang, and Qi Hang*

Achieving Balanced Workload Distribution Amongst Cross-Trained Teams. . . . . 355  
*Oladipupo Olaitan, Erlend Alfnes, Jørn Vatn, and Jan Ola Strandhagen*

**Global Supply Chain - Supply Chain Management**

Exploring the Role of Information Systems in Mitigating Gate Congestion Using Simulation: Theory and Practice at a Bulk Export Terminal Gate. . . . . 367  
*Mihai Neagoe, Mohammad Sadegh Taskhiri, Hong-Oanh Nguyen, and Paul Turner*

Influence of Setup Cycles on the Throughput Time of Rush Orders . . . . . 375  
*Friederike Engehausen and Hermann Lödding*

A Flow Based Foundation for Capacity Dimensioning. . . . . 384  
*Joakim Wikner and Lisa Hedvall*

On Comparison of Multiple Non-linear Profiles for Process Selection . . . . . 392  
*Chen-ju Lin and Pei-Ying Lin*

Combinatorial Benders’ Cut for the Admission Control Decision in Flow Shop Scheduling Problems with Queue Time Constraints. . . . . 399  
*Rudi Nurdiansyah and I-Hsuan Hong*

Simulation Analysis for Demonstrating the Economic Competitiveness of Busan Port in the Northeast Asia . . . . . 406  
*Ilkyeong Moon, Qian-Ru Shen, and Xuehao Feng*

Causes of Delivery-Time Variance in Maritime-Equipment Manufacturing Supply-Chains: An Empirical Study . . . . . 415  
*Olumide E. Oluoyisola, Tuomo E. Salmi, and Jan O. Strandhagen*

**Knowledge Based Production Planning and Control**

Discrete Event Simulation – A New Approach to Multi-level Capacitated Planning? . . . . . 425  
*Ernst-August Stehr, Jan Reschke, and Günther Schuh*

Procurement Decisions in Multi-period Supply Chain . . . . .	433
<i>Izabela Nielsen and Subrata Saha</i>	
Due-Date Based Multi-period Part Selection for Flexible Manufacturing Systems with Controllable Processing Times . . . . .	443
<i>Issa B. Zeid, Hyoung-Ho Doh, Jeong-Hoon Shin, and Dong-Ho Lee</i>	
Inventory Model with the Consideration of Pricing, Product Substitution and Value Deterioration . . . . .	450
<i>Felix T. S. Chan, J. H. Ruan, A. H. Tai, S. H. Chung, and A. E. E. Eltoukhy</i>	
Improving Carry-Out Operations of Inbound Containers Using Real-Time Information on Truck Arrival Times . . . . .	457
<i>Sanghyuk Yi, Lin Gui, and Kap Hwan Kim</i>	
Dual Resource Constrained Scheduling Considering Operator Working Modes and Moving in Identical Parallel Machines Using a Permutation-Based Genetic Algorithm . . . . .	464
<i>Muhammad Akbar and Takashi Irohara</i>	
Process Planning Assessment Framework . . . . .	473
<i>Günther Schuh, Jan-Philipp Prote, and Philipp Hünnekes</i>	
Dynamic Scheduling of the Dual Stocker System Using Reinforcement Learning . . . . .	482
<i>Seol Hwang, Sang Pyo Hong, and Young Jae Jang</i>	
<b>Knowledge Based Engineering</b>	
Integrating Experiential Learning and Accreditation Requirements – A Case Study Based Course . . . . .	493
<i>Khaled Medini</i>	
Towards the Generation of Setup Matrices from Route Sheets and Feedback Data with Data Analytics . . . . .	502
<i>Moritz Schröter, Ben Lütkehoff, Markus Fischer, Matthias Blum, and Volker Stich</i>	
Evaluation of Leadership in Nontechnical Skills . . . . .	510
<i>Haruka Ohba, Shinya Mizuno, Yoshikazu Fujisawa, Masashi Uramatsu, Mikihiko Kano, Naoki Hirabayashi, and Takahiro Souma</i>	
A Framework for Task-Based Ambidexterity in Manufacturing SMEs . . . . .	518
<i>Kristina Sollander, Annika Engström, and Joakim Wikner</i>	

Analyzing Intuitive Skills of a Waitperson in a Restaurant Dining Room  
Using a Serious Game . . . . . 526  
*Fumihide Nishimura, Emi Kinoshita, Tomomi Nonaka,  
and Hajime Mizuyama*

Revisiting Challenges in Using Discrete Event Simulation in Early Stages  
of Production System Design . . . . . 534  
*Erik Flores-Garcia, Magnus Wiktorsson, Jessica Bruch,  
and Mats Jackson*

Knowledge Management as an Important Tool in Participatory Design . . . . . 541  
*Xiaoli Chen, Ralph Riedel, Michael Bojko, Mandy Tawalbeh,  
and Egon Müller*

Using Serious Gaming to Discover and Understand Distributed Ledger  
Technology in Distributed Energy Systems. . . . . 549  
*J. W. Veeningen and Nick B. Szirbik*

University Education as a Networked Service for Competence Co-creation. . . 557  
*Riitta Smeds, Rita Lavikka, and Miia Jaatinen*

**Author Index** . . . . . 567

## Contents – Part II

### **Intelligent Diagnostics and Maintenance Solutions for Smart Manufacturing**

Upgrading Legacy Equipment to Industry 4.0 Through a Cyber-Physical Interface . . . . .	3
<i>Hanna Jónasdóttir, Karishma Dhanani, Kenneth McRae, and Jörn Mehnert</i>	
Development of Maturity Levels for Agile Industrial Service Companies . . . .	11
<i>Achim Kampker, Jana Frank, Roman Emonts-Holley, and Philipp Jussen</i>	
The Role of Internet of Services (IoS) on Industry 4.0 Through the Service Oriented Architecture (SOA) . . . . .	20
<i>Jacqueline Zonichenn Reis and Rodrigo Franco Gonçalves</i>	
Evaluating Impact of AI on Cognitive Load of Technicians During Diagnosis Tasks in Maintenance . . . . .	27
<i>Hyunjong Shin and Vittaldas V. Prabhu</i>	
An In-Process BSR-Noise Detection System for Car Door Trims . . . . .	35
<i>Woonsang Baek and Duck Young Kim</i>	
The Future of Maintenance Within Industry 4.0: An Empirical Research in Manufacturing. . . . .	39
<i>Irene Roda, Marco Macchi, and Luca Fumagalli</i>	
Modeling the Influence of Technician Proficiency and Maintenance Strategies on Production System Performance. . . . .	47
<i>Kai-Wen Tien and Vittaldas Prabhu</i>	

### **Service Engineering Based on Smart Manufacturing Capabilities**

How to Increase Share of Product-Related Services in Revenue? Strategy Towards Servitization . . . . .	57
<i>Ugljesa Marjanovic, Bojan Lalic, Vidosav Majstorovic, Nenad Medic, Jasna Prester, and Iztok Palcic</i>	
A Hybrid Forecasting Framework with Neural Network and Time-Series Method for Intermittent Demand in Semiconductor Supply Chain . . . . .	65
<i>Wenhan Fu, Chen-Fu Chien, and Zih-Hao Lin</i>	

Constructing a Metrology Sampling Framework for In-line Inspection in Semiconductor Fabrication . . . . .	73
<i>Chen-Fu Chien, Yun-Siang Lin, and Yu-Shin Tan</i>	
Maturity Models for Digitalization in Manufacturing - Applicability for SMEs . . . . .	81
<i>Stefan Wiesner, Paolo Gaiardelli, Nicola Gritti, and Gianluca Oberti</i>	
The Impacts of Quick Response in a Dual-Channel Supply Chain . . . . .	89
<i>Huihui Zhang and Danqin Yang</i>	
Smart Service Lifecycle Management: A Framework and Use Case . . . . .	97
<i>Mike Freitag and Stefan Wiesner</i>	
acatech Industrie 4.0 Maturity Index – A Multidimensional Maturity Model. . . . .	105
<i>Violett Zeller, Christian Hocken, and Volker Stich</i>	
An Analysis of the Impact of Industrie 4.0 on Production Planning and Control . . . . .	114
<i>Uwe Dombrowski and Yannick Dix</i>	
The Strategic Landscape of Industry 4.0 . . . . .	122
<i>Børge Sjøbakk</i>	
Online Life Cycle Assessment for Fluid Power Manufacturing Systems – Challenges and Opportunities . . . . .	128
<i>Marcel Rückert, Stephan Merkelbach, Raphael Alt, and Katharina Schmitz</i>	
<b>Smart City Interoperability and Cross-Platform Implementation</b>	
Study on the Utilization of Digital Manufacturing for Production Operations . . . . .	139
<i>Masahiro Shibuya, Kenichi Iida, and Koki Mikami</i>	
Semantic Interoperability and Open IoT APIs for Smart Cities Applications . . . . .	146
<i>Prodromos Kolyvakis, Christian Mader, and Dimitris Kiritsis</i>	
Towards a Smart Manufacturing Maturity Model for SMEs (SM <sup>3</sup> E) . . . . .	155
<i>Sameer Mittal, David Romero, and Thorsten Wuest</i>	
An Order Control Policy in Crowdsourced Parcel Pickup and Delivery Service . . . . .	164
<i>Yuncheol Kang</i>	

Node and Edge Surveillance Using Drones Considering Required Camera Altitude and Battery Charging . . . . .	172
<i>Ivan Kristianto Singgih, Jonghwa Lee, and Byung-In Kim</i>	
How to Choose the Greenest Delivery Plan: A Framework to Measure Key Performance Indicators for Sustainable Urban Logistics. . . . .	181
<i>Adriana Giret, Vicente Julián, Juan Manuel Corchado, Alberto Fernández, Miguel A. Salido, and Dunbing Tang</i>	
Developing an Advanced Cloud-Based Vehicle Routing and Scheduling System for Urban Freight Transportation . . . . .	190
<i>Sotiris P. Gayialis, Grigorios D. Konstantakopoulos, Georgios A. Papadopoulos, Evripidis Kechagias, and Stavros T. Ponis</i>	
Lease Contract in Usage Based Remanufactured Equipment Service System . . . . .	198
<i>H. Husniah, U. S. Pasaribu, and B. P. Iskandar</i>	
 <b>Manufacturing Performance Management in Smart Factories</b>	
Increasing Rate of Diffusion of Innovation in Supply Chain: Targeting the Early Adopters in UK Supply Chain . . . . .	209
<i>S. Y. Lee, M. K. Lim, D. Food, and J. Hu</i>	
The Interaction of Global Networks in Their Evolutions: A Longitudinal Case Study. . . . .	215
<i>Yang Cheng and Ruihong Gao</i>	
Measuring Similarity for Manufacturing Process Models . . . . .	223
<i>Hyun Ahn and Tai-Woo Chang</i>	
Dynamic Rescheduling in Energy-Aware Unrelated Parallel Machine Problems. . . . .	232
<i>Sergio Ferrer, Giancarlo Nicolò, Miguel A. Salido, Adriana Giret, and Federico Barber</i>	
Information Support for Supplier Kit Preparation . . . . .	241
<i>Maria Kollberg Thomassen, Lars Skjelstad, and Erlend Gjønnes</i>	
Real-Time Linked Open Data for Life Cycle Inventory . . . . .	249
<i>Jayakrishnan Jayapal and Senthilkumaran Kumaraguru</i>	
The Construction Value Chain in a BIM Environment. . . . .	255
<i>Myrna Flores, Ahmed Al-Ashaab, Oliver Mörth, Pablo Cifre Usó, Harry Pinar, Fatimah Alfaraj, and Ming Yu</i>	

Performance Measurement in Sensorized Sociotechnical Manufacturing Environments . . . . .	263
<i>Emrah Arica, Manuel Oliveira, and Christos Emmanouilidis</i>	
<b>Industry 4.0 - Digital Twin</b>	
A Scheduling Tool for Achieving Zero Defect Manufacturing (ZDM): A Conceptual Framework. . . . .	271
<i>Foivos Psarommatis and Dimitris Kiritsis</i>	
Predictive Maintenance Platform Based on Integrated Strategies for Increased Operating Life of Factories. . . . .	279
<i>Gökan May, Nikos Kyriakoulis, Konstantinos Apostolou, Sangje Cho, Konstantinos Grevenitis, Stefanos Kokkorikos, Jovana Milenkovic, and Dimitris Kiritsis</i>	
Conceptual Design of a Digital Shadow for the Procurement of Stocked Products. . . . .	288
<i>Daniel Pause and Matthias Blum</i>	
A Framework Based on Predictive Maintenance, Zero-Defect Manufacturing and Scheduling Under Uncertainty Tools, to Optimize Production Capacities of High-End Quality Products . . . . .	296
<i>Paul-Arthur Dreyfus and Dimitrios Kyritsis</i>	
An Introduction to PHM and Prognostics Case Studies . . . . .	304
<i>Hong-Bae Jun</i>	
A Hybrid Machine Learning Approach for Predictive Maintenance in Smart Factories of the Future . . . . .	311
<i>Sangje Cho, Gökan May, Ioannis Tourkogiorgis, Roberto Perez, Oscar Lazaro, Borja de la Maza, and Dimitris Kiritsis</i>	
Skill Modelling for Digital Factories . . . . .	318
<i>D. Arena, F. Ameri, and D. Kiritsis</i>	
Digital Twin Approach for Solving Reconfiguration Planning Problems in RMS . . . . .	327
<i>Kezia Amanda Kurniadi, Sangil Lee, and Kwangyeol Ryu</i>	
Remaining Useful Life Estimation for Informed End of Life Management of Industrial Assets: A Conceptual Model . . . . .	335
<i>Marco Macchi, Irene Roda, and Leonardo Toffoli</i>	
Heat Recovery Unit Failure Detection in Air Handling Unit . . . . .	343
<i>Manik Madhikermi, Narges Yousefnezhad, and Kary Främling</i>	

**Industry 4.0 - Smart Factory**

Towards Digital Lean Cyber-Physical Production Systems: Industry 4.0 Technologies as Enablers of Leaner Production. . . . . 353  
*Daryl Powell, David Romero, Paolo Gaiardelli, Chiara Cimini, and Sergio Cavalieri*

Big Data Analytics for Logistics and Distributions Using Blockchain . . . . . 363  
*Benedito Cristiano A. Petroni, Elisângela Mônaco de Moraes, and Rodrigo Franco Gonçalves*

A Study on the Integrations of Products and Manufacturing Engineering Using Sensors and IoT. . . . . 370  
*Dahye Hwang and Sang Do Noh*

Towards a Platform for Smart Manufacturing Improvement Planning. . . . . 378  
*SangSu Choi, Thorsten Wuest, and Boonserm (Serm) Kulvatunyou*

Manufacturing Execution Systems: The Next Level of Automated Control or of Shop-Floor Support? . . . . . 386  
*S. Waschull, J. C. Wortmann, and J. A. C. Bokhorst*

Construct an Intelligent Yield Alert and Diagnostic Analysis System via Data Analysis: Empirical Study of a Semiconductor Foundry . . . . . 394  
*Yi-Jyun Chen, Yen-Han Lee, and Ming-Chuan Chiu*

The Industrial Ontologies Foundry Proof-of-Concept Project . . . . . 402  
*Boonserm (Serm) Kulvatunyou, Evan Wallace, Dimitris Kiritsis, Barry Smith, and Chris Will*

The Lean Production System 4.0 Framework – Enhancing Lean Methods by Industrie 4.0 . . . . . 410  
*Uwe Dombrowski and Thomas Richter*

AR/VR-Based Live Manual for User-Centric Smart Factory Services. . . . . 417  
*Minseok Kim, Kyeong-Beom Park, Sung Ho Choi, Jae Yeol Lee, and Duck Young Kim*

Active Role-Based Database System for Factory Planning . . . . . 422  
*Uwe Dombrowski, Christoph Imdahl, and Alexander Karl*

**Industry 4.0 – Collaborative Cyber-physical Production and Human Systems**

A Method to Assess Social and Human Factors of Production Innovations. . . 433  
*Stanisław Strzelczak and Stanisław Marciniak*



A Literature Review on Human Changeover Ability in High-Variety Production. . . . .	442
<i>Christopher Ketelsen, Rasmus Andersen, Kjeld Nielsen, Ann-Louise Andersen, Thomas D. Brunoe, and Sofie Bech</i>	
A Conceptual Digital Assistance System Supporting Manual Changeovers in High-Variety Production. . . . .	449
<i>Rasmus Andersen, Christopher Ketelsen, Kjeld Nielsen, Ann-Louise Andersen, Thomas D. Brunoe, and Sofie Bech</i>	
Softbots Supporting the Operator 4.0 at Smart Factory Environments . . . . .	456
<i>Ricardo J. Rabelo, David Romero, and Saulo Popov Zambiasi</i>	
A Fundamental Study on the Effect of Visual Guidance to Inspectors Using Visual Indicator on Defect Detection in Visual Inspection Utilizing Peripheral Vision . . . . .	465
<i>Ryosuke Nakajima, Kosuke Fujie, Takuya Hida, and Toshiyuki Matsumoto</i>	
Digitalizing Occupational Health, Safety and Productivity for the Operator 4.0 . . . . .	473
<i>David Romero, Sandra Mattsson, Åsa Fast-Berglund, Thorsten Wuest, Dominic Gorecky, and Johan Stahre</i>	
A Framework for Process Model Based Human-Robot Collaboration System Using Augmented Reality . . . . .	482
<i>Hwaseop Lee, Yeeyeng Liau, Siku Kim, and Kwangyeol Ryu</i>	
Management of Reconfigurable Production Networks in Order-Based Production . . . . .	490
<i>Johannes be Isa, Helge Epha, Stefan Braunreuther, and Gunther Reinhart</i>	
<b>Author Index . . . . .</b>	<b>499</b>