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PROCEEDINGS

APIEMS

APIEMS 2014

The 15th
Asia Pacific Industrial Engineering
and Management Systems Conference

> October 12~15, 2014
> Ramada Plaza Jeju Hotel, Jeju, Korea

APIEMS 2014 Information

Detailed Program

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EXIT

KOFST DOOSAN sas KOREA TOURISM ORGANIZATION Jeju CVB Jeju Convention & Visitor Bureau

Message from the APIEMS President

Greeting and a warm welcome to the participants of the 15th Asia Pacific Industrial Engineering and Management Systems Conference. Started in 1998, APIEMS has grown to become the premier conference for industrial engineering and management systems in the region with participants from all around the world. The main theme of this year conference: "Sustainable Industrial Systems and Big Data Management", is an attempt to address the balance among economic and technical development, social development, and environmental protection in this fast changing world.

I congratulate and thank Prof. Dr. Chi-Hyuck Jun, the conference chair, whose leadership made this APIEMS 2014 conference possible. We are also grateful for the enthusiastic support of APIEMS from the KIIE and the Korea research community.

On behave of the Asia Pacific Industrial Engineering and Management Society, I wish you a successful conference with many thoughtful discussions and debates with old and new friends.

Professor Voratas Kachitvichyanukul
APIEMS President, (2013-2014)
Professor of Industrial & Manufacturing Engineering
Dean, School of Engineering and Technology
Asian Institute of Technology, THAILAND

Message from the General Chair

Welcome to APIEMS 2014 in Jeju City, a beautiful island located at the most south of Korea. It is our great pleasure to organize this conference, which is supported by Korean Institute of Industrial Engineers (KIIE). APIEMS conferences have rapidly emerged as an important forum for exchange of ideas and information about latest developments in the field of industrial engineering and management systems among professionals mostly from Asia-Pacific countries. APIEMS 2014 conference encourages contributors to address the topical theme: Sustainable Industrial Systems and Big Data Management. Papers will represent the latest academic thinking and successful case examples. The wider audience will benefit from the knowledge and experience of leading practitioners and academics in this area.

The conference seeks research contributions from researchers, educators, modelers, software developers, users and practitioners. We hope that you enjoy participating in APIEMS 2014 and staying in Jeju.

Professor Chi-Hyuck Jun
General Chair, APIEMS 2014
Industrial & Management Engineering
POSTECH, Korea

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Conference Committee

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- ErhanKozan (Queensland University of Technology, Australia)
- HirokazuKono (Keio University, Japan)
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- Jinwoo, Park (Seoul National Univ., Korea)
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- Kin Keung Lai (City University of Hong Kong, Hong Kong)
- Mao Jiun Wang (National Tsing Hua Univeristy, Taiwan)
- Min K. Chung (POSTECH, Korea)
- Mitsuo Gen (Fuzzy Logic Systems Institute, Japan)
- P. L. Chang (Feng Chia Uni)
- Shouyang Wan (Chinese Academy of Sciences, China)
- Tae Eog Lee (KAIST, Korea)
- Takashi Oyabu (Kanazawa Seiryo University, Japan)
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Keynote Speech I
Research Issues in Future Logistics

Oct 13 (Monday) 11:00-12:00

Room: Ramada-1

Chung– Yee Lee
Hong Kong University of Science and Technology, China

Dr. Chung-Yee Lee is Chair Professor/Cheong Ying Chan Professor of Engineering in the Department of Industrial Engineering & Logistics Management at Hong Kong University of Science and Technology. He served as Department Head for seven years (2001- 2008). He is also the Founding and Current Director of Logistics and Supply Chain Management Institute. He is a Fellow of the Institute of Industrial Engineers in U.S. and also a Fellow of Hong Kong Academy of Engineering Science. Before joining HKUST in 2001, he was Rockwell Chair Professor in the Department of Industrial Engineering at Texas A&M University. He worked as a plant manager and also had few years consulting experience in Taiwan. In the past thirty years he has engaged in more than forty research projects sponsored by NSF, RGC, ITF, IBM, Motorola, AT&T Paradyne, Harris Semicon ductor, Northern Telecom, Martin Marietta, Hong Kong Air Cargo Terminal, Hongkong International Terminal, Philips Medical, ...,etc.

His search areas are in logistics and supply chain management, scheduling and inventory management. He has published more than 130 papers in refereed journals. According to an article in Int. J. Prod. Eco. (2009), which looked at all papers published in the 20 core journals during last 50 years in the field of production and operations management, he was ranked No. 6 among all researchers worldwide in h-index.

He received a BS degree in Electronic Engineering (1972) and a MS degree in Management Sciences (1976) both from National Chiao-Tung University in Taiwan. He also received a MS degree in Industrial Engineering from Northwestern University (1980) and PhD degree in Operations Research from Yale University (1984).

Keynote Speech II
Data-Driven Decision Making in Manufacturing: Lessons Learned and Future Opportunities

Oct 14 (Tuesday) 11:00-12:00

Room: Ramada-1

Ronald G. Askin
Arizona State University, USA

Ronald G. Askin, Ph.D., is a Professor of Industrial Engineering and Director of the School of Computing, Informatics, and Decision Systems Engineering at Arizona State University. Professor Askin received his B. S. in Industrial Engineering from Lehigh University followed by an M.S. in Operations Research and PhD in Industrial and Systems Engineering from the Georgia Institute of Technology. He has over 30 years of experience in the development, teaching and application of methods for systems design and analysis with particular emphasis on production and material flow systems. Other interests include quality engineering and decision analysis. He has published over 120 journal and conference proceedings papers in these areas.

Dr. Askin is a Fellow of the Institute of Industrial Engineers (IIE) and serves as Editor-in-Chief of IIE Transactions. He has served on the IIE Board of Trustees, as President of the IIE Council of Fellows, Chair of the Association of Chairs of Operations Research Departments (ACORD) Chair of the Industrial Engineering Academic Department Heads (CIEADH) and President of the INFORMS Manufacturing and Service Operations Management Society (MSOM). He was also General Chair of the 2012 INFORMS Annual Conference. His list of awards includes a National Science Foundation Presidential Young Investigator Award, the Shingo Prize for Excellence in Manufacturing Research, IIE Joint Publishers Book of the Year Award (twice), IIE Transactions on Design and Manufacturing Best Paper Award (twice), the Eugene L. Grant best paper award from The Engineering Economist, and the IIE Transactions Development and Applications Award.

Keynote Speech III
Big Data Management

Oct 14 (Tuesday) 13:00-14:00

Room: Ramada-1

Sungzoon Cho
Seoul National University, Korea.

Sungzoon Cho is currently professor of Industrial Engineering Department, the director of Data Mining Center at Seoul National University (SNU) and a member of Government 3.0 Committee of Korean government. He is on the editorial board of International Journal of Operations Research and Information Systems and International Journal of Cognitive Biometrics. He served as the presi yundai Motors, Hyundai Heavy Industries, POSCO, Daewoo Shipbuilding and Marine Engineering, LG Electronics, Doosan Infracore, SK Hynix, SK Telecommunication and CJ. He advised nine PhDs and 56 Master students. He teaches Data Mining and Computational Intelligence at SNU as well as at firms. He received BS and MS in Industrial Engineering at SNU. He won a Fulbright Scholarship to obtain Masters and PhD at University of Washington in Seattle, US, and University of Maryland in College Park, US, respectively.

Conference at a Glance

Oct 12 (Sunday)		Oct 13 (Monday)		Oct 14 (Tuesday)		Oct 15 (Wednesday)	
		08:00-17:00	Registration	08:00-17:00	Registration	08:00-12:00	Registration
		08:30-10:10	Technical sessions MA	08:40-10:40	Technical sessions TA	08:30-10:10	Technical sessions WA
10:00-18:00	Registration	10:10-10:30	Coffee break			10:10-10:30	Coffee break
		10:30-11:00	Opening addresses : APIEMS President, KIIE President, General Chair	10:40-11:00	Coffee break	10:30-12:10	Technical sessions WB
		11:00-12:00	Keynote speech I (Prof. Chung-Yee Lee: Research issues in Future Logistics)	11:00:12:00	Keynote speech II (Prof. Ronald Askin: Data-Driven Decision Making in Manufacturing)		
13:00-17:20	Excursion	12:00-13:30	Lunch	12:00-13:00	Lunch	12:10-13:30	Lunch
		13:30-15:30	Technical sessions MB	13:00-14:00	Keynote speech III (Prof. Sungzoon Cho: Big Data Management)		
				14:00-14:20	Coffee break		
		15:30-15:50	Coffee break	14:20-16:00	Technical sessions TB		
		15:50-17:50	Technical sessions MC	16:00-16:20	Coffee break		
	Registration			16:20-18:00	Technical sessions TC		
				13:00-18:00	Poster Session		
18:00-20:00	Welcome Reception			18:30-21:00	General Reception		

Oct 12 (Sunday)	
10:00-18:00	**Registration**
13:00-17:20	**Excursion**
18:00-20:00	**Welcome Reception**

Oct 13 (Monday)									
08:00-17:00	**Registration**								
Room	**Mara**	**Biyang**	**Udo**	**Chuja**	**Ramada-1**	**Ramada-2**	**Ramada-3**	**Ramada-4**	**Halla(8F)**
08:30-10:10	**Technical sessions MA**								
	MA1	**MA2**	**MA3**	**MA4**	**MA5**	**MA6**	**MA7**	**MA8**	**MA9**
Session name	Data Mining 1	Management of Technology and Innovations 1	ERP/ E-Business	Service Sciences 1	Quality Engineering & Management 1	Production and Operations Management 1	Metaheuristics	Financial Models & Engineering	Uncertainty Theory (Session I)
Paper #	**528**	**100**	**37**	**54**	**23**	**75**	**42**	**41**	**551**
	207	**111**	**38**	**55**	**28**	**158**	**43**	**146**	**555**
	276	**143**	**352**	**108**	**109**	**211**	**175**	**180**	**556**
	324	**44**	**360**	**215**	**113**	**269**	**353**	**267**	**584**
	296	**97**	**255**	**244**	**226**	**213**	**465**	**273**	
10:10-10:30	**Coffee break**								
10:30-11:00	**Opening addresses: APIEMS President, KIIE President, General Chair**								
11:00-12:00	**Keynote speech I (Prof. Chung-Yee Lee: Research Issues in Future Logistics)**								
12:00-13:30	**Lunch**								
13:30-15:30	**Technical sessions MB**								
	MB1	**MB2**	**MB3**	**MB4**	**MB5**	**MB6**	**MB7**	**MB8**	**MB9**
Session name	Decision Support Systems & Expert Systems	Probability & Statistical Modeling	Ergonomics/ Human Factors 1	Service Sciences 2	Quality Engineering & Managment 2	Production and Operations Management 2	Green Manufacturing/ Management	Transportation	Ergonomics & Welfare Management
Paper #	**173**	**190**	**96**	**322**	**227**	**338**	**417**	**73**	**488**
	254	**299**	**131**	**401**	**228**	**362**	**550**	**91**	**484**
	290	**333**	**305**	**411**	**229**	**394**	**119**	**103**	**530**
	460	**334**	**315**	**479**	**346**	**396**	**156**	**312**	**485**
	116	**3354**	**326**	**504**	**294**	**442**	**342**	**340**	**471**
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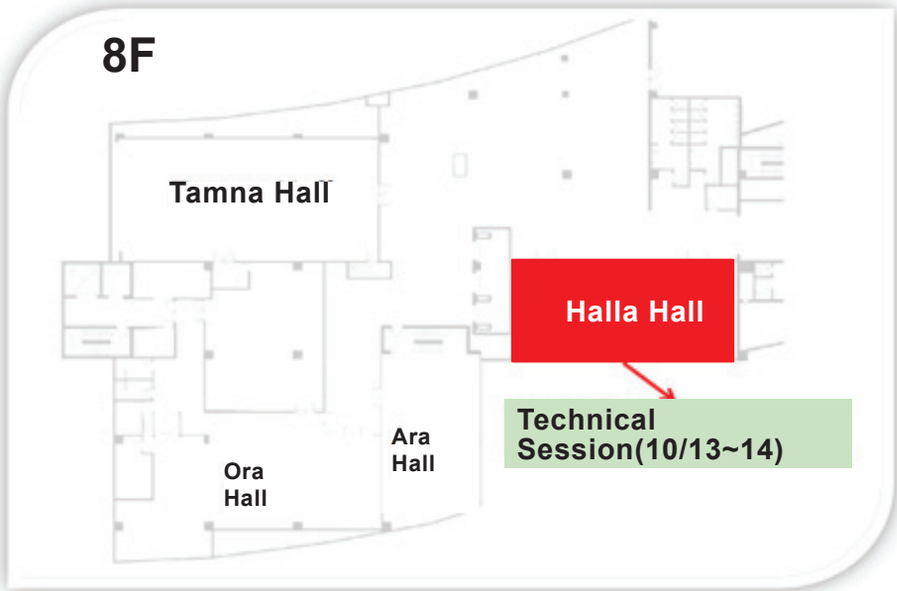
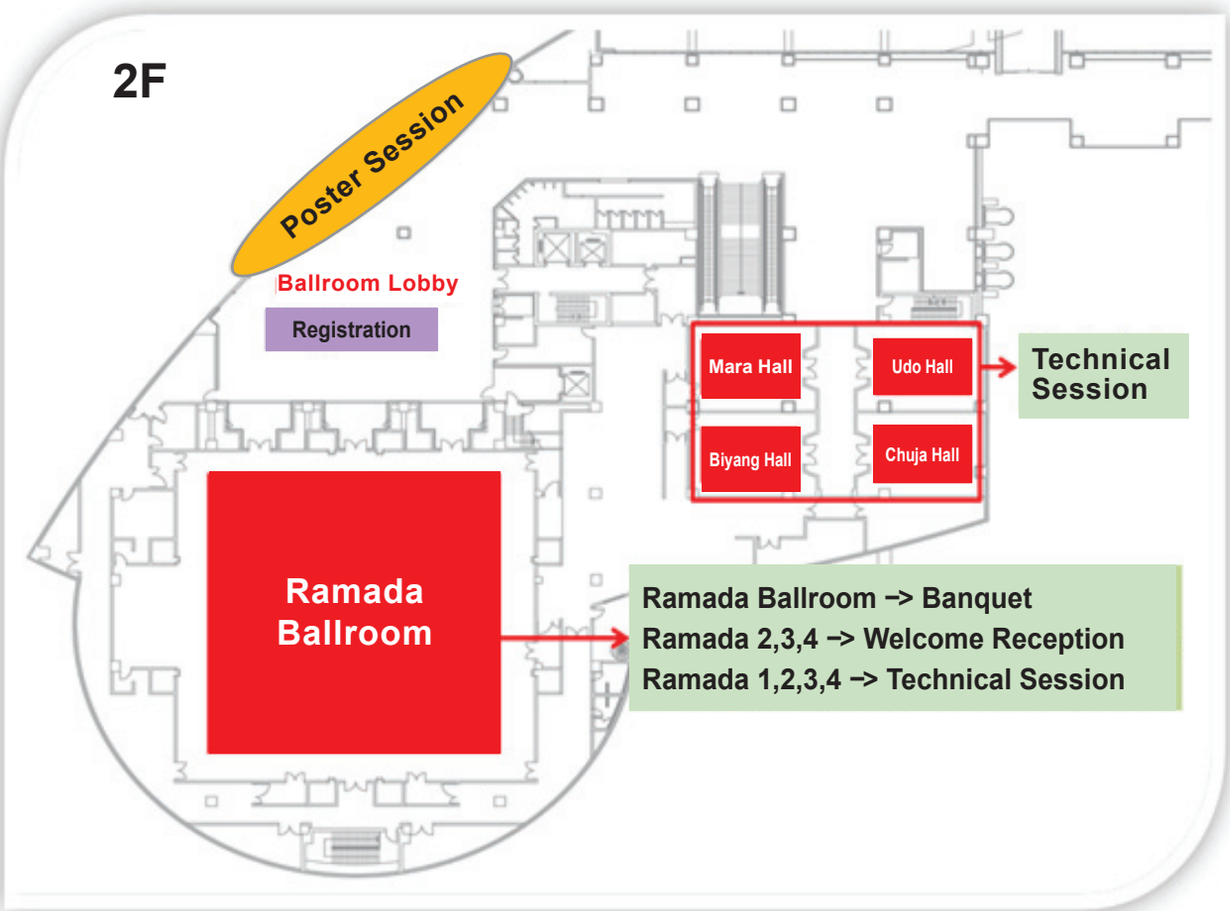
15:30-15:50	**Coffee break**								
15:50-17:50	**Technical sessions MC**								
	MC1	**MC2**	**MC3**	**MC4**	**MC5**	**MC6**	**MC7**	**MC8**	**MC9**
Session name	Supply Chain Management 1	Reliability & Maintenance	Ergonomics/ Human Factors 2	Network Optimization	Quality Engineering & Management 3	Simulation 1	Healthcare Systems 1	Optimization Techniques 1	Educational Support System
Paper #	**252**	**118**	**456**	**407**	**325**	**500**	**482**	**374**	**501**
	261	**121**	**359**	**363**	**328**	**196**	**99**	**217**	**562**
	279	**153**	**393**	**268**	**339**	**424**	**112**	**201**	**448**
	280	**320**	**419**	**515**	**346**	**66**	**194**	**169**	**455**
	355	**580**	**449**	**319**	**370**	**179**	**248**	**206**	**154**
	336	**582**	**341**	**142**	**402**			**271**	**507**

Oct 14 (Tuesday)									
08:00-17:00	**Registration**								
Room	**Mara**	**Biyang**	**Udo**	**Chuja**	**Ramada-1**	**Ramada-2**	**Ramada-3**	**Ramada-4**	**Halla(8F)**
08:40-10:40	**Technical sessions TA**								
	TA1	**TA2**	**TA3**	**TA4**	**TA5**	**TA6**	**TA7**	**TA8**	**TA9**
Session name	Supply Chain Management 2	Communication Support	Data Mining 2	Tourism Management/ Topics in IE/MS	Sustainable Management	Simulation 2	Production & Operations Management 1	Logistics Management	Uncertainty Theory (Session II)
Paper #	**50**	**443**	**128**	**472**	**35**	**98**	**282**	**440**	**558**
	59	**535**	**147**	**444**	**114**	**105**	**327**	**477**	**559**
	60	**489**	**203**	**564**	**136**	**221**	**349**	**483**	**560**
	61	**536**	**392**	**15**	**137**	**272**	**431**	**543**	**561**
	130	**480**	**412**	**264**	**291**	**295**	**104**	**344**	**565**
	161	**537**	**216**	**225**	**347**	**356**	**218**	**313**	**428**
10:40-11:00	**Coffee break**								
11:00-12:00	**Keynote speech II (Prof. Ronald Askin: Data Driven Decision Making in Manufacturing)**								
12:00-13:00	**Lunch**								
13:00-14:00	**Keynote speech III (Prof. Sungzoon Cho: Big Data Management)**								
14:00-14:20	**Coffee break**								
14:20-16:00	**Technical sessions TB**								
	TB1	**TB2**	**TB3**	**TB4**	**TB5**	**TB6**	**TB7**	**TB8**	**TB9**
Session name	Supply Chain Management 3	Management of Technology and Innovations 2	Data Mining 3	Scheduling & Sequencing 1	Knowledge & Information Management	Production & Operations Management 2	Healthcare Systems 2	Flexible Manufacturing Systems	Topics in IE/MS
Paper #	**165**	**188**	**437**	**122**	**250**	**49**	**95**	**579**	**575**
	176	**425**	**469**	**233**	**278**	**124**	**106**	**48**	**354**
	208	**317**	**486**	**284**	**445**	**151**	**306**	**62**	**378**
	160	**150**	**502**	**287**	**297**	**187**	**379**	**286**	**212**
	234	**22**	**581**	**309**	**389**	**12**	**76**	**457**	**202**
16:00-16:20	**Coffee break**								
16:20-18:00	**Technical sessions TC**								
	TC1	**TC2**	**TC3**	**TC4**					**TC9**
Session name	Heuristics/Metaheuristics	Inventory Modeling / Artificial Intelligence	Artificial Intelligence	Scheduling & Sequencing 2					Lean Production Management
Paper #	**70**	**381**	**182**	**399**					**542**
	464	**123**	**260**	**405**					**546**
	481	**101**	**490**	**418**					**94**
	520	**318**	**391**	**398**					**545**
	192		**499**	**79**					**547**
13:00-18:00	**POSTER Session**								
Paper #	**47**	**149**	**166**	**204**	**220**	**245**	**253**	**265**	**205**
	365	**366**	**382**	**400**	**414**	**422**	**432**	**435**	**524**
	451	**473**	**487**	**522**	**527**	**491**	**420**	**145**	
18:30-21:00	**General Reception**								

Oct 15 (Wednesday)								
08:00-12:00	**Registration**							
Room	**Mara**	**Biyang**	**Udo**	**Chuja**	**Ramada-3**	**Ramada-4**	**Ramada-1**	**Ramada-2**
08:30-10:10	**Technical sessions WA**							
	WA1	**WA2**	**WA3**	**WA4**	**WA5**	**WA6**		
Session name	Inventory Modeling & Management	SCM and Forecasting 1	Production Design & Management 1	Scheduling & Sequencing 3	Fuzzy Logic	Optimization Techniques 2		
Paper #	**65**	**92**	**117**	**85**	**30**	**125**		
	80	**31**	**162**	**120**	**58**	**69**		
	71	**34**	**198**	**177**	**224**	**288**		
	446	**32**	**222**	**316**	**576**	**577**		
	518	**102**	**249**	**509**		**415**		
10:10-10:30	**Coffee break**							
10:30-12:10	**Technical sessions TB**							
	WB1	**WB2**	**WB3**	**WB4**	**WB5**	**WB6**		
Session name	Industrial Engineering Education	SCM and Forecasting 2	Production Design & Management 2	Scheduling & Sequencing 4	Quality Engineering & Reliability	Lean Manufacturing		
Paper #	**526**	**52**	**283**	**329**	**453**	**129**		
	139	**36**	**348**	**46**	**508**	**371**		
	256	**87**	**350**	**403**	**270**	**553**		
	495	**413**	**93**	**426**	**517**	**110**		
			84	**454**	**421**	**516**		
12:10-13:30	**Lunch**							

Floor Plan


8F
Tamna Hall
Halla Hall
Technical Session(10/13~14)
Ara Hall
Ora Hall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Udo Hall
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Ramada 2,3,4 -> Welcome Reception
Ramada 1,2,3,4 -> Technical Session

Detailed Program

MA1 Data Mining 1

Mara, 08:30-10:10

Chair: Kuo-Hao Chang (National Tsing Hua University, Taiwan)

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Biyang, 08:30-10:10

Chair: Muh-Cherng Wu (National Chiao Tung University, Taiwan)

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MA5 Quality Engineering & Management 1

Ramada-1, 08:30-10:10

Chair: Ruey Huei (Robert) Yeh (National Taiwan Univeristy of Science and Technology, Taiwan)

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Chair: Shinya Mizuno (Shizuoka University, Japan)

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Chair: Hsiao-Fan Wang (Universiti Malaysia Pahang, Taiwan)

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Chair: Shi-Woei Lin (National Taiwan University of Science and Technology, Taiwan)

MC8-1 (374) Evaluating the Economic Performance of ASEAN Countries by Data Envelopment Analysis 879
*Mohammad Jerusalem, *Shi-Woei Lin(National Taiwan University of Science and Technology, Taiwan)*

MC8-2 (217) Detecting the Masked Efficient DMU in DEA 887
*Chiao-Pin Bao(I-Shou University, Taiwan), *Meei-Ing Tsai, Ming-Chi Tsai(College of Management, Taiwan)*

MC8-3 (201) Process and Cost Optimization for Plastic Injection Molding by Data Envelope Analysis and Mathematical Programming 894
*Wu-Lin Chen(Providence University, Taiwan), Wan-Qiao Lai, Chen-Yu Huang, *Chin-Yin Huang(Tunghai University, Taiwan)*

MC8-4 (169) Stochastic Global Optimization Using Sequential Kriging Metamodeling 901
*Yan-Han Lu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)*

MC8-5 (206) Optimization of Air-Conditioning Energy Conservation by Mathematical Programming 907
*Wu-Lin Chen(Providence University, Taiwan), Chung-Wei Chou, Szu-han Chiu, *Chin-Yin Huang(Tunghai University, Taiwan)*

MC8-6 (271) Expertise-based Experts Ranking at Multiplicative Preference Relations on Alternatives 914
*evy herowati, *evy herowati, evy herowati(University of Surabaya and Institute of Technology Sepuluh Nopember, Indonesia), Udisubakti Ciptomulyono(Institute of Technology Sepuluh Nopember, Indonesia), Joniarto Parung(University of Surabaya, Indonesia), Suparno Suparno(Institute of Technology Sepuluh Nopember, Indonesia)*

MC9 Educational Support System

Halla(8F), 15:50-17:50

Chair: Masahide Yamamoto (Kanazawa Seiryo University, Japan)

MC9-1 (501) A system of real time advice for speech improvement 920
**Hiroshi Arai(Kinjo college, Japan), Hidetaka Nambo(Kanazawa University, Japan), Yuko Shimomura, Hiroyuki KAWABE(Kinjo University, Japan), Shuichi Seto(Kinjo College, Japan)*

MC9-2 (562) Consideration on English Learning for Undergraduates Using the Nintendo DS 924
**Hiromi Ban(Nagaoka University of Technology, Japan), Haruhiko Kimura(Kanazawa University, Japan), Takashi Oyabu(Kokusai Business Gakuin College, Japan)*

MC9-3 (448) The Analysis of Concept and Effect Factors on Financial Literacy 929
**Yuji Kitano(Kanazawa Seiryo University, Japan), Koji Osanai(Shiga Junior college, Japan), Keiichiro Nishio(Matsuyama University, Japan)*

MC9-4 (455) The Present Conditions of the Computerization of Education and its Problems Concerning the Educator 936
**Yumi Tatsushima(Kanazawa Seiryo University, Japan)*

MC9-5 (154) AN ANALYSIS OF JOB SATISFACTION OF FACULTY MEMBERS OF BULACAN STATE UNIVERSITY MAIN CAMPUS (COLLEGE OF ENGINEERING) 941
**Dyan Gonzales(Philippine Institute of Industrial Engineers, Philippines)*

MC9-6 (507) Analysis the Influence of Study Program's Education Quality towards Graduates' Potential Marketing 948
**Yulianti Talar, Jimmy Gozaly(Maranatha Christian University, Indonesia)*

TA1 Supply Chain Management 2

Mara, 08:40-10:40

Chair: Etsuko Kusukawa (Osaka Prefecture University, Japan)

TA1-1 (50) Impact of information sharing regarding customer returns ratio on optimal sales strategy under e-commerce 957
**Yuta Saito, Etsuko Kusukawa(Osaka Prefecture University, Japan)*

TA1-2 (59) Analyzing the evolutionary stability for behavior strategies in green supply chain 965
**Daijiro Tomita, Etsuko Kusukawa(Osaka Prefecture University, Japan)*

TA1-3 (60) Pareto-Based PSO Algorithm for Multi-Objective LRP 973
**jie liu(student, Thailand), Voratas Kachitvichyanukul(professor, Thailand), jie liu(student, Thailand)*

TA1-4 (61)	Optimal Ordering Policy in Dual-Sourcing Supply Chain considering Supply Disruptions and Demand Information *Naoki Watanabe, Etsuko Kusukawa(Osaka Prefecture University, Japan)	980
TA1-5 (130)	Research in Supply Chain Management: Issue and Area Development elisa kusrini(Department of Industrial Engineering, Indonesia), *siti Budijati(Faculty of Engineering, Indonesia), subagyo subagyo(Indonesian Islamic University, Indonesia), nuraini masruroh(Yogjakarta, Indonesia)	988
TA1-6 (161)	Cold Chain Logistics Development: Analyzing Taiwan Influences in Indonesia Market James C. Chen(National Tsing Hua University, Taiwan), Janet Chen, Yun-Wei Hung(Industrial Technology Research Institute, Taiwan), *Muhammad Rinaldi Darmawan, Nadia Aulia Arifin, Hsin-Yu Shih(National Tsing Hua University, Taiwan)	996

TA2 Communication Support

Biyang, 08:40-10:40

Chair: Sakiko Ogoshi (Kanazawa University, Japan)

TA2-1 (443)	Discrimination of Positive / Negative Attitude Using Optical Flow *Yuta Kobayashi(Kanazawa University, Japan), Munehiro Nakamura(Kanazawa Institute of Technology, Japan), Hidetaka Nambo, Haruhiko Kimura(Kanazawa University, Japan)	1003
TA2-2 (535)	Development of the support system for facial expression training *Yusuke Amagata, Yasuhiro Ogoshi(University of Fukui, Japan), Sakiko Ogoshi(Kanazawa University, Japan), Tomohiro Takezawa(The National Institute of Vocational Rehabilitation, Japan), Yoshinori Mitsuhashi(Chiba, Japan)	1010
TA2-3 (489)	Discrimination of Micro-Expression with Subjective Assessments *Kiyotaka nakashima(Graduate School of Natural Science, Japan), Munehiro Nakamura(Kanazawa Institute of Technology, Japan), Haruhiko Kimura(Graduate School of Natural Science, Japan)	1015
TA2-4 (536)	Facial electromyogram (FEMG) analysis of perception and rendering of facial expression *Akira Takahara, Yasuhiro Ogoshi(University of Fukui, Japan), Sakiko Ogoshi(Kanazawa University, Japan), Tomohiro Takezawa(The National Institute of Vocational Rehabilitation, Japan), Yoshinori Mitsuhashi(University of Fukui, Japan)	1020
TA2-5 (480)	Text extraction in natural image *Masayoshi Ueno, Hidetaka Nambo, Haruhiko Kimura(Kanazawa University, Japan)	1025
TA2-6 (537)	Electroencephalogram activity during imagined imitative learning *Shu Momose(University of Fukui, Japan), Sakiko Ogoshi(Kanazawa University, Japan), Yasuhiro Ogoshi(University of Fukui, Japan), Tomohiro Takezawa(The National Institute of Vocational Rehabilitation, Japan), Yoshinori Mitsuhashi(University of Fukui, Japan)	1030

TA3 Data Mining 2

Udo, 08:40-10:40

Chair: Jong-Seok Lee (Sungkyunkwan University, Korea)

TA3-1 (128)	AUC-based C4.5 tree induction for imbalanced data classification Jungmin Lee, Sungho Lee, *Jong-Seok Lee(Sungkyunkwan University, Korea)	1035
TA3-2 (147)	Comparison of machine learning classifiers for glaucoma diagnosis using variable selection Su-Dong Lee, Jihyung Lee, Heecheon You, *Chi-Hyuck Jun(POSTECH, Korea)	1042
TA3-3 (203)	An iterative random sampling procedure for outlier detection Jihyun Ha, Seulgi Seok, *Jong-Seok Lee(Sungkyunkwan University, Korea)	1049
TA3-4 (392)	Development of Knowledge Management for Forecasting in Restaurant Using Association Rule Mining and Regression Analysis *Annisa Khasanah, Agus Mansur, Yasser Ulil Albab(Universitas Islam Indonesia, Indonesia)	1057
TA3-5 (412)	Data stream clustering by controlling decision errors Jeonghwa Lee, *Chi-Hyuck Jun(POSTECH, Korea)	1064
TA3-6 (216)	The moderating impact of employee's perceived self-efficacy on knowledge sharing intention *Mei-Fang Chen, Ssu-Wei Huang(Tatung University, Taiwan), Pei-Ju Tung(National Chengchi University, Taiwan)	1071

TA4 Tourism Management/ Topics in IE/MS

Chuja, 08:40-10:40

Chair: Hidetaka Nambo (Kanazawa University, Japan)

TA4-1 (472)	Evaluation for painting show of kindergartner on rout bus in Kaga City *Eri Ishikawa, Ayano Kawasaki, Izumi Yamasaki(Kanazawa Seiryo University, Japan), *Takashi Oyabu(Kokusai Business Gakuin College, Japan)*	1077
TA4-2 (444)	Utilization of historical materials and CGM for foreign visitors **Ayako Sawada(Hokuriku Gakuin Junior College, Japan), Taketoshi Yoshida(Japan Advanced Institute of Science and Technology, Japan)*	1084
TA4-3 (564)	The Verification of Mass Customization Systems in the Chinese Market **Bin Fang(Kanazawa Seiryo University, Japan), Akinori Ono(Keio University, Japan)*	1090
TA4-4 (15)	Using SWOT Analysis to Evaluate the Public Procurement in Compliance with SNI (Case Study: Government Agency at Central of Java) **Aries Susanty, Hery Suliantoro, Diana Puspitasari, Diena Novitasari, Nia Budi Puspitasari(Diponegoro Unversity, Indonesia)*	1094
TA4-5 (264)	Designing Variables Quick Switching System with Process Loss Consideration *Yi-Jhen Jian, *Chien-Wei Wu(National Tsing Hua University, Taiwan)*	1100
TA4-6 (225)	A Variables Multiple Dependent State Sampling Plan for Products with Unilateral Specification Limit *Chih-Chieh Chang Chien, *Chien-Wei Wu, Yi-Feng Hung(National Tsing Hua University, Taiwan)*	1105

TA5 Sustainable Management

Ramada-1, 08:40-10:40

Chair: Mei-Fang Chen (Tatung University, Taiwan)

TA5-1 (35)	Sustainable supply chain management in competitiveness environment *Ming-Lang Tseng(Lunghwa University of Science and Technology, Taiwan), *Anthony Shun Fung Chiu(De La Salle University, Philippines), Ming Lim(Derby University, United Kingdom)*	1110
TA5-2 (114)	Sustainable management of Taiwan's semiconductor supply chain **Chi-Tai Wang, Chui-Sheng Chiu(National Central University, Taiwan)*	1119
TA5-3 (136)	The Use of Smart Meter Data to Analyze the Consumption Patterns *Chia-Yu Shen(National Tsing Hua University, Taiwan), *Hsiao-Fan Wang(Hsinchu, Taiwan)*	1124
TA5-4 (137)	Time of Use Electricity Pricing Optimization in a Monopolized Electricity Market *Hsin-Yu Chiang, *Hsiao-Fan Wang(National Tsing Hua University, Taiwan)*	1131
TA5-5 (291)	Modeling and Optimization of Power Storage Strategy of Hybrid Renewable Energy System in Uncertainty Environments *Chi-Kang Su, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)*	1136
TA5-6 (347)	What psychological factors influence the protection motivation of climate change? **Mei-Fang Chen(Tatung University, Taiwan)*	1141

TA6 Simulation 2

Ramada-2, 08:40-10:40

Chair: Udom Janjarassuk (King Mongkut's Institute of Technology Ladkrabang, Thailand)

TA6-1 (98)	Application of Agent-Based Modeling and Simulation for an Outpatient Department in a Hospital **Chumpol Yuangyai(King Mongkut's Institute of Technology Ladkrabang, Thailand), Udom Janjarassuk(Faculty of Engineering, Thailand), Chonnupong Siritan(King Mongkut's Institute of Technology Ladkrabang, Thailand), Kanokporn Rienkhemaniyom(King Mongkut's University of Technology Thonburi, Thailand)*	1147
TA6-2 (105)	Integrated Maintenance and Inventory Optimisation Model for Offshore Assets **Winda Cahyo(Islamic University of Indonesia, Indonesia)*	1154

TA6-3 (221)	A PSO-based Hybrid Approach for Buffer Allocation Problem with Uncertainty *James T. Lin, Chun-Chih Chiu(National Tsing-Hua University, Taiwan)*	1161
TA6-4 (272)	State-based Modeling and Simulation of Urban Traffic Systems Including Signalized Intersections *Mira Myong, Donghun Kang, Byoung Kyu Choi(KAIST, Korea)*	1167
TA6-5 (295)	MCMC algorithm using self-adaptive differential evolution and local optimization technique for Bayesian framework of complex systems *Jun-Seong Kim, *Chi-Hyuck Jun(POSTECH, Korea)*	1174
TA6-6 (356)	Evaluation of the Behavior of Persons on a Floor ina Disaster Situation by Multi-Agent Simulation *Keita Sugiura, Masahiro Arakawa(Nagoya Institute of Technology, Japan)*	1179

TA7 Production & Operations Management 1

Ramada-3, 08:40-10:40

Chair: Takayoshi Tamura (Aichi Institute of Technology, Japan)

TA7-1 (282)	Study and findings based on actual case data of the degree of the integration in regard to the production quality of information systems *Hideaki Hayashi, Etsuji Ohmura(Osaka University, Japan)*	1187
TA7-2 (327)	A Study on Standard Productivity for Compering Productivity of an Assembly Line in Diversified Production Conditions *Kagehisa Nakayama(Waseda University, Japan), Shohei Machida, Hisashi Onari(WASEDA University, Japan)*	1195
TA7-3 (349)	Inventory Valuation Model Considering Profitability and Risk *Kiho Kamiya, *Satoshi Kumagai(Aoyama Gakuin University, Japan), Ohba Masaaki(College of Economics, Japan)*	1201
TA7-4 (431)	A method of operational planning for project-based production in consideration of learning effects and demand uncertainty *YOSHIHIKO SUZUKI(Seiryo Technica Co. Ltd, Japan), Nobuaki Ishii(Bunkyo University, Japan), masaaki muraki(Emeritus Professor, Japan)*	1208
TA7-5 (104)	Integrated Transport Terminal: Its Effect on Commuters' Travel Time, Cost, and Comfort (Or How Bitter-Sweet is the Metro Manila SWITT?) *RUMEL ATIENZA, RUMEL ATIENZA, Carlo Tansuk(DE LA SALLE UNIVERSITY, Philippines)*	1213
TA7-6 (218)	Effectiveness of an Exponential Smoothing System for a Multi-Stage Multi-Item Production System with Advance Demand Information *Takayoshi Tamura(Aichi Institute of Technology, Japan), Tej Dhakar(Southern New Hampshire University, United States)*	1219

TA8 Logistics Management

Ramada-4, 08:40-10:40

Chair: Anchalee Supithak (Thai-Nichi Institute of Technology, Thailand)

TA8-1 (440)	Logistics Management of Oil Palm in Southern Region of Thailand *Phajongjit Pijitbanjong(Faculty of Industrial Technology, Thailand), Paroon Mayachearw(Songkhla Rajabhat University, Thailand), Rapeepan Pitakaso(Songkhla, Thailand)*	1227
TA8-2 (477)	On the resources required to provide persistent robotic service agents: Multiple immobile customers and a single service station *Hyorin Park, *James Morrison(KAIST, Korea)*	1234
TA8-3 (483)	Solving Integrated Inventory and Open Vehicle Routing Problem in Two Depots and Multiple Retailers' Distribution System *Anchalee Supithak(Thai-Nichi Institute of Technology, Thailand)*	1242
TA8-4 (543)	Competitive Facility Location and Design Problem by Considering Conditions of Government Regulation and Regional Saturation *Suprayogi Suprayogi, Yosi Hidayat(Institut Teknologi Bandung, Indonesia), *Utaminingsih Linarti(Ahmad Dahlan University, Indonesia)*	1250
TA8-5	Cooperative Tactical Planning in Road Transportation with Backhauling Management	1256

(344) *Apichit Manee-ngam(Faculty of Engineering, Thailand), Apinanthana Udomsakdigool(King Mongkut's University of Technology Thonburi, Thailand)

TA8-6 (313) Monitoring Framework for Dynamic Inbound Flows 1264
*Kiyoul Lee(POSTECH (Pohang University of Science & Technology), Korea), Hyunbo Cho(POSTECH (Pohang University of Science & Techonology), Korea), *Mooyoung Jung(UNIST (Ulsan National Institute of Science & Technology), Korea)*

TA9 Uncertainty Theory (Session II)

Halla(8F), 08:40-10:40

Chair: Xiaowei Chen (Nankai University, China)

TA9-1 (558) Towards Uncertain Network Optimization 1270
**Jin Peng(Huanggang Normal University, China)*

TA9-2 (559) Viral Marketing of Multiple-Attribute Products in a Social Network 1271
*Wei Li, *Yaodong Ni(University of International Business and Economics, China)*

TA9-3 (560) Uncertain Logic Controller and Its Applications 1279
**Wei Dai(Central University of Finance and Economics, China)*

TA9-4 (561) Uncertain Random Multilevel Programming 1280
**Hua Ke(Tongji University, China)*

TA9-5 (565) Assets Pricing and Risk Management in Uncertain Market 1281
**Xiaowei Chen(School of Economics Nankai University, China)*

TA9-6 (428) Liquidity Crashes and Robust Portfolio Management 1282
*Seungkyu Lee(Pohang University of Science and Technology, Korea), *Bong-Gyu Jang, Seyoung Park(POSTECH, Korea)*

TB1 Supply Chain Management 3

Mara, 14:20-16:00

Chair: Muhammad Rusman (Hasanuddin University, Indonesia)

TB1-1 (165) Nash Equilibrium Retail Prices in a Planer Duopoly Market 1295
**Koichi Nakade, Akira Kanazawa(Nagoya Institute of Technology, Japan)*

TB1-2 (176) A Proposal of Bargaining Solution for Cooperative Contract in a Supply Chain 1303
**Wakana Kato, Ikuo Arizono(Okayama University, Japan)*

TB1-3 (208) Capacity Planning and Partnership Management 1310
**Cheng-Hung Wu, Wen-Lan Hsu(National Taiwan University, Taiwan)*

TB1-4 (160) A muli-objective facility location problem in congested systems with service level for each facility and competitive environment 1314
**Mahsa Boroushaki(M.Sc. student of industrial engineering, Iran), hasan hosseini nasab(Associate professor, Iran)*

TB1-5 (234) Blood Bank Location Model for Blood Distribution Planning in Makassar City 1323
**Muhammad Rusman(Hasanuddin University, Indonesia), Amrin Rapi(Ministry of Industry of Republic of Indonesia, Indonesia)*

TB2 Management of Technology and Innovations 2

Biyang, 14:20-16:00

Chair: Chih Wang (National Chiao Tung University, Taiwan)

TB2-1 (188) Establishment and development of the innovation-promoting organization for Industry 1328
**Kana Hayase, Nobutaka Odake(Nagoya Institute of Technology, Japan), Takeshi Matsumoto(Osaka Gas Co., Japan)*

TB2-2 (425) Using Innovative Intellectual Property Indicators to Identify National Knowledge Flow Effects 1336
**Chin-Yuan Fan, Chia-Hao Hsu(Science & Technology Policy Research and Information Center, Taiwan), shu-hao Chang(National Applied Research Labs, Taiwan), pin-hua Lin(Zhongli, Taiwan)*

TB2-3 (317)	Development of Virtual Organisation Framework Model in Tourism Industry Using Axiomatic Design *Agus Fauzi, Eny Maftuchah, Nasrullah Setiawan, Bambang Suratno(Universitas Islam Indonesia, Indonesia)	1345
TB2-4 (150)	Supporting Technology Foresight for Disruptive Innovation: Keyword-based Visual Analysis for Futuristic Data Jieun Kim, *Yongtae Park(Seoul National University, Korea)	1352
TB2-5 (22)	Combining correspondence analysis with association rule mining to carry out market segmentation and product configuration *Chih Wang(National Chiao Tung University, Taiwan)	1358

TB3 Data Mining 3

Udo, 14:20-16:00

Chair: Jen-Ying Shih (National Taiwan Normal University, Taiwan)

TB3-1 (437)	Comparative Benchmarking Analysis among Fine Jewelry and Costume Jewelry Companies in the Philippines Using Data Envelopment Analysis (DEA) *Dennis Beng Hui, Emil Fernandez(De La Salle University Manila, Philippines)	1366
TB3-2 (469)	A Prediction Method based on Weighted Ensemble of Decision Tree on Alternating Decision Forests. *Shotaro Misawa, Naohiro Fujiwara(Graduate Student of Waseda University, Japan), Kenta Mikawa(Waseda University, Japan), Masayuki Goto Goto(Waseda University., Japan)	1375
TB3-3 (486)	Creating Attractive Digital Signage Content at Universities *RYO AKAIWA(Aoyama Gakuin University, Japan), RYUJI MAEKAWA, KAKURO AMASAKA(AOYAMA GAKUIN UNIVERSITY, Japan)	1383
TB3-4 (502)	A Data Mining Approach for Loan Marketing Response Model *Jen-Ying Shih(National Taiwan Normal University, Taiwan), Wun-Hwa Chen(National Taiwan University, Taiwan)	1388
TB3-5 (581)	The 7-Eleven Rule in the Simulation Output Analysis *Wheyming Song(professor, Taiwan)	1394

TB4 Scheduling & Sequencing 1

Chuja, 14:20-16:00

Chair: Byung Do Chung (Sungkyunkwan University, Korea,)

TB4-1 (122)	A two-stage assembly scheduling problem with makespan minimization Lulu Hu, *Tsui-Ping Chung, Hongying Shan(Jilin University, China), Chien-Ming Chen(Harbin Institute of Technology Shenzhen Graduate School, China)	1413
TB4-2 (233)	Particle swarm Optimization for minimizing electrical consumption for flexible flowshop problem Krisanarach Nitisiri(Research Unit on Advanced Productivity Improvement and Logistics Management, Thailand), *Kanchana Sethanan(Faculty of engineering. Khon Kaen university, Thailand)	1420
TB4-3 (284)	Campaign Planning for Multi-Purpose Batch Plants: A Case Study from the Pharmaceutical Industry Mao-Kai Hsu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)	1427
TB4-4 (287)	Multi-Jobs Lot Streaming to Minimize the Mean Maximum Completion Time in Multi-Stages Hybrid Flow Shop Scheduling *Said Syahputra(Institut Teknologi Bandung, Indonesia, Indonesia), Anas Ma'ruf(Indonesia, Indonesia)	1434
TB4-5 (309)	Shift-Scheduling Characteristic Identification of Non-Star Hotel Industry in Yogyakarta Indonesia *Deny Yuniartha(Universitas Atma Jaya Yogyakarta, Indonesia), Ignatius Luddy Indra Purnama(Atma Jaya Yogyakarta University, Indonesia)	1442

TB5 Knowledge & Information Management

Ramada-1, 14:20-16:00

Chair: Minseok Song (Ulsan National Institute of Science and Technology, Korea)

TB5-1 (250) Mergers and Acquisitions of ICT Firms for Technological Knowledge Sourcing 1449
*Yoonjung An, *Yongtae Park(Seoul National University, Korea)*

TB5-2 (278) Analyzing Service Processes Using Process Mining: A Case Study 1454
*Hanna Yang, *Minseok Song(Ulsan National Institute of Science and Technology, Korea)*

TB5-3 (445) Document Control for Research Reactor Construction by Advanced Nuclear Safety Information Management System 1458
**Kook-Nam Park(Korea Atomic Energy Research Institute, Korea), Sung-Kyu Lee(Divi-vision Co., Korea), Seung-Mi Baek(Korea Atomic Energy Research Instituti, Korea), Min-Ho Choi(Korea Atomic Energy Research Institute, Korea), Yong-Se Kwon(Korea Atomic Energy Research institute, Korea)*

TB5-4 (297) Factors influencing user acceptance of intelligent personal assistants on smart devices 1463
*Jihye Park(LG Household & Health Care, Korea), Euiho Suh(Pohang University of Science and Technology, Korea), *Kiwon Lee(Pohang University of Science and Technology (POSTECH), Korea)*

TB5-5 (389) Prognosis and Survival Prediction of Lung Cancer by Bayesian Network 1471
**Shi-Woei Lin, Yu-Wei Chen, Mohammad Jerusalem(National Taiwan University of Science and Technology, Taiwan)*

TB6 Production & Operations Management 2

Ramada-2, 14:20-16:00

Chair: Ivy Mar Lamos (Bulacan State University, Philippines)

TB6-1 (49) Application of ECRS and Simulation Techniques in Bottleneck Identification and Improvement:A Paper Package Factory 1477
**Chompoonoot Kasemset, Prin Pinmanee, Primapun Umarin(Chiang Mai University, Thailand)*

TB6-2 (124) Assembly line type II problem of sewing lines in garment industry 1485
*James C. Chen(National Tsing Hua University, Taiwan), Tzu-Li Chen(Fu Jen Catholic University, Taiwan), Yi-Jhen Lin, *Chun-Ju Lin, Yi-Hsin Hu(National Tsing Hua University, Taiwan)*

TB6-3 (151) EFFICIENCY AND BETTER PRODUCTION FLOW FOR A MANUFACTURER OF STATUES: AN APPLICATION OF MOTION AND TIME STUDY 1492
**Ivy Mar Ramos, Ivy Mar Ramos(Bulacan State University, Philippines)*

TB6-4 (187) A Genetic Algorithm for Solving Assembly Line Balancing Problem in Footwear Stitching Line 1500
*James C. Chen, Tzu-Li Chen, *Chieh-Ying Lin, Chun-Ju Lin(National Tsing Hua University, Taiwan)*

TB6-5 (12) Pricing, Production, and Channel Coordination with Stochastic Learning 1507
*Tao Li(Santa Clara University, United States), *Suresh Sethi(University of Texas At Dallas, United States), Xiuli He(University of North Carolina at Charlotte, United States)*

TB7 Healthcare Systems 2

Ramada-3, 14:20-16:00

Chair: Gino Lim (University of Houston, UnitedStates)

TB7-1 (95) Construct the Analysis Platform for Evaluating the Static Postural Stability 1512
**Chih-Hung Jen(Lunghwa University of Science and Technology, Taiwan), Bernard C. Jiang(National Taiwan University of Science and Technology, Taiwan), Yin-Sung Chen(Yuan Ze University, Taiwan)*

TB7-2 (106) Recent Advances in Intensity Modulated Proton Therapy Treatment Planning Optimization 1520
**Gino Lim, Wenhua Cao(University of Houston, United States), Radhe Mohan(The University of Texas MD Anderson Cancer Center, United States)*

TB7-3 (306) Developing A Productivity Improving Framework by Overall Equipment Efficiency and An Empirical Study in A Hospital 1526
**Chen-Fu Chien, Pei-Chun Chu, Mei-Li Kuo(National Tsing Hua University, Taiwan)*

TB7-4 (379) An analysis of patients flow in a hospital case study using Simulation model and plant layout 1534

*Patcharaphorn Poobanchao(KhonKaen University, Thailand), *Panitarn Peerapattana(Department of Industrial Engineering Faculty of Engineering of Khon Kean University, Thailand)*

TB7-5 (76)	Willingness to pay for BPJS Health Insurance: Findings from an Exploratory Study **Aries Susanty(Lecturer, Indonesia), nia puspitasari(diponegoro university, Indonesia), Purnawan Wicaksono(Lecturer, India), Petty Primatury(Student, Indonesia)*	1540

TB8 Flexible Manufacturing Systems

Ramada-4, 14:20-16:00

Chair: Ibrahim Buseif (, Libya)

TB8-1 (579)	The Comparison between Perpetual and Periodic-Review Models for Fast-Moving Products in Convenience Store Distribution Center **Yosi Hidayat, Veronica Adelein, Lucia Diawati(Institut Teknologi Bandung, Indonesia)*	1547
TB8-2 (48)	Using Petri Net (PN) Model for Design Flexible Manufacturing Systems (Prototype FMS's) **Ibrahim Buseif(Staff member, Libya)*	1554
TB8-3 (62)	New Model of FMS using FTPN with Demand Variability and Machine Breakdown **Muhammad Haris Aziz(University of Engineering and Technology, Pakistan), Erik L.J. Bohez(Asian Institute of Technology, Thailand), Abid Ali, Neelum Iqbal(UET Taxila, Pakistan)*	1561
TB8-4 (286)	Cellular Manufacturing System Model under Demand Uncertainty **Muhammad Shodiq Abdul Khannan(Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia), Anas Ma'ruf(Indonesia, Indonesia), Rachmawati Wangsaputra(Institut Teknologi Bandung, Indonesia), sutrisno sutrisno(UPN Veteran Yogyakarta Indonesia, Indonesia)*	1567
TB8-5 (457)	An iterative production planning approach for flexible semiconductor fabrication **Sun Hoon Kim, Young Hoon Lee, Cheng Yu Hwang, Kee Yong Shin, Ki Yol Nam(Yonsei University, Korea)*	1575

TB9 Topics in IE/MS

Halla(8F), 14:20-16:00

Chair: Taufiq Immawan (Islamic University of Indonesia, Indonesia)

TB9-1 (575)	A study on relieving electric power shortage by on-site solar power supply *SangYun Choe, *Jinwoo Park(Seoul National Univ., Korea)*	1579
TB9-2 (354)	Preliminary Study for Mapping of Business Process Re-engineering of Batik in Jogja and Solo **Taufiq Immawan(Islamic University of Indonesia, Indonesia)*	1584
TB9-3 (378)	Evaluation Method of Information Value Applying for Website **GaoYang Liang(Graduate School of Business Administration Daito Bunka University, Japan), Kiyoshi Nagata(Informatics Faculty of Business Administration and Department of Business Studies Daito Bunka University, Japan)*	1590
TB9-4 (212)	Lean Production in Automotive Parts Industry-A Case Study *James C. Chen(National Tsing Hua University, Taiwan), Tzu-Li Chen(Fu Jen Catholic University, Taiwan), Kirin Chen, Amy Hung(AXIS-group, Taiwan), *Yu Liang, Chun-Ju Lin(National Tsing Hua University, Taiwan)*	1598
TB9-5 (202)	Optimum Humanitarian Relief Logistics for Facility and Stock Location under Time Restriction: Thai Flooding Case Study **WAPEE MANOPINIWES, KEISUKE NAGASAWA, TAKASHI IROHARA(Sophia University, Japan)*	1604

TC1 Heuristics/Metaheuristics

Mara, 16:20-18:00

Chair: Ma. Cecilia Buseif (Mapua Institute of Technology, Philippines)

TC1-1 (70)	GA-BASED OPTIMAL FACILITY LAYOUT DESIGN: CROSSOVER AND MUTATION PROBABILITY EVALUATIONS *Maricar Misola(Technological Institute of the Philippines- Quezon City, Philippines), *Ma. Cecilia Carlos(Mapua Institute of Technology, Philippines), Bryan Navarro(Philippine Institute of Industrial Engineers (PIIE), Philippines)*	1612

TC1-2 (464)	An Improved Differential Evolution Algorithm for Vehicle Routing Problem: An Application in Mobile Medical Equipment Maintenance Unit *Kanokwan Supakdee(Department of Industrial Management Technology, Thailand), Natthapong Nanthasamroeng(Faculty of Industrial Technology, Thailand), Rapeepan Pitakaso(Metaheuristics for Logistics Optimization Laboratory (MLO), Thailand)	1620
TC1-3 (481)	Heuristic for multi-stage capacitated p-median problem with supplier evaluation *Anurak Chaiwichian, Rapeepan Pitakaso(Ubonratchathani University, Thailand)	1626
TC1-4 (520)	Heuristic Shift Scheduling forAirport Ground Staff *Kong Weng Lee(UNIMAS, Malaysia), San Nah Sze(Faculty of Computer Science and Information Technology Universiti Malaysia Sarawak, Malaysia), Keat Keong Phang(Faculty of Computer Science and Information Technology Universiti Malaya, Malaysia)	1633
TC1-5 (192)	Optimization of Milk Productivity in Dairy Cattles by Genetic Algorithm *Senol Altan(Gazi University, Turkey), Fatih Akturk(Ulsan National Insttute Of Science and Technology, Korea), Emrecan Ozeler(Republic of Turkey Ministry of Food, Turkey)	1639

TC2 Inventory Modeling / Artificial Intelligence

Biyang, 16:20-18:00

Chair: Wisut Supithak (Kasetsart University, Thailand)

TC2-1 (381)	Multi-Item Economic Production Quantity Model with the Consideration of Raw Material Inventory Management Costs *Wisut Supithak(Kasetsart University, Thailand), Sasiprapa Limpakan(Kasetsart Uniersity, Thailand)	1647
TC2-2 (123)	A Stochastic Programming Model for Vendor Managed Inventory System of an Animal Feed Factory and Farm Network *Thawee Nakrachata-Amon(Faculty of Engineering, Thailand), Supachai Pathumakul(Khon Kaen University, Thailand)	1654
TC2-3 (101)	Vender Managed Inventory for Fresh Agricultural Products *Mitsuyoshi Horikawa, Takeo Takeno, Mitsumasa Sugawara(Iwate Prefectural University, Japan)	1659
TC2-4 (318)	Vehicle risk assessment in accidents using neural network Yuri Castro, *Young Jin Kim, Baek An Sun(Kyung Hee University, Korea)	1665

TC3 Artificial Intelligence

Udo, 16:20-18:00

Chair: Ronaldo Polancos (De La Salle University, Philippines)

TC3-1 (182)	The Study of Tokai Cluster as a Leader of CFRP Industries in Japan *Akihito Zenke, Nobutaka Odake(Nagoya Institute of Technology, Japan)	1672
TC3-2 (260)	Agent-based Real-time Scheduling for Smart Household Appliances Bobby Kurniawan, *Anggoro Pramudyo, Didik Aribowo(Untirta, Indonesia), Anas Ma'ruf(Institut Teknologi Bandung, Indonesia)	1678
TC3-3 (391)	APPLICATION OF CLOUD-BASED KANBAN SYSTEM IN PROJECT MANEGEMENT Chi-Wei Shih, *Chen-Yang Cheng(Tunghai University, Taiwan)	1683
TC3-4 (490)	User's Free Time Estimation When Using Smartphone *kohei Yamamoto(Kanazawa Graduate School of Natural Science and Technology, Japan), Tatsuhito Hasegawa(Tokyo Health Care University, Japan), Haruhiko Kimura(Kanazawa University, Japan)	1688
TC3-5 (499)	Earned Value Management considering Milestone Weighting and Dependency Structure Matrix *Ronaldo Polancos(De La Salle University, Philippines)	1692

TC4 Scheduling & Sequencing 2

Chuja, 16:20-18:00

Chair: Hans-Otto Guenther (Seoul National University, Korea)

TC4-1 (399)	Improvement of Scheduling n Jobs m Machines Parallel Algorithm to Minimize Makespan *Rifa Arifati(University of Pembangunan Nasional Veteran Jakarta, Indonesia), Aji P.	1696

Gunoto(Universitas Pembangunan Nasional Veteran Jakarta, Indonesia)

TC4-2 (405)	A Batch-scheduling problem to minimize actual flowtime of parts through the shop which has m heterogenous batch processors *Nita Hidayat(Industrial Engineering ITB, Indonesia), Andi Cakravastia, TMA Ari Samadhi(Bandung Institute of Technology, Indonesia), *Abdul Halim(Industrial Engineering ITB, Indonesia)*	1701
TC4-3 (418)	Genetics Algorithm for Hybrid and Flexible Flowshop with Non-Identical Machines and Subcontract Case **Nora Azmi(Trisakti University, Indonesia), Gibtha Fitri Laksmi(Ibnu Khaldun University, Indonesia)*	1707
TC4-4 (398)	Mixed Integer Linear Programming for Un-related Parallel Machine Problems to Minimize Total Earliness and Tardiness - A Case Study of Precision Metal Tools Industry *Chun Hsiung Lai, *Chen-Yang Cheng(Tunghai University, Taiwan)*	1714
TC4-5 (79)	A block planning model for integrated lot sizing and scheduling of continuous casters and hot strip mills in the steel industry **Hans-Otto Guenther(Seoul National University, Korea), Imke Mattik(TU Berlin, Germany)*	1719

TC9 Lean Production Management

Halla(8F), 16:20-18:00

Chair: Kenichi Nakashima (Kanagawa university, Japan)

TC9-1 (542)	Single-period inventory model considering a competitive store and two qualities of the product **Takashi Hasuike(Osaka University, Japan)*	1720
TC9-2 (546)	A Single-Producer Multi-Retailer Integrated Inventory System with Scrap in Production and Shortage in sale **Hitoshi Hohjo, Tomoki Koreeda(Osaka Prefecture University, Japan)*	1728
TC9-3 (94)	Joint replenishment problem with can-order policies under carrier capacity and correlated demands **KEISUKE NAGASAWA, Takashi Irohara(Sophia University, Japan), Yosuke Matoba, Shuling Liu(Fairway Solutions Inc., Japan)*	1733
TC9-4 (545)	Inventory-Production System with Non-Zero Target Inventory **Mohammadreza Parsanejad(Keio University, Japan), Bongsung Chu(Soonchunhyang University, Japan), Hiroaki Matsukawa(Keio University, Japan)*	1741
TC9-5 (547)	A Lean Supply Chain Control Problem with Stochastic Demand **Kenichi Nakashima, Thitima Sornmanapong(Kanagawa University, Japan), Hans Ehm(Infineon Technologies AG, Japan), Geraldine Yachi(nfineon Technologies AG, Japan)*	1746

WA1 Inventory Modeling & Management

Mara, 08:30-10:10

Chair: Nobuaki Ishii (Bunkyo University, Japan)

WA1-1 (65)	A Lot Size-Based Collaborative Demand-to-Supply Management System for Make-to-Order Environment **Nobuaki Ishii(Bunkyo University, Japan), Ko Sakashita, Tetsuo Yamada(University of Electro-Communications, Japan), Masaaki Ohba(Nihon University, Japan), Masayuki Matsui(Kanagawa University, Japan)*	1754
WA1-2 (80)	Reorder Point Determination Considering Customer Service Constraint under Limited Demand Information **Yasuhiko Takemoto(Prefectural University of Hiroshima, Japan), Ikuo Arizono(Okayama University, Japan)*	1762
WA1-3 (71)	Inventory Classification Involving Substitution Rules **ikou kaku, Xinyi Zhang(Tokyo City University, Japan)*	1769
WA1-4 (446)	Reducing Inventory using Inventory Management Models **Sakgasem Ramingwong, Danuchin Anantana(Center of Excellence in Logistics and Supply Chain Management, Thailand)*	1775
WA1-5 (518)	An Approach for Avoiding Information Loss in Managing Product Safety Issue Associated with Suppliers *Muhammad Saad Memon, **Young Hae Lee, Sonia Irshad Mari(Hanyang University, Korea)*	1779

WA2 SCM and Forecasting 1

Biyang, 08:30-10:10

Chair: Kazuhiro Takeyasu (Tokoha University, Japan)

WA2-1 (92)	Forecasting utilizing a Day of the Week Index in the Case of Cafe *Koumei Suzuki, Kazuhiro Takeyasu(Tokoha University, Japan)	1787
WA2-2 (31)	Building BTO System in the Sanitary Materials Manufacturer Under the Improvement of Forecasting Accuracy *Kazuhiro Takeyasu(Tokoha University, Japan), hirotake yamashita(Chubu University, Japan)	1795
WA2-3 (34)	UTILIZATION OF GENETIC ALGORITHM TO IMPROVE FORECASTING ACCURACY ? AN APPLICATION TO THE DATA OF A TUBE AND A CATHETER? *Daisuke Takeyasu(The Open University of Japan, Japan), Kazuhiro Takeyasu(Tokoha University, Japan)	1803
WA2-4 (32)	Optimal operation for green supply chain with quality of recyclable parts and contract for recycling activity *Etsuko Kusukawa(Osaka Prefecture University, Japan), Sho Akizawa(Nara Institute of Science and Technology, Japan)	1811
WA2-5 (102)	A Hybrid Method to Improve Forecasting Accuracy In the Case of Japanese Food Restaurant *Jun Tatebayashi, Kazuhiro Takeyasu(Tokoha University, Japan)	1819

WA3 Production Design & Management 1

Udo, 08:30-10:10

Chair: Philip Ermita (PIIE, Philippines)

WA3-1 (117)	Development a Latex Pillow to Meet Customer Requirements *Nattapong KONGPRASERT(Facluty of Engineering, Thailand)	1827
WA3-2 (162)	BananaNut Paper: REENGINEERING PAPER COMPONENT *Marianne Calayag(Bulacan State University, Philippines)	1834
WA3-3 (198)	An Optimal Modularity for Platform-based Product Family Design of Wind Power Generators *Qingnan Li(University of Southern Denmark, Denmark)	1838
WA3-4 (222)	Composite Board Development: Use of Cardava Banana Peel and Watermelon Rind as Alternative Raw Materials *Philip Ermita(PIIE, Philippines)	1845
WA3-5 (249)	Fairing of High Speed Milling tool-path by Using The Cubic NURBS *Anh Duong, Anh Duong(International University in Vietnam, Viet Nam)	1852

WA4 Scheduling & Sequencing 3

Chuja, 08:30-10:10

Chair: San-Nah Sze (Universiti Malaysia Sarawak, Malaysia)

WA4-1 (85)	Scheduling with multi-attribute setup times on unrelated parallel machines Ching-Jong Liao(National Taiwan University of Science and Technology, Taiwan), *Cheng-Hsiung Lee(Chihlee Institute of Technology, Taiwan), Hsing-Tzu Tsai, Kuo-Jui Wu(National Taiwan University of Science and Technology, Taiwan)	1859
WA4-2 (120)	Scheduling on parallel machines with mold constraints Haidan Zhao, *Tsui-Ping Chung, Hongying Shan(Jilin University, China), Chien-Ming Chen(Harbin Institute of Technology Shenzhen Graduate School, China)	1867
WA4-3 (177)	Transient Period Scheduling of Dual Armed Cluster Tools *Nurhak Aktas, Taesun Yu, Tae-Eog Lee(KAIST, Korea)	1874
WA4-4 (316)	Adaptive Hybrid Genetic algorithm for solving two-stage reentrant flexible flow shop with blocking constraint Chatnugrob Sangsawang, *Kanchana Sethanan(Research Unit on Advanced Productivity	1880

Improvement and Logistics Management, Thailand), Mitsuo Gen(Fuzzy Logic Systems Institute, Japan)

WA4-5 (509)	Decision Support System for Order Online Delivery **San-Nah Sze, Bui-Fat Thian, Kang-Leng Chiew(Universiti Malaysia Sarawak, Malaysia)*	1888

WA5 Fuzzy Logic

Ramada-3, 08:30-10:10

Chair: Rionel Caldo (Lyceum of the Philippines University - Laguna, Philippines)

WA5-1 (30)	Predictive Approach of Assessing the Passing of Engineering Board Courses in Lyceum of the Philippines University-Laguna (LPU-L) Using Fuzzy Logic Technology **Rionel Caldo(Lyceum of the Philippines University - Laguna, Philippines)*	1894
WA5-2 (58)	Fuzzy Logic Simulation of DC-DC Boost Converter Using Matlab Fuzzy Logic Toolbox *Rionel Caldo, *Rionel Caldo(Lyceum of the Philippines University - Laguna, Philippines)*	1902
WA5-3 (224)	Cost Effectiveness Analysis Comparing Mastectomy versus Lumpectomy with Fuzzy Logic *Aysun Aktas, *gozde tutuncu(Izmir University of Echonomics, Turkey)*	1908
WA5-4 (576)	Fuzzy AHP based Supplier Selection considering the Triple Bottom Line Concept *Wannimit Khampanya, Tritos Laosirihongthong(Thammasat University, Thailand), *Premaratne Samaranayake(University of Western Sydney, Australia)*	1914

WA6 Optimization Techniques 2

Ramada-4, 08:30-10:10

Chair: Daniel Siek (Chung Yuan Christian University, Taiwan)

WA6-1 (125)	Impact of Globalization on Total Factor Productivity of the Manufacturing Sector in Pakistan **Usama Bin Perwez, Muhammad Faseeh Tahir, Aamir Ahmed Baqai(National University of Sciences & Technology, Pakistan)*	1920
WA6-2 (69)	Optimal Solar Photovoltaic (PV) Penetration in Secondary Distribution Network Using Genetic Algorithm *Bryan Navarro(Technological Institute of the Philippines, Philippines), *Maricar Misola(Technological Institute of the Philippines- Quezon City, Philippines)*	1929
WA6-3 (288)	Numerical Analysis of Three Rookies Assignment Optimization in Limited-Cycled Model with Multiple Periods -the case of Erlang Distribution **Peiya Song, Xianda Kong, Hisashi Yamamoto(Tokyo Metropolitan University, Japan), Jing Sun(Nagoya Institute of Technology, Japan), Masayuki Matsui(Kanagawa University, Japan)*	1937
WA6-4 (577)	Optimal Ordering Policies under a Progressive Interest Scheme with Supplier's Quantity Discount *Gary Chen, *Daniel Siek, Hui Wee(Chung Yuan Christian University, Taiwan)*	1945
WA6-5 (415)	An analysis on the influences of flat pricing for unlimited voice callings: the aspects of MNOs and consumers in Korea **SEONGJUN LEE, SAESOL CHOI(Electronics and Telecommunications Research Institute, Korea)*	1951

WB1 Industrial Engineering Education

Mara, 10:30-12:10

Chair: Young Jae Jang (KAIST, Korea)

WB1-1 (526)	Solution Based Learning: A New Approach in Product Design and Development Andragogy **Risdiyono Risdiyono(Islamic University of Indonesia, Indonesia)*	1957
WB1-2 (139)	A study for making standardized-work tables suited for enterprises of the engineering / metalworking industry **Masahiro Shibuya(Tokyo Metropolitan University, Japan), Kenichi Iida(Hokkaido Research Organization, Japan), Koki Mikami(Hokkaido University of Science, Japan)*	1962
WB1-3 (256)	"Implementation of methods and solutions for improving statistical thinking of non-English speaking students studying in Industrial Engineering field" **Huy Nguyen, Huy Nguyen, Huy Nguyen(International University - Vietnam National University*	1967

HCMC, Viet Nam)

WB1-4 (495)	Industrial Engineering Education using KAIST LEGO Manufacturing Systems (KLMS) **Young Jang, Vina Yosephine(KAIST, Korea), Sun Kyung Oh(Korea Advanced Institute of Science and Technology, Korea), Sukhyun Cho, Kiryong Kyeong(KAIST, Korea)*	1975

WB2 SCM and Forecasting 2

Biyang, 10:30-12:10

Chair: Kazuhiro Takeyasu (Tokoha University, Japan)

WB2-1 (52)	Improving Forecasting Accuracy in the Case of Intermittent Demand Forecasting *Daisuke Takeyasu(The Open University of Japan, Japan), *Asami Shitara(Tax Corporation Arknet, Japan), Kazuhiro Takeyasu(Shizuoka City, Japan), Asami Shitara(Tax Corporation Arknet, Japan)*	1983
WB2-2 (36)	Reformation of Production System Based Upon Demand Forecasting *hirotake yamashita(Chubu University, Japan), *Kazuhiro Takeyasu(Tokoha University, Japan)*	1991
WB2-3 (87)	A Hybrid Method to Improve Forecasting Accuracy with An Application to the Data of Bread **Yuki Higuchi(Setsunan University, Japan), Hiromasa Takeyasu(Kagawa???Junior???College, Japan), Kazuhiro Takeyasu(Tokoha University, Japan)*	1999
WB2-4 (413)	EXTENDED OPTIMAL REPLACEMENT POLICY FOR A TWO-UNIT SYSTEM UNDER CUMULATIVE DAMAGE MODEL **Shey-Huei Sheu, TZU-HSIN LIU(Providence University, Taiwan), ZHE-GEORGE ZHANG(Western Washington University, United States)*	2006

WB3 Production Design & Management 2

Udo, 10:30-12:10

Chair: Masahiro Arakawa (Nagoya Institute of Technology, Japan)

WB3-1 (283)	The Implementation of Affective Based Product Design in Small Enterprise Manufacturers **Imam Widodo, Tio Sampurno(Islamic University of Indonesia, Indonesia)*	2007
WB3-2 (348)	A Study of Product Design Using Parts and Parts Structures Characterized by Reviews on Internet **Masahiro Arakawa, Eriko Katou(Nagoya Institute of Technology, Japan)*	2012
WB3-3 (350)	Derivation of design freeze sequence using Bayesian network framework *Jihwan Lee, *Yoo Hong(Seoul National University, Korea)*	2018
WB3-4 (93)	Investigation of PLA/PCL biocomposite scaffolds fabricated via SVM rapid prototyping *Kanokporn Kamonchit, *Thittikorn Phattanaphibul(Kasetsart University (Sriracha Campus), Thailand)*	2025
WB3-5 (84)	Assessment of an ERP Graphical User Interface Design Related to Human Cognition **Grace Lorrain Intal, Catherine Briones(Mapua Institute of Technology, Philippines)*	2031

WB4 Scheduling & Sequencing 4

Chuja, 10:30-12:10

Chair: Katsumi Morikawa (Hiroshima University, Japan)

WB4-1 (329)	Simulation-based outpatient appointment scheduling with the aid of clearing function **Katsumi Morikawa, Katsuhiko Takahashi(Hiroshima University, Japan), Daisuke Hirotani(Prefectural University of Hiroshima, Japan)*	2040
WB4-2 (46)	Flexible Jobshob Scheduling Model Considering Production Cost and Tardiness Cost Simultaneously **Devy Sari, Anas Ma'ruf(Institut Teknologi Bandung (Bandung Institute of Technology), Indonesia)*	2048
WB4-3 (403)	Batch Scheduling for a Single Machine with Forgetting Effect to Minimize Total Actual Flow Time *Rinto Yusriski, *Sukoyo -(Bandung Institute of Technology, Indonesia), T.M.Agung Samadhi(Institut Teknologi Bandung, Indonesia), Abdul Halim(Industrial Engineering ITB, Indonesia)*	2055
WB4-4 (426)	Integrating Batch Production and Maintenance Scheduling on a Deteriorating Machine to Minimize Production and Maintenance Costs in Just in Time Environment	2061

*ZAHEDI *(INSTITUT TEKNOLOGI BANDUNG, Indonesia), TMA Ari Samadhi, Suprayogi .(Bandung Institute of Technology, Indonesia), *Abdul Halim(Industrial Engineering ITB, Indonesia)*

WB4-5 (454)	Creation of Total Shift Scheduling Model in Restaurant Service -An Example of the Highly Classical Luxury Hotel Restaurant - **Kazuki Fujita, Kakuro Amasaka(Aoyama Gakuin University, Japan)*	2070

WB5 Quality Engineering & Reliability

Ramada-3, 10:30-12:10

Chair: Rionel Caldo (Lyceum of the Philippines University - Laguna, , Philippines)

WB5-1 (453)	Establishment of a New Vietnam Production Model **Shogo Miyashita, Kakuro Amasaka(Aoyama gakuin University, Japan)*	2077
WB5-2 (508)	A taxonomy of failure rate indexes based on literature review *sanghyeon koh(Pohang University of Science and Technology, Korea), kiwook jung, Bongjun Ji(Pohang university of science and technology, Korea), *Hyunbo Cho(POSTECH, Korea)*	2083
WB5-3 (270)	Comparative Study of SA algorithms of optimal arrangement problem in a Multi-state k-out-of-n:F system **Naoki Yoshida(Tokyo Metropolitan University, Japan), Koji Shingyochi(Jumonji University, Japan), Hisashi Yamamoto(Tokyo Metropolitan University, Japan), Tomoaki Akiba(Chiba Institute of Technology, Japan), Xiao Xiao(Tokyo Metropolitan University, Japan)*	2090
WB5-4 (517)	A New Universal Generating Function Method to Search for all Minimal Paths Generate in Networks *Wei-Chang Yeh(National Tsing Hua University, Taiwan), *Hui-Wen Lee(National Tsing Hua University Hsinchu, Taiwan)*	2098
WB5-5 (421)	Prioritizing the Factors for Quality Excellence Practices Using Analytic Hierarchy Process (AHP) Method **Mehran Doulat Abadi(Universiti Teknologi Malaysia (UTM), Malaysia), Sha'ri Mohd. Yusof(Universiti Teknologi Malaysia, Malaysia)*	2106

WB6 Lean Manufacturing

Ramada-4, 10:30-12:10

Chair: Daniel Siek (Chung Yuan Christian University , Taiwan)

WB6-1 (129)	LINEASSEMBLY ANALYSIS FOR PC-250 PRODUCT TYPE WITH HEURISTIC METHOD AT PT. TIRTA INTIMIZU NUSANTARA **Lina Gozali(Tarumanagara University, Indonesia), Silvi Ariyanti(University of Mercu Buana, Indonesia), Rendy .(University of Tarumanagara, Indonesia)*	2107
WB6-2 (371)	Waste Reduction in Work Processes Using Lean Tools and Simulation: A Case Study Logistics Service Providers *Worakit Changjutturas(Department of Industrial Engineering Faculty of Engineering of Khon Kaen University, Thailand), *Panitarn Peerapattana(Department of Industrial Engineering Faculty of Engineering of Khon Kean University, Thailand)*	2113
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WB6-4 (110)	A Study on the E-Waste Generation and Management in the Philippines: It's Impact and Significance **Nestor Ong(University of Santo Tomas, Philippines), Patricia Kamil Kinol, Angela Camille San Miguel, Charlene Mae Ramirez(Faculty of Engineering, University of Santo Tomas, Philippines)*	2126
WB6-5 (516)	A model for Designing Resilient and Sustainable Supply Chain under Disruptions *Sonia Irshad Mari, *Young Hae Lee, Muhammad Saad Memon(Hanyang University, Korea)*	2134

POSTER Poster Session

Halla(8F), 13:00-18:00

Chair: (,)

POSTER-1 (47)	Measuring organizational performance by integrating competitive intelligence into decision support system	2142

*Chi-Yen Yin(National Taiwan University, Taiwan)

POSTER-2 (149)	Expediting Rate of Production of Flip Flops through Methods Engineering *Dyan Gonzales(Philippine Institute of Industrial Engineers, Philippines)	2148
POSTER-3 (166)	A Framework for Intelligent Condition Monitoring System using Knowledge Discovery in Databases Sedo Oh, *Young-jin Kim(Kyung Hee University, Korea)	2156
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POSTER-6 (245)	An intelligent parking guidance methodology *Jong-Ho Shin(UNIST, Korea), Hong-Bae Jun, Sang-Je Cho(Hongik University, Korea)	2169
POSTER-7 (253)	Effect of number of operations of touch panel on whole body working posture and physical workload *Makoto Kadomatsu, Akihiko Seo(Tokyo Metropolitan University, Japan)	2175
POSTER-8 (265)	Development of Factory Layout Design Method by Distribution Time-space Mesh Analysis *Munenori Kakehi(Tokyo University of Science, Japan), Ichie Watanabe(Seikei University, Japan), Masahiro Nakamura(LEXER RESEARCH Inc., Japan)	2179
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A Particle Swarm Optimization Algorithm for Solving Economic Lot Scheduling Problems

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Abstract. The Economic Lot Scheduling Problem (ELSP) is the problem for determining the production schedule of many products to single production facility where the setup times, production and demand rates of each product are different. Due to its practical importance in the field of production and inventory management, this problem has been attracted many researchers and lead to many problem variants. Some exact and heuristics approaches had been proposed in the past for solving the ELSP and its variants, however, each approach is usually intended to solve a particular ELSP variant. This paper tries to develop a new and unified solution methodology for solving the ELSP and its variants using the particle swarm optimization, especially by proposing the solution representation and its decoding method. The computational results show that the proposed algorithm is able to find good solution of ELSP.

Keywords: Economic Lot Scheduling Problem, Production and Inventory Management, Particle Swarm Optimization, Computational Method, Metaheuristics

1. INTRODUCTION

The Economic Lot Scheduling Problem (ELSP) is the problem to determine the production schedule of several products to single production facility, where the setup times, production and demand rates of each product are different, to minimize the total cost per unit time. This problem is commonly appear in various type industries including plastic injection molding, automobiles, electronics, paints, textile, and pharmaceutical (Boctor, 1987; Gallego and Joneja, 1994). Due to its practical importance in the field of production and inventory management, this problem has been attracted many researchers and lead to many problem variants. Elmaghraby (1978), Lopez and Kingsman (1991), Silver et al. (1998), and Winands et al. (2011) have provided an excellent review of ELSP.

The basic or traditional version of ELSP can be formulated as follow. A single production facility produces m item of products, in which only one product can be produced at a time on the production facility. Each product i has a deterministic and constant demand rate (d_i) and production rate (p_i). The setup cost (A_i) and the setup times (s_i) of each product are independent of the production sequence. The production facility is assumed to be capable of satisfying demand predicted during the planning horizon. The decision variables of this problem are the production cycle of each product (T_i), in order to minimize the total production cost. The total production cost consists of setup cost and inventory holding cost (h_i) that can be formulated as follow

$$Z = \sum_i \frac{A_i}{T_i} + \frac{1}{2}\sum_i h_i d_i \left(1 - \frac{d_i}{p_i}\right) T_i \qquad (1)$$

Even for the basic version of ELSP, there are three different main scheduling policies for ELSP, namely, common cycle approach, basic period approach, and time-varying lot sizes approach. The common cycle approach applies the same cycle time for all products, i.e. $T_i = T$ for

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all i (Khoury et al., 2001; Torabi et al., 2005; Moon et al., 2002a; Moon et al., 200b; Chatfield, 2007). In the basic period approach, the cycle time may different for different products, however, each cycle time must be an integer multiplication of the basic period (W), i.e. $T_i = n_i W$ where n_i is the integer multiplier for item i. A popular version of this approach is called power of two approach, in which the integer multiplier is selected to be the power of two (2^k) only instead of all integer number (Moon et al., 2002a; Moon et al., 2002b; Raza et al., 2006; Raza and Akgunduz, 2008). In the time-varying lot sizes approach, different lot sizes are possible for any given products in a cycle schedule (Dobson, 1987; Moon et al., 2002a; Moon et al., 2002b; Raza et al., 2006; Raza and Akgunduz, 2008).

While some basic versions of ELSP works with a lot of simplifying assumptions, ELSP research is also well developed in the complication versions with sophisticated mathematical model due to considering several real world situation, such as sequence dependent setup (Oh and Karimi, 2001; Wagner and Davis, 2002; Brander and Forsberg, 2005), stochastic demand (Winands et al., 2011), imperfect production facility (Kim et al., 1997; Khouja, 2000; Ma et al., 2010), and multi-stage production facility (Sun et al., 2009; Haksoz and Pinedo, 2011; Chan et al., 2012). Since these problem variants are more complex than the basic versions, the solution of these problem are difficult to obtain analytically. Therefore, various approximations, heuristics and metaheuristics approaches are being popular for solving these ELSP variants.

Some researchers have been trying to use particle swarm optimization (PSO) as one of the most widely applied metaheuristics for solving the ELSP. It is clearly seen from those examples that there are two disadvantages of those PSO application for ELSP: too complicated and problem dependent.

This paper is trying to develop a simple PSO algorithm for solving ELSP. Even it starts with the PSO for basic ELSP, by focus on the common cycle approach and basic period approach, the algorithm is expected to be a foundation for more complex ELSP variants, i.e. there is no substantial and significant adjustment whenever more complex ELSP variants are being solved with the proposed PSO for basic ELSP.

The remainder of this paper is organized as follows: Second section is review some basic PSO. After that the PSO algorithm for common cycle approach and basic period approach are proposed in section 3 and 4, respectively. The following section presents a computational test of the proposed algorithms. Finally, some the conclusion of this study is presented with some suggestions for further research in this research area.

2. PARTICLE SWARM OPTIMIZATION

In 1995, Kennedy and Eberhart proposed the Particle Swarm Optimization (PSO) after got some inspiration from the behavior of swarm organism such as bee swarm, fish school, and bird flock. The PSO is then proposed as a population-based stochastic optimization technique, by mimics the physical movement of individuals in the swarm to conduct the search mechanism of problem solution. For representing individuals in the swarm, an object called particle is defined along with its two important properties of particle namely position and velocity.

A particle position, which is usually placed in multi-dimensional space, represents an alternative of problem solution. Velocity of particle is the driver of particle movement from one position to another. In the PSO, particle movement represents evaluation process of alternatives of problem solution. In other words, the particle velocity expresses the searching capability of the problem solution.

There are two important behaviors of the swarm organism that are formulated in the PSO, namely the cognitive behavior and the social behavior. The cognitive behavior is defined as the tendency of particle moving towards the best position ever visited by the particle, which is usually called personal best or pbest. While the social behavior is defined as the tendency of particle moving towards the best position ever visited by all particles in the swarm, which is usually called personal best or pbest. The movement of particles can be stated as following equations:

$$\omega_{lh}(\tau+1) = w(\tau+1)\omega_{lh}(\tau) + c_p\, u(\psi_{lh}-\theta_{lh}(\tau)) + c_g\, u(\psi_{gh}-\theta_{lh}(\tau)) \quad (2)$$

$$\theta_{lh}(\tau+1) = \theta_{lh}(\tau) + \omega_{lh}(\tau+1) \quad (3)$$

where τ is iteration index, l is particle index, h is dimension index, u is uniform random number in interval [0,1], $w(\tau)$ is inertia weight in the τth iteration, $\omega(\tau)$ is velocity of lth particle at the hth dimension in the τth iteration, $\theta(\tau)$ is position of lth particle at the hth dimension in the τth iteration, ψ_{lh} is personal best position (pbest) of lth particle at the hth dimension, ψ_{gh} is global best position (gbest) of lth particle at the hth dimension, c_p is personal best acceleration constant, and c_g is global best acceleration constant.

In general, the algorithm of PSO can be formally defined as follow:

1. initialization of particles, their position and initial velocity,
2. decode particles into problem solutions,
3. evaluate the quality of particles, based on their corresponding objective functions,
4. update pbest value,
5. update gbest value,
6. update velocity and position for each particle, i.e. based

equations 2 and 3,

7. if the stopping criterion, i.e. maximum number of iteration, is reached, stop. Otherwise return to step 2.

Based on the algorithm above, at the end of iteration, the best problem solution is represented by the global best. Excellent review on the PSO methodologies and applications can be found in Kennedy and Eberhart (2001) and Clerc (2006). The algorithm is able to apply for solving various types of problems by defining the solution representation, that is how the particle represents the problem, which is usually called the solution representation, and how the particle can be translated into problem solution, which is usually called the decoding method. Therefore for applying PSO for ELSP, we need to define the solution representation and the decoding method in the following subsections.

3. PSO FOR COMMON CYCLE APPROACH

The common cycle approach applies the same production cycle time for all products, that is $T_i = T$ for all i. Therefore, if it is defined $\rho_i = d_i/p_i$, the optimization problem can be expressed as

$$\min Z(T) = \frac{\sum_i A_i}{T} + \frac{\sum_i h_i d_i (1-\rho_i) T}{2} \tag{4}$$

subject to

$$T \geq \sum_i s_i \Big/ \left(1 - \sum_i \rho_i\right) \tag{5}$$

The equation (5) guarantees the capability of production facility to satisfy demand predicted during the planning horizon. Two conditions should be considered for this guarantee: the total setup and production uptime of all item should be less than or equal to the production cycle and the demand of each item i has to be equal with the production of its corresponding item over the production cycle time. If τ_i is defined as the production uptime of item i, these two conditions can be written as

$$\sum_i s_i + \sum_i \tau_i \leq T \tag{6}$$

$$d_i T = \tau_i p_i \tag{7}$$

By simple algebra, i.e. after solving equation (7) for τ_i and substituting the expression to equation (6), we can easily proof the expression in equation (5).

Therefore, it is easily seen that the ELSP with common cycle approach is a single variable optimization with decision variable T. In order to apply PSO for solving ELSP with common cycle approach, the solution representation is a single dimension particle in which the position of the particle is defined as real value number. This real value number can be directly transformed into the decision variable T. Figure 1 illustrates the transformation of particle position into the decision variable.

dimension	1
position	1.52

→

solution	
T =	1.52

Figure 1: Solution representation and its conversion to T.

For the effectiveness of the searching process, we may set the lower bound of searching (the minimum value of particle position) based on equation (5) and the upper bound of searching (the maximum value of particle position) is the largest value among the independent solution of item i. It is noted that from the ELSP early references (i.e. Elmaghraby, 1978), the independent solution T_i is obtained by solving independently for each item i its corresponding cost, which can be formulated by following objective function

$$\min Z_i(T_i) = \frac{A_i}{T_i} + \frac{h_i d_i (1-\rho_i) T_i}{2} \tag{8}$$

The solution of equation (8) can be found using classical optimization method, that is by setting the necessary optimality condition of $dZ_i/dT_i = 0$. Therefore the lower and upper bound of searching for T can be written as

$$T_{\min} = \sum_i s_i \Big/ \left(1 - \sum_i \rho_i\right) \tag{9}$$

$$T_{\max} = \max_i \left\{ \sqrt{\frac{2A_i}{h_i d_i (1-\rho_i)}} \right\} \tag{10}$$

4. PSO FOR BASIC PERIOD APPROACH

In the basic period approach, production cycle of each product is the multiplication of basic period (W), that is $T_i = n_i W$. Therefore, the total production cost can be written as

$$Z(T_i) = \sum_i \frac{A_i}{T_i} + \frac{1}{2}\sum_i h_i d_i (1-\rho_i) T_i \tag{11}$$

or

$$Z(W, n_i) = \sum_i \frac{A_i}{n_i W} + \frac{1}{2}\sum_i h_i d_i (1-\rho_i) n_i W \tag{12}$$

A very tight feasibility condition of this approach can be stated as

$$\sum_i s_i + \sum_i \rho_i n_i W \le W \tag{13}$$

This condition is based on the worst case possibility of producing all products in at least single cycle. However, this condition is excessive since only if all n_i = 1, there always a cycle producing all products. Otherwise, there is a possibility to schedule products such that not producing all products in every cycle.

Chatfield (2007) formulated the problem with additional decision variables b_i in which defined as the starting period of item *i*. Based on n_i and b_i, we can identify what items produced in each cycle 1, …, *M*; in which *M* is the least common multiplier of all n_i. Therefore, the feasibility checking can be done in each cycle *j*, *j* =1, …, *M* by following formula

$$\sum_{i \in I_j} \left(s_i + \rho_i n_i W \right) \le W \tag{14}$$

in which I_j is the set of item *i* that being produced in cycle *j*. Based on this idea, the ELSP with basic period approach can be considered as an optimization problem with 2*m*+1 variables.

We are proposing a solution representation for ELSP with basic period approach with 2*m*+1 dimensions, all are real number within the interval [0, 1]. The dimensions are categorized as follows:

- First *m* dimensions of particles are for n_i
- Next *m* dimensions of particles are for b_i
- Last dimension of particles is for *W*

The decoding method which translates particle position into ELSP solution is defined using following equations:

$$n_i = \lceil x_i n_{\max} \rceil \tag{15}$$

$$b_i = \lceil x_{m+i} n_i \rceil \tag{16}$$

$$W = x_{2m+1} T_{CC} \tag{17}$$

where $n_{\max}$ is defined as the largest value of n_i and T_{CC} is the common cycle time period. Using this definition, in other words, the value of n_i is an integer number in the range of [1, $n_{\max}$] and the value of b_i is an integer number in the range of [1, n_i]. Figure 2 illustrates the transformation of particle position into the decision variables.

We can slightly modify this definition for applying the power of two approach, which is $n_i = 2^k$, by replacing equation (15) with this equation

$$n_i = 2^{\lfloor x_i k_{\max} \rfloor} \tag{18}$$

The advantage of using power of two approach is we can set the value of *M* by the biggest n_i, instead of finding the least common multiplier of all n_i.

dimension	1	2	3	4	5	6	7
position	0.52	0.94	0.03	0.35	0.69	0.37	0.29

variable	n_1	n_2	n_3	b_1	b_2	b_3	W
value	5	8	1	2	6	1	11.6

Figure 2: Solution representation of ELSP with 3 items product and its conversion to the decision variables (with $n_{\max}$ = 8 and T_{CC} = 40).

5. COMPUTATIONAL TEST

In order to evaluate the proposed solution representation, a computational test is conducted by using the Bomberger problem, in which a metal stamping machine that must be used to produce 10 different products. The details of this problem can be found easily in several ELSP references, including Chatfield (2007), therefore it is not necessary to rewrite the details in this paper.

The PSO algorithm and the proposed decoding methods are implemented using C# language and supported by PSO computational library called ET-Lib (Nguyen et al., 2010). It is noted that the ET-Lib uses a PSO variant called GLNPSO that has three different social behavior terms called global best, local best, and nearest neighbor best with its corresponding acceleration constant (c_g, c_l, and c_n). All the test instances are run on a computer with an Intel i5-2410M @ 2.30 GHz CPU and 4 GB RAM.

5.1 Test for Common Cycle Approach

The computational test for the common cycle approach are using following PSO parameters: number of particle 30, number of iteration 1000, number of neighbor 5, $w_{\max}$ = 0.9, $w_{\min}$ = 0.4, c_p = 1, c_g = 1, c_l = 1, c_n = 1, and 10 replication runs of the algorithm is conducted. The results is very consistent, all replications can obtain the same result, which is *T* = 42.754 days and *Z*(*T*) = \$ 41.1657/day or \$ 9879.77 /year. This result is also similar with the optimal result in the existing literature (i.e. Elmaghraby, 1978).

Figure 3 shows the progress of the best objective function value in the first 100 iterations of a replication. It shows that actually the best objective function for whole iterations is actually found before iteration number 20. In other word, the optimal solution of this problem can be found within small number of iteration. Therefore, actually it is not necessary to use 1000 iterations for this problem.

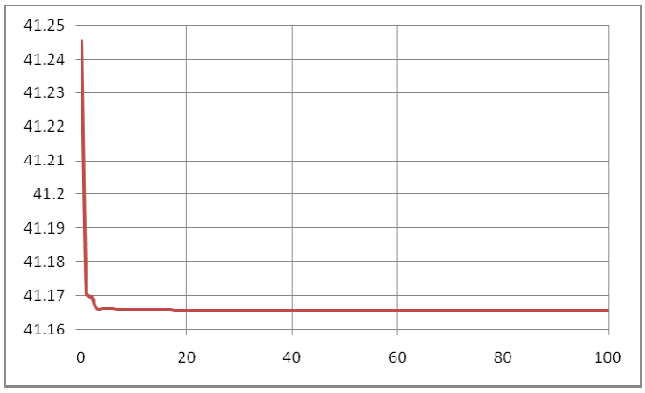

Figure 3: The best objective function value across iterations.

5.2 Test for Basic Period Approach

The computational test for the basic period approach are using following PSO parameters: number of particle 100, number of iteration 2000, number of neighbor 5, $w_{\max}$ = 0.9, $w_{\min}$ = 0.4, c_p = 1, c_g = 1, c_l = 1, c_n = 1, and 10 replication runs of the algorithm is conducted. We are using directly the power of two approach, for avoiding the additional effort to compute the least common multiplier in the feasibility checking of each solution. The value of $k_{\max}$ and T_{CC} are selected to be 5 and 41, respectively. The computational results of each replication are presented in Table 1, while the details on the decision variables of the best found solution (which is in the replication 7) is presented in Table 2.

It is noted that the best solution found by the PSO (with Z = 7697.09) is also consistent with the best found solution from other literature (see Chatfield, 2007). Some variations among the results are shown by this proposed algorithm, however, the average deviation from the best found solution is not more than 5%.

Table 1: Computational result of basic period approach

rep	W	Z ($/day)	Z ($/year)
1	29.08	34.60	8304.25
2	29.19	34.60	8304.75
3	33.98	35.24	8457.43
4	24.21	32.21	7730.86
5	29.08	34.60	8304.25
6	12.37	33.44	8025.83
7	**23.42**	**32.07**	**7697.09**
8	25.49	32.20	7728.29
9	25.56	32.90	7894.96
10	29.19	34.60	8304.75

Table 2: Detail of the decision variables on the best found solution

item	n_i	b_i
1	8	4
2	2	1
3	2	1
4	1	1
5	2	1
6	4	2
7	8	8
8	1	1
9	2	2
10	2	1

6. CONCLUDING REMARK

This paper is successfully presented that a simple version of PSO is able to solve the ELSP using the common cycle and basic period approaches. Fine tuning the algorithm for the basic period approach is still required in order to increase the consistency of the computational results. Some significant effort is still needed for developing the PSO for ELSP with time-varying lot sizes approach. This proposed PSO algorithm for common cycle and basic period approaches are ready to be applied for more complex ELSP variants using respective approaches, including ELSP with imperfect production system.

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