

# LINE BALANCING ANALYSIS FOR PRODUCT TYPE PC-250 BIT WITH HEURISTIC METHOD AT PT TIRTA INTIMIZU NUSANTARA

*by* Lina Gozali

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# APIEMS 2014

The 15th  
Asia Pacific Industrial Engineering  
and Management Systems Conference

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

PROCEEDINGS

APIEMS 2014 Information

Detailed Program

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EXIT



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## 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 KIEE and the Korea research community.

On behalf 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 (KIIIE). 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.

*Chi H. Jun*

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



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# Keynote Speech

## Keynote Speech I Research Issues in Future Logistics

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

Room: Ramada-1

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**Chung-Yee Lee**

Hong Kong University of Science and Technology, China



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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 Semiconductor, Northern Telecom, Martin Marietta, Hong Kong Air Cargo Terminal, Hongkong International Terminal, Philips Medical, ...,etc.

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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.

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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).

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## Keynote Speech

### 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



<sup>1</sup> 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

### Keynote Speech III Big Data Management

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

*Room: Ramada-1*

#### Sungzoon Cho

Seoul National University, Korea.



<sup>24</sup> 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 <sup>70</sup> is on the editorial board of International Journal of Operations Research and Information Systems and International Journal of Cognitive Biometrics. He served as the president of Hyundai 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

127 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			10:40-11:00	Coffee break
		10:30-11:00	Opening addresses : APEMS President, KIE President, General Chair	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. Sungsoo Cho: BigData 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		
16:20-18:00	Technical sessions TC						
	Registration			13:00-18:00	Poster Session		
				18:00-20:00	Welcome Reception		

Oct 12 (Sunday)									
10:00-13:00	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	Halls(BF)
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, KIE 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 & Management 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
538	450	332	323	307		361	53	505	
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	

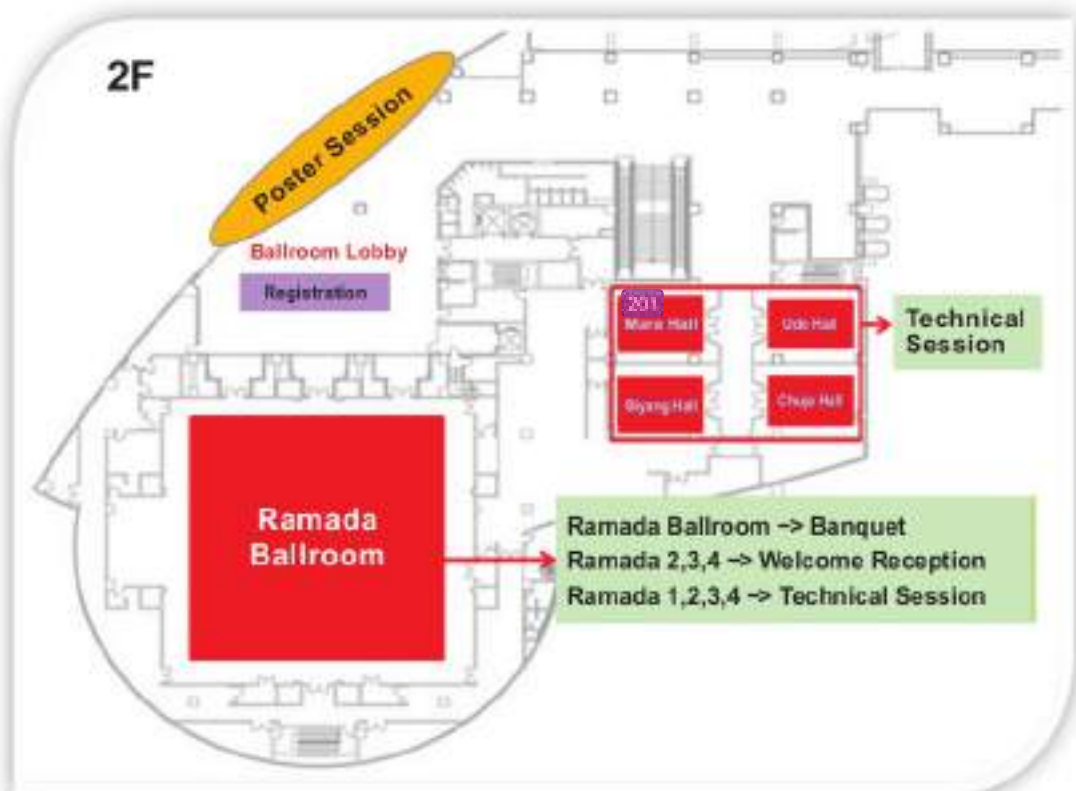
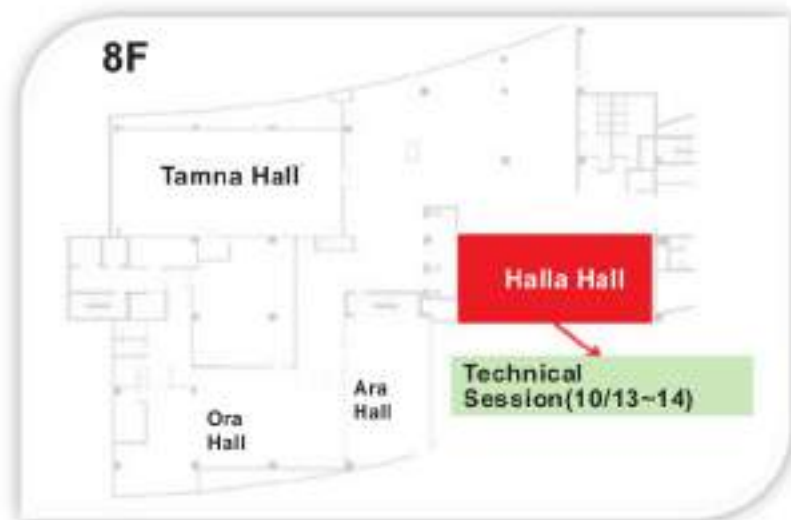
## Oct 14 (Tuesday)

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 1)
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	589		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



## Detailed Program

### MA1 Data Mining 1

Mara, 08:30-10:10

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

MA1-1 (528)	<a href="#">The Development Of An Educational Social Network To Support Blended-Learning In A University</a>	1
	<i>Vo Duy Khoi</i> (International University, Viet Nam), <i>Do Trung</i> (Vietnam National University Ho Chi Minh City, Viet Nam), <i>Pham Quoc Son Lam, Le Thanh Son</i> (International University, Viet Nam)	
MA1-2 (207)	<a href="#">A model for improving the customers' purchase willingness considering their latent intentions and media contacts.</a>	7
	<i>*Keisuke Kawanaga, Satoshi Kumagai</i> (Aoyama Gakuin University, Japan), <i>Hiroki Nakano</i> (NIFTY Corporation, Japan)	
MA1-3 (276)	<a href="#">The research of the onset factor of sports injuries in basketball</a>	14
	<i>*Takashi Matsumoto, Yuki Maruyama</i> (Tokyo Metropolitan University, Japan), <i>Hisashi Yamamoto</i> (Nippon Institute of Technology, Japan)	
MA1-4 (324)	<a href="#">Multi-Objective Genetic Algorithm Using Fuzzy Membership Chromosome for Categorical Data</a>	19
	<i>*Chao-Lung Yang, Thi-Phuong-Quyen Nguyen, Ren-Jieh Kuo</i> (National Taiwan University of Science and Technology, Taiwan)	
MA1-5 (296)	<a href="#">Using data mining methods to forecast book purchase quantities</a>	25
	<i>*Farnaz Pirasteh</i> (Pukyong National University, Korea), <i>Mohammad Rouzbeh</i> (Dayche Data Mining Group, Iran), <i>Jay Liu</i> (Pukyong National University, Korea)	

### MA2 Management of Technology and Innovations 1

Byang, 08:30-10:10

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

MA2-1 (100)	<a href="#">Analyzing the effect of platform update period on platform diffusion in mobile ecosystem</a>	29
	<i>Gyesik Oh, *Yoo Hong</i> (Seoul National University, Korea)	
MA2-2 (111)	<a href="#">Integrated Coal Gasification Technology Selection Model Considering Company's Research &amp; Development and Operational Decision Making</a>	35
	<i>*awan Wiradnata</i> (Bandung Institute of Technology, Indonesia), <i>Muhammad Akbar, Anas Mufit, Nanda Rusyda Saufa, Rajesri Govindaraju, Indiyati Sunaryo</i> (Faculty of Industrial Technology, Indonesia)	
MA2-3 (143)	<a href="#">ASSESSING TECHNOLOGY LEVEL OF INDUSTRIAL ESTATE TO MEET STANDARD OF ENVIRONMENT</a>	43
	<i>Dwi F.D. Nurcahya</i> (Ministry of Industry, Indonesia), <i>Muhammad Akbar</i> (Bandung Institute of Technology, Indonesia), <i>*dardjad inanto</i> (bandung institute of technology, Indonesia)	
MA2-4 (44)	<a href="#">Economic Evaluation Method and Procedure for Improvement Activities</a>	50
	<i>*Hirokazu Kono</i> (Keio University, Japan)	
MA2-5 (97)	<a href="#">A Market-Share-Driven Membership Pricing Strategy for Gyms</a>	57
	<i>*Muh-Cheng Wu, Wan-Ling Shien, Chung-Yu Chung</i> (National Chiao Tung University, Taiwan)	

### MA3 ERP/E-Business

Udo, 08:30-10:10

Chair: Kazuhiko Yasuda (Tohoku University, Japan)

MA3-1 (37)	<a href="#">Review of the Concepts, Meanings, and Uses of Life Cycle</a>	62
	<i>*Kazuhiko Yasuda</i> (Tohoku University, Japan), <i>Jingling Huang</i> (TOHOKU University, Japan)	
MA3-2 (38)	<a href="#">ERP Life Cycle Models: An Annotated Bibliographic Review</a>	70
	<i>*Kazuhiko Yasuda</i> (Tohoku University, Japan), <i>Jingling Huang</i> (TOHOKU University, Japan)	
MA3-3 (352)	<a href="#">Analysis of Pricing and Promotional Strategies in The SAP ERP Simulation Game By Using A Model of A Dynamic System</a>	78



	<i>*Zulf Rochman</i> (Universitas Islam Indonesia, Indonesia), <i>erlangga fausa</i> (Islamic University of Indonesia, Indonesia)	
MA3-4 (360)	<b>Causal Analysis of Time Gap between Events in Multi-dimensional Process View</b> <i>Biska Sutrisnawati</i> (Pusan National University, Korea), <i>Sung-ook Sul</i> (Total Soft Bank Ltd., Korea), <i>Hyemin Bae</i> (Pusan National University, Korea)	82
MA3-5 (255)	<b>The Alignment Relationships between Electronic Business Strategy and Information Technology Capabilities</b> <i>*Yue-Yang Chen</i> (I-Shou University, Taiwan), <i>Szu-Yuan Sun</i> , <i>Chang-Yuan Chen</i> (National Kaohsiung First University of Science and Technology, Taiwan)	88

#### MA4 Service Sciences 1

Chuja, 08:30-10:10

Chair: Kwang-Jae Kim (POSTECH, Korea)

MA4-1 (54)	<b>Service Quality Measurement Using Fuzzy Analytic Hierarchy Process: A Case Study</b> <i>*Chirakiat Salthong</i> , <i>Dusadee Yaimana</i> (Kasetsart University, Thailand)	93
MA4-2 (55)	<b>Quantifying the Relationships Among Service Quality, Customer Satisfaction, and Behavioural Intentions in Fast Food Restaurants Using Structural Equation Modeling</b> <i>*WILLY ZALATAR</i> (DE LA SALLE UNIVERSITY, Philippines)	100
MA4-3 (108)	<b>Product-Service System Development Methods and Knowhow: A Review and Classification</b> <i>Chie-Hyeon Lim</i> , <i>*Kwang-Jae Kim</i> (POSTECH, Korea)	105
MA4-4 (215)	<b>Designing a Service Process for Hypertension Patient Support</b> <i>Byeok-Hwan Kwon</i> , <i>Chie-Hyeon Lim</i> , <i>Ki-Hun Kim</i> , <i>*Kwang-Jae Kim</i> (POSTECH, Korea), <i>Yeasun Kim</i> , <i>Sung-Hong Kang</i> (Inje University, Korea)	111
MA4-5 (244)	<b>A Data-Driven Approach to Developing Service Concepts for Driving Safety Enhancement (a Case Study)</b> <i>Min-Jun Kim</i> (POSTECH, Korea), <i>Changho Lee</i> (Quality System Laboratory, Korea), <i>Chie-Hyeon Lim</i> , <i>*Kwang-Jae Kim</i> , <i>JINWOO JEON</i> (POSTECH, Korea), <i>Kyungim Choi</i> , <i>Yongsung Park</i> (Korea Transportation Safety Authority, Korea)	116

#### MA5 Quality Engineering & Management 1

Ramada-1, 08:30-10:10

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

MA5-1 (23)	<b>Application of a Design for Six Sigma (DFSS) Framework on a Proposed Launch of Operation of an Airline Exclusively for Pets</b> <i>*Marc Immanuel Isip</i> (University of the Philippines Los Banos, Philippines)	122
MA5-2 (28)	<b>Traceability System for Quality Assurance on Make to Order Products</b> <i>*Iwan Vianay</i> (Institut Teknologi Sepuluh Nopember Surabaya, Indonesia), <i>Nur Ain Rahmawati</i> (Institut Teknologi Sepuluh Nopember (ITS), Indonesia)	130
MA5-3 (109)	<b>Sequential Sampling Plan on Operating Characteristics Indexed by Quality Loss</b> <i>*Ryosuke Tomohiro</i> , <i>Ikuo Arizono</i> (Okayama University, Japan), <i>Yasuhiko Takamoto</i> (Prefectural University of Hiroshima, Japan)	137
MA5-4 (113)	<b>Variable Repetitive Group Sampling Plan with Screening for Acceptance Quality Loss Limit Scheme</b> <i>*Yusuke Okada</i> , <i>Ryosuke Tomohiro</i> , <i>Ikuo Arizono</i> (Okayama University, Japan)	145
MA5-5 (226)	<b>A Proposed Measures for Evaluation of Quality Excellence Practices in United Arab Emirates Industries</b> <i>*Mehran Dardar Abadi</i> (Universiti Teknologi Malaysia (UTM), Malaysia), <i>Shah Mohd Yusoff</i> (Universiti Teknologi Malaysia, Malaysia)	153

#### MA6 Production and Operations Management 1

Ramada-2, 08:30-10:10

Chair: Daisuke Hirofani (Prefectural University of Hiroshima, Japan)

MA6-1 (75)	<b>173</b> Hybrid Algorithm Based on an Integration of Genetic Algorithm and Recommended Heuristic Rules for Job Shop Scheduling Problem <i>*Amer Boushaala, Amer Boushaala</i> (Benghazi University, Benghazi, Libya, Libya)	159
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Ramada-3, 13:30-15:30

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	*Saiful Manggore(Hasanuddin University, Indonesia), Syamsul Bahri(Engineering Faculty Of Hasanuddin University, Indonesia)		

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Chair: Jinho Lee (Korea Naval Academy, Korea)

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Halla(8F), 13:30-15:30

Chair: Hiromi Ban ((Nagaoka University of Technology, Japan)

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**MC1 Supply Chain Management 1**

Mara, 15:50-17:50

Chair: Rainisa Heryanto (Maranatha Christian University, Indonesia)

MC1-1 (252)	A Multi-Criteria Selection for Inventory Aggregation Problem under Risk Pooling: A Case Study <i>*Kanokporn Biekkhemaanyom, Nipa Suttachet(King Mongkut's University of Technology Thonburi, Thailand)</i>	607
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MC1-3 (279)	The Proposal of Applying Multi Echelon Inventory to Minimize Supply Chain Total Cost for Soft Drinks <i>*Santoso S., Rainisa Heryanto(Maranatha Christian University, Indonesia)</i>	623
MC1-4 (280)	The Improvement of the Model of Wheat Flour Requirement at Eastern Indonesia by Determining the Number Location of the New Plant <i>*Rainisa Heryanto(Maranatha Christian University, Indonesia), Senator Bahagia(Bandung Institute of Technology, Indonesia)</i>	630
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MC1-6 (336)	A MECE Feature Selection Framework for Yield Improvement in Semiconductor Manufacturing <i>*CHIA-YEN LEE, BO-SYUN CHEN(National Cheng Kung University, Taiwan)</i>	645

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Byang, 15:50-17:50

Chair: Shinya Mizuno (Shizuoka University, Japan)

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MC2-6 (582)	The implementation of the mobile Computerized Procedure System Editor <i>*Dae Seung Park, *Yeonsub Jung(Central Research Institute of Korea Hydro and Nuclear Power Co., Korea)</i>	688

**MC3 Ergonomics/Human Factors 2**

Udo, 15:50-17:50

Chair: Zahari Taha (Universiti Malaysia Pahang, Malaysia)



MC3-1 (456)	<b>100</b> Ergonomic Assessment on Fatigue among Malaysian Express Bus Drivers Using the Partial Least Squares (PLS) Approach <i>YUSOF HASHIM</i> , *ZAHARI TAHA(Universiti Malaysia Pahang, Malaysia)	692
MC3-2 (359)	Usability Point of View for Klasiber E-Learning in Islamic University of Indonesia *Muhammad Supriyanto(Universitas Islam Indonesia, Indonesia), Amalia San(Islamic University of Indonesia, Indonesia), amalia rahmayani(Islamic university of indonesia, Indonesia), Miftahulkhair Adianto(Islamic University of Indonesia, Indonesia)	702
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MC3-4 (419)	Evaluating the Appropriateness of Qualitative Research data using the measures in Semantic Network Analysis <i>Ye Lim Rhie</i> (Seoul National University, Korea), *Ji Hyoun Lim, Min Ho Lee(Hongik University, Korea), Myung Hwan Yim(Seoul National University, Korea)	718
MC3-5 (449)	Analysis and Proposal about the Effect of Time, Types of Subject and Types of Room Factor to the Students' Concentration *Elty Savia, Evan Sentosa(Matanatha Christian University, Indonesia)	724
MC3-6 (341)	Walking on the spot effect <b>111</b> sleep quality <i>Ting Shao</i> , *Dengchuan Cai(National Yunlin University of Science and Technology, Taiwan)	731

#### MC4 Network Optimization

Chuja, 15:50-17:50

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

MC4-1 (407)	Paired Property Analysis for Optimal Worker Assignment -Worker Efficiency vs. Task - *Kianda Kong, Hisashi Yamamoto, Peiya Song(Tokyo Metropolitan University, Japan), Jing Sun(Nagoya Institute of Technology, Japan), Masayuki Matsui(Kanagawa University, Japan)	739
MC4-2 (363)	<b>101</b> Optimal Energy Supply-mix Model with Uncertain Monthly Capacity Factor of Renewable Energies <i>Meng-Ping Sung</i> , *Hsiao-Fan Wang(National Tsing Hua University, Taiwan), Hsin-Wei Hsu(Industrial Technology Research Institute (ITRI), Taiwan) <b>100</b>	745
MC4-3 (268)	Search Process for Pareto Solutions of a Two-objective Network by Combination of Network Properties <b>117</b> *Natsumi Tsuchi, Hisashi Yamamoto(Tokyo Metropolitan University, Japan), Tomoaki Akiba(Chiba Institute of Technology, Japan), Xiao Xiao(Tokyo Metropolitan University, Japan) <b>100</b>	753
MC4-4 (515)	Acceleration Techniques of the Dynamic Programming Algorithms for Resource-Constrained Elementary Shortest Path Problem <i>Hyunchul Tae</i> , *Byung-In Kim(POSTECH, Korea) <b>200</b>	760
MC4-5 (319)	Solving the Multi-Modal Orienteering Problem with Time Windows using Particle Swarm Optimization <b>200</b> Vincent F. Yu, *Parida Jeyapana, A.A.N. Perera Redi(National Taiwan University of Science and Technology, Taiwan)	768
MC4-6 (142)	Alternative-Fuel station location problem: efficiency and fairness <i>Sungjae Park</i> (Sungkyunkwan University, Korea), Chang hyun Kwon(University at Buffalo, United States), *Byung Do Chung(Sungkyunkwan University, Korea)	776

#### MC5 Quality Engineering & Management 3

Ramada-1, 15:50-17:50

Chair: Chia-Yu Hsu (Yuan Ze University, Taiwan)

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MC5-3 (339)	Variables Quick Switching Sampling System based on Process Performance Index *Mei-Hsu Shih, *Chien-Wei Wu(National Tsing Hua University, Taiwan)	793
MC5-4 (346)	Applying Evolutionary Algorithm Approach for Optimizing Design of Chip Size *Chia-Yu Hsu, Shih-Chang Chiu(Yuan Ze University, Taiwan)	799
MC5-5 (370)	Quality Design of Yarn Dyed Production Residu based on Taguchi and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method *Ali Parkhan, Faisal M. Djani Hartika, Imam Widodo(Islamic University of Indonesia, Indonesia)	804
MC5-6 (402)	Tool to Identify and Assess Human Issues for TQM Implementation: A Proposal *Muhammad Malik(Universiti Teknologi Malaysia, Malaysia), *Shah Mohd Yusof(Universiti Teknologi Malaysia, Malaysia)	810

#### MC6 Simulation 1

Ramada-2, 15:50-17:50

Chair: Puji Astuti (Trisakti University, Indonesia)

MC6-1 (500)	Development of an Artificial Housing Market Using Agent-Based Modeling *Byeongsun Kwon, Ri YU, KyeongTae Lee(Bank of Korea, Korea), *Nam-Wook Cho(Seoul National University of Science & Technology, Korea)	817
MC6-2 (196)	Design and development of a semiconductor wafer manufacturing simulation system *Li-Chih Wang(Tungshai University, Taiwan), Allen Wang(Department of Industrial Engineering and Enterprise Information, Tungshai University, Taiwan), Chun-Ya Chuah(Tungshai University, Taiwan), Tai-Yen Tseng(Department of Industrial Engineering and Enterprise Information, Taiwan)	823
MC6-3 (424)	CONCEPTUAL MODEL FOR SIMULATION OF COMMUTER LINE TRAFFIC AND OPTIMIZING HEADWAY *Puji Astuti, Wini Septiani, Sucipto Adisuwiryo, Liana Anton(Trisakti University, Indonesia)	829
MC6-4 (66)	Automatic defect inspection of TFT-LCD panels using Fourier image reconstruction *Du-Ming Tsai, Yan-Hsin Tseng(Yuan-Ze University, Taiwan), Wei-Yao Chiu(Industrial Technology Research Institute, Taiwan)	834
MC6-5 (179)	Application of value stream mapping for lean management: a case study of air conditioner production line *Yi-Hsin Hu, James C. Chen(National Tsing Hua University, Taiwan), Tzu-Li Chen(Fu Jen Catholic University, Taiwan), Kirn Chen, Amy Hung(AXIS-group, Taiwan), Chun-Ju Lin(National Tsing Hua University, Taiwan)	842

#### MC7 Healthcare Systems 1

Ramada-3, 15:50-17:50

Chair: Chie-Hyeon Lim (POSTECH, Korea)

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MC7-2 (99)	Risk Assessment of Drug Safety for Emergency Patients Using Modified HFMEA *Chien-Chih Wang(Ming Chi University of Technology, Taiwan), Li-Jung Huang(Division Director, Taiwan), Hsin-Ning Pan, Yun-Ru Yang(Ming Chi University of Technology, Taiwan)	856
MC7-3 (112)	A Multi-Perspective Approach to Service Quality Assessment in Private Hospitals *Joy Mar Bautista, Jazmin Tangsac(De La Salle University, Philippines)	859
MC7-4 (194)	A Personalized Tele-home Care System for Solitary Elders *Jun-Han Lin, *Hsiao-Fan Wang(National Tsing Hua University, Taiwan)	866
MC7-5 (248)	A Robust Parameter Design Approach for Emergency Department Simulation *Chumpol Yuangyai, sunyaphong nitsang(King Mongkut's Institute of Technology Ladkrabang, Thailand), Kanokporn Riankhomniyom(King Mongkut's University of Technology Thonburi, Thailand), Udom Janjerassuk(King Mongkut's Institute of Technology Ladkrabang, Thailand)	872

#### MC8 Optimization Techniques 1

Ramada-4, 15:50-17:50



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 <i>Mohammed Jersalem, *Shi-Woei Lin(National Taiwan University of Science and Technology, Taiwan)</i>	879
MC8-2 (217)	Detecting the Masked Efficient DMU in DEA <i>Chiao-Pin Bao(I-Shou University, Taiwan), *Mei-Ing Tsai, Ming-Chi Tsai(College of Management, Taiwan)</i>	887
MC8-3 (201)	Process and Cost Optimization for Plastic Injection Molding by Data Envelope Analysis and Mathematical Programming <i>Wu-Lin Chen(Providence University, Taiwan), Wan-Qiao Lai, Chen-Yu Huang, *Chin-Yin Huang(Tungshai University, Taiwan)</i>	894
MC8-4 (169)	Stochastic Global Optimization Using Sequential Kriging Metamodeling <i>Yan-Han Lu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)</i>	901
MC8-5 (206)	Optimization of Air-Conditioning Energy Conservation by Mathematical Programming <i>Wu-Lin Chen(Providence University, Taiwan), Chung-Wei Chou, Szu-han Chiu, *Chin-Yin Huang(Tungshai University, Taiwan)</i>	907
MC8-6 (271)	Expertise-based Experts Ranking at Multiplicative Preference Relations on Alternatives <i>ery herowati, *ery herowati, ery herowati(University of Sepuluh Nopember, Indonesia), Udisubakti Optomulyono(Institute of Technology Sepuluh Nopember, Indonesia), Joniarto Parung(University of Surabaya, Indonesia), Suparno Suparno(Institute of Technology Sepuluh Nopember, Indonesia)</i>	914

## MC9 Educational Support System

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

Chair: Masahide Yamamoto (Kanazawa Seiryō University, Japan)

MC9-1 (501)	A system of real time advice for speech improvement <i>*Hiroshi Arai(Kinjo college, Japan), Hidetaka Nambo(Kanazawa University, Japan), Yoko Shimomura, Hiroyuki KAWABE(Kinjo University, Japan), Shuichi Seto(Kinjo College, Japan)</i>	920
MC9-2 (562)	Consideration on English Learning for Undergraduates Using the Nintendo DS <i>*Hiromi Ban(Nagaoka University of Technology, Japan), Haruhiko Kimura(Kanazawa University, Japan), Takashi Oyabu(Kokusai Business Gakuin College, Japan)</i>	924
MC9-3 (448)	The Analysis of Concept and Effect Factors on Financial Literacy <i>*Yuki Kitano(Kanazawa Seiryō University, Japan), Koji Osanai(Shiga Junior college, Japan), Keiichiro Nishio(Matsuyama University, Japan)</i>	929
MC9-4 (455)	The Present Conditions of the Computerization of Education and its Problems Concerning the Educator <i>*Yumi Tatsuhashi(Kanazawa Seiryō University, Japan)</i>	936
MC9-5 (154)	AN ANALYSIS OF JOB SATISFACTION OF FACULTY MEMBERS OF BULACAN STATE UNIVERSITY MAIN CAMPUS (COLLEGE OF ENGINEERING) <i>*Dyan Gonzales(Philippine Institute of Industrial Engineers, Philippines)</i>	941
MC9-6 (507)	Analysis the Influence of Study Program's Education Quality towards Graduates' Potential Marketing <i>*Yuliani Talar, Jimmy Gozaly(Maranatha Christian University, Indonesia)</i>	948

## TA1 Supply Chain Management 2

Mars, 08:40-10:40

Chair: Etsuko Kusakawa (Osaka Prefecture University, Japan)

TA1-1 (50)	Impact of information sharing regarding customer returns ratio on optimal sales strategy under e-commerce <i>*Yuta Saito, Etsuko Kusakawa(Osaka Prefecture University, Japan)</i>	957
TA1-2 (59)	Analyzing the evolutionary stability for behavior strategies in green supply chain <i>*Daiiro Tomita, Etsuko Kusakawa(Osaka Prefecture University, Japan)</i>	965
TA1-3 (60)	Pareto-Based PSO Algorithm for Multi-Objective LRP <i>*Je lu(student, Thailand), Vorasit Kachitvichyanukul(professor, Thailand), Je lu(student, Thailand)</i>	973

TA1-4 (61)	<b>07</b> Optimal Ordering Policy in Dual-Sourcing Supply Chain considering Supply Disruptions and Demand Information *Naoki Watanabe, Etsuko Kusakawa(Osaka Prefecture University, Japan)	980
TA1-5 (130)	<b>04</b> Research in Supply Chain Management: Issue and Area Development *Sisa Juwani(Department of Industrial Engineering, Indonesia), *Siti Budjati(Faculty of Engineering, Indonesia), subagyo subagyo(Indonesian Islamic University, Indonesia), nuraini masrurah(Yogyakarta, 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 Rivaldi Darmawan, Nadea Aulia Arifin, Han-Yu Shih(National Tsing Hua University, Taiwan)	996

## TA2 Communication Support

Byang, 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)	<b>37</b> Development of the support system for facial expression training *Yusuke A. <b>38</b> <b>39</b> , 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 *Kiyotake 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)	<b>37</b> Facial electromyogram (FEMG) analysis of perception and rendering of facial expression *Akira Tak <b>38</b> <b>39</b> , 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 <b>38</b> <b>39</b> , 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 *Angmin Lee, SungHo Lee, *Jong-Seok Lee(Sungkyunkwan University, Korea)	1035
TA3-2 (147)	<b>B</b> Comparison of machine learning classifiers for glaucoma diagnosis using variable selection *Su-Qiang Lee, Jhyung Lee, Heechoon You, *Chi-Hyuck Jun(POSTECH, Korea)	1042
TA3-3 (203)	An iterative random sampling procedure for outlier detection *Jhyun Ha, Seung 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 Uli 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), *Pai-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<br>(472) | Evaluation for painting show of kindergartner on rout bus in Kaga City<br>Eni Ishikawa, Ayano Kawasaki, Izumi Yamasaki(Kanazawa Seiryō University, Japan), *Takashi Oyahji(Kokusai Business Gakuin College, Japan)  | 1077 |
| TA4-2<br>(444) | Utilization of historical materials and CGM for foreign visitors<br>*Ayako Sawada(Hokuriku Gakuin Junior College, Japan), Takatoshi Yoshida(Japan Advanced Institute of Science and Technology, Japan)  | 1084 |
| TA4-3<br>(564) | The Verification of Mass Customization Systems in the Chinese Market<br>*Bin Fang(Kanazawa Seiryō University, Japan), Akinori Ono(Keio University, Japan)   | 1090 |
| TA4-4<br>(15)  | Using SWOT Analysis to Evaluate the Public Procurement in Compliance with SNI (Case Study: Government Agency at Central of Java)<br>*Aries Susanty, Hery Sulantoro, Diana Puspitasari, Diena Novitasari, Nia Budi Puspitasari(Diponegoro University, Indonesia) | 1094 |
| TA4-5<br>(264) | Designing Variables Quick Switching System with Process Loss Consideration<br>Yi-Jhen Jian, *Chien-Wei Wu(National Tsing Hua University, Taiwan)  | 1100 |
| TA4-6<br>(225) | A Variables Multiple Dependent State Sampling Plan for Products with Unilateral Specification Limit<br>Chih-Chieh Chang, Chiao, *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<br>(35)  | Sustainable supply chain management in competitiveness environment<br>Ming-Lang Tseng(Lunghwa University of Science and Technology, Taiwan), *Anthony Shum Fung Chau(De La Salle University, Philippines), Ming Lim(Derby University, United Kingdom) | 1110 |
| TA5-2<br>(114) | Sustainable management of Taiwan's semiconductor supply chain<br>*Chi-Tai Wang, Chui-Sheng Chu(National Central University, Taiwan)   | 1119 |
| TA5-3<br>(136) | The Use of Smart Meter Data to Analyze the Consumption Patterns<br>Chia-Yu Shen(National Tsing Hua University, Taiwan), *Hsiao-Fan Wang(Hsinchu, Taiwan)  | 1124 |
| TA5-4<br>(137) | Time of Use Electricity Pricing Optimization in a Monopolized Electricity Market<br>Hsin-Yu Chiang, *Hsiao-Fan Wang(National Tsing Hua University, Taiwan)  | 1131 |
| TA5-5<br>(291) | Modeling and Optimization of Power Storage Strategy of Hybrid Renewable Energy System in Uncertainty Environments<br>Chi-Kang Su, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)   | 1136 |
| TA5-6<br>(347) | What psychological factors influence the protection motivation of climate change?<br>*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<br>(98)  | Application of Agent-Based Modeling and Simulation for an Outpatient Department in a Hospital<br>*Chumpol Yungyai(King Mongkut's Institute of Technology Ladkrabang, Thailand), Udom Janjarassuk(Faculty of Engineering, Thailand), Chonnapong Sirtan(King Mongkut's Institute of Technology Ladkrabang, Thailand), Kanokporn Rienkhemanyom(King Mongkut's University of Technology Thonburi, Thailand) | 1147 |
| TA6-2<br>(105) | Integrated Maintenance and Inventory Optimisation Model for Offshore Assets<br>*Winda Cahya(Islamic University of Indonesia, Indonesia)   | 1154 |



TA6-3 (221)	134 1002 130 Q-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 Cho(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 Sugura, 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 Comparing Productivity of an Assembly Line in Diversified Production Conditions Kagohisa 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), Ohtsuka 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 YOSHIMIKO SUZUKI(Sekyo 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 S'WITT?) 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 Phatongt Pithanong(Faculty of Industrial Technology, Thailand), Paroon Maysachearw(Songkhla Rajabhat University, Thailand), Rapeepan Pitakaso(Songkhla, Thailand)	1227
TA8-2 (477)	71 On the resources required to provide persistent robotic service agents: Multiple immobile customers and a single service station Hyun 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)	60 Competitive Facility Location and Design Problem by Considering Conditions of Government Regulation and Regional Saturation Suprayogi Suprayogi, Yosi Hidayat(Institut Teknologi Bandung, Indonesia), Utaminingsih Linari(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) 89
- TA8-6 Monitoring Framework for Dynamic Inbound Flows 1264
- [313] Kyo-Ho Cho(POSTECH (Pohang University of Science & Technology), Korea), Hyunbo Cho(POSTECH (Pohang University of Science & Technology), Korea), \*Mooyoung Jung(UHIST (Ulsan National Institute of Science & Technology), Korea)

#### TA9 Uncertainty Theory (Session II)

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

Chair: Xiaowei Chen (Nankai University, China)

- TA9-1 Towards Uncertain Network Optimization 1270
- [558] \*Jin Peng(Huanggang Normal University, China)
- TA9-2 Viral Marketing of Multiple-Attribute Products in a Social Network 1271
- [559] Wei Li, \*Yaping Mi(University of International Business and Economics, China)
- TA9-3 Uncertain Logic Controller and Its Applications 1279
- [560] \*Wei Dai(Central University of Finance and Economics, China)
- TA9-4 Uncertain Random Multilevel Programming 1280
- [561] \*Hua Ke(Tongji University, China)
- TA9-5 Assets Pricing and Risk Management in Uncertain Market 1281
- [565] \*Xiaowei Chen(School of Economics Nankai University, China)
- TA9-6 Liquidity Shocks and Robust Portfolio Management 1282
- [428] Seungkyu Lee(Pohang University of Science and Technology, Korea), \*Bong-Gyu Jang, Seoyoung Park(POSTECH, Korea)

#### TB1 Supply Chain Management 3

Mara, 14:20-16:00

Chair: Muhammad Rusman (Hasanuddin University, Indonesia)

- TB1-1 Nash Equilibrium Retail Prices in a Planer Duopoly Market 1295
- [165] \*Koichi Nakade, Akira Kamazawa(Nagoya Institute of Technology, Japan) 124
- TB1-2 A Proposal of Bargaining Solution for Cooperative Contract in a Supply Chain 1303
- [176] \*Wakana Kato, Ayo Arizono(Okayama University, Japan)
- TB1-3 Capacity Planning and Partnership Management 1310
- [208] \*Cheng-Hung Wu, Wen-Lan Hsu(National Taiwan University, Taiwan)
- TB1-4 A multi-objective facility location problem in congested systems with service level for each facility and competitive environment 1314
- [160] \*Mahsa Borouhaki(M.Sc. student of industrial engineering, Iran), hasean hosseini nasab(Associate professor, Iran) 114
- TB1-5 Blood Bank Location Model for Blood Distribution Planning in Makassar City 1323
- [234] \*Muhammad Rusman(Hasanuddin University, Indonesia), Amrin Rapi(Ministry of Industry of Republic of Indonesia, Indonesia)

#### TB2 Management of Technology and Innovations 2

Byang, 14:20-16:00

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

- TB2-1 Establishment and development of the innovation-promoting organization for industry 1328
- [188] \*Kana Hayase, Nobutaka Otsake(Nagoya Institute of Technology, Japan), Takeshi Matsumoto(Osaka Gas Co., Japan) 80
- TB2-2 Using Innovative Intellectual Property Indicators to Identify National Knowledge Flow Effects 1336
- [425] \*Chin-Yuan Fao, Chia-Hao Hsu(Science & Technology Policy Research and Information Center, Taiwan), shu-hao Chang(National Applied Research Labs, Taiwan), pin-hua Lin(Zhongli, Taiwan) 100



TB2-3 (317)	Development of Virtual Organisation Framework Model in Tourism Industry Using Axiomatic Design <i>*Agus Fauzi, Ery Maftuchah, Nasrullah Setiawan, Bambang Suraino(Universitas Islam Indonesia, Indonesia)</i>	1345
TB2-4 (150)	Supporting Technology Foresight for Disruptive Innovation: Keyword-based Visual Analysis for Futuristic Data <i>*Jeon Kim, *Yonghee Park(Seoul National University, Korea)</i>	1352
TB2-5 (22)	Combining correspondence analysis with association rule mining to carry out market segmentation and product configuration <i>*Chih Wang(National Chiao Tung University, Taiwan)</i>	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) <i>*Dennis Beng Hui, Emil Fernandez(De La Salle University Manila, Philippines)</i>	1366
TB3-2 (469)	A Prediction Method based on Weighted Ensemble of Decision Tree on Alternating Decision Forests. <i>*Shotaro Misawa, Naohiro Fujiwara(Graduate Student of Waseda University, Japan), Kenta Makawa(Waseda University, Japan), Masayuki Goto Goto(Waseda University, Japan)</i>	1375
TB3-3 (486)	Creating Attracting Digital Signage Content at Universities <i>*RYO AKAWA(Aoyama Gakuin University, Japan), RYUN MAEKAWA, KAKURO AMASAKI(AOYAMA GAKUIN UNIVERSITY, Japan)</i>	1383
TB3-4 (502)	A Data Mining Approach for Loan Marketing Response Model <i>*Jen-Ying Shih(National Taiwan Normal University, Taiwan), Wu-Hwa Chen(National Taiwan University, Taiwan)</i>	1388
TB3-5 (581)	The 7-Eleven Rule in the Simulation Output Analysis <i>*Wheyming Song(professor, Taiwan)</i>	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 <i>*Lulu Hu, *Tsu-Ping Chung, Hongying Shan(Jilin University, China), Chen-Ming Chen(Harbin Institute of Technology Shenzhen Graduate School, China)</i>	1413
TB4-2 (233)	Particle swarm Optimization for minimizing electrical consumption for flexible flowshop problem <i>*Krisanaratch Nilsin(Research Unit on Advanced Productivity Improvement and Logistics Management, Thailand), *Kanchana Selthanan(Faculty of engineering, Khon Kaen university, Thailand)</i>	1420
TB4-3 (284)	Campaign Planning for Multi-Purpose Batch Plants: A Case Study from the Pharmaceutical Industry <i>*Mao-Kai Hsu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)</i>	1427
TB4-4 (287)	Multi-Jobs Lot Streaming to Minimize the Mean Maximum Completion Time in Multi-Stages Hybrid Flow Shop Scheduling <i>*Said Syahputra(Institut Teknologi Bandung, Indonesia, Indonesia), Aras Ma'arif(Indonesia, Indonesia)</i>	1434
TB4-5 (309)	Shift-Scheduling Characteristic Identification of Non-Star Hotel Industry in Yogyakarta Indonesia <i>*Deny Yuniartha(Universitas Alma Jaya Yogyakarta, Indonesia), Ignatius Luddy Indra Purnama(Alma Jaya Yogyakarta University, Indonesia)</i>	1442

### TB5 Knowledge & Information Management

		Ramada-1, 14:20-16:00
<b>Chair: Minseok Song (Ulsan National Institute of Science and Technology, Korea)</b>		
TB5-1 (250)	Mergers and Acquisitions of ICT Firms for Technological Knowledge Sourcing <i>Yoonjung An, *Yongtae Park(Secul National University, Korea)</i>	1449
TB5-2 (278)	Analyzing Se <sup>303</sup> Processes Using Process Mining: A Case Study <i>Hanna Yang, *Minseok Song(Ulsan National Institute of Science and Technology, Korea)</i>	1454
TB5-3 (445)	Document Control for Research Reactor Construction by Advanced Nuclear Safety Information <sup>304</sup> Management System <i>*Kook-Nam Park(Korea Atomic Energy Research Institute, Korea), Sung-Kyu Le<sup>305</sup>-vision Co., Korea), Seung-Mi Baek(Korea Atomic Energy Research Institute, Korea), Min-Ho Choi(Korea Atomic Energy Research Institute, Korea), Yong-Se Kwon(Korea Atomic Energy Research Institute, Korea)</i>	1458
TB5-4 (297)	Factors influencing user acceptance of intelligent personal <sup>306</sup> assistants on smart devices <i>Jinye Park(LG Household &amp; Health Care, Korea), Eunho Suh(Pohang University of Science and Technology, Korea), *Kwon Lee(Pohang University of Science and Technology (POSTECH), Korea)</i>	1463
TB5-5 (389)	Prognosis and Survival Prediction of Lung Cancer by Bayesian Network <i>*Shi-Woei Lin, Yu-Wei Chen, Mohammad Jerusalem(National Taiwan University of Science and Technology, Taiwan)</i>	1471

		Ramada-2, 14:20-16:00
<b>TB6 Production &amp; Operations Management 2</b>		
<b>Chair: Ivy Mar Ramos (Bulacan State University, Philippines)</b>		
TB6-1 (49)	Application of ECRS and Simulation Techniques in Bottleneck Identification and Improvement: A Paper Package Factory <i>*Chomponool Kasemsaet<sup>47</sup>, Prin Pinmanee, Prinapun Umarin(Chiang Mai University, Thailand)</i>	1477
TB6-2 (124)	Assembly line type II problem of sewing lines in garment <sup>307</sup> industry <i>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)</i>	1485
TB6-3 (151)	EFFICIENCY AND BETTER PRODUCTION FLOW FOR A MANUFACTURER OF STATUES: AN APPLICATION OF MOTION AND TIME STUDY <i>Ivy Mar Ramos, Ivy Mar Ramos(Bulacan State University, Philippines)</i>	1492
TB6-4 (187)	A Genetic Algorithm for Solving Assembly Line Balancing Problem in Footwear Stitching Line <i>James C. Chen, Tzu-Li Chen, *Chieh-Ying Lin, Chun-Ju Lin(National Tsing Hua University, Taiwan)</i>	1500
TB6-5 (12)	Pricing, Production, and Ch <sup>308</sup> Coordination with Stochastic Learning <i>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)</i>	1507

		Ramada-3, 14:20-16:00
<b>TB7 Healthcare Systems 2</b>		
<b>Chair: Gino Lim (University of Houston, United States)</b>		
TB7-1 (95)	Construct the A <sup>309</sup> Platform for Evaluating the Static Postural Stability <i>*Chih-Hung Jen(Lung<sup>310</sup> University of Science and Technology, Taiwan), Bernard C. Jang(National Taiwan University of Science and Technology, Taiwan), Yin-Sung Chen(Yuan Ze University, Taiwan)</i>	1512
TB7-2 (106)	Recent Advances in Intensity Modulated Proton Therapy Treatment Plan <sup>311</sup> Optimization <i>*Gino Lim, Wenhua Cao(University of Houston, United States), Radhe Mohan(The University of Texas MD Anderson Cancer Center, United States)</i>	1520
TB7-3 (306)	Developing A Productivity Improving Framework by Overall Equipment Efficiency and An Empirical Study in A Hospital <i>*Chen-Fu Chien, Pei-Chun Chu, Mei-Li Kuo(National Tsing Hua University, Taiwan)</i>	1526
TB7-4 (379)	An analysis of patients flow in a hospital case study using Simulation model and plant layout	1534



Patcharaphon Poobanichao(KhonKaen University, Thailand), \*Panitum 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 1540  
 \*Aries Susanty(Lecturer, Indonesia), *dia puspitasari*(diponegoro university, Indonesia), Purnawan Wicaksono(Lecturer, India), Petty Primatuty(Student, Indonesia)

#### 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 1547  
 \*Yosi Hidayat, Veronica Adelein, Lucia Diawati(Institut Teknologi Bandung, Indonesia)
- TB8-2 (48) Using Petri Net ( PN ) Model for Design Flexible Manufacturing Systems ( Prototype FMS's ) 1554  
 \*Ibrahim Buseif(Staff member, Libya)
- TB8-3 (62) New Model of FMS using FTPN with Demand Variability and Machine Breakdown 1561  
 \*Muhammad Hanis Aziz(University of Engineering and Technology, Pakistan), Erik L.J. Bohez(Asian Institute of Technology, Thailand), Abid Ali, Neelum Iqbal(UET Taxila, Pakistan)
- TB8-4 (286) er Manufacturing System Model under Demand Uncertainty 1567  
 \*Muhammad Shadyk 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)
- TB8-5 (457) An iterative production planning approach for flexible semiconductor fabrication 1575  
 \*Sun Hoon Kim, Young Hoon Lee, Cheng Yu Hwang, Kee Yong Shin, Ki Yol Nam(Yonsei University, Korea)

#### TB9 Topics in IE/MS

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

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

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

#### 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 1612  
 Maricar Masala(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)



TC1-2 (464)	<b>02</b> An Improved Differential Evolution Algorithm for Vehicle Routing Problem: An Application in Mobile Medical Equipment Maintenance Unit <i>*Kanokwan Supakdee</i> (Department of Industrial Management Technology, Thailand), <i>Natthapong Nanthasamroeng</i> (Faculty of Industrial Technology, Thailand), <i>Rapeepan Pitakaso</i> (Metaheuristics for Logistics Optimization Laboratory (MLO), Thailand)	1620
TC1-3 (481)	<b>210</b> Heuristic for multi-stage capacitated p-median problem with supplier evaluation <i>*Anurak Chawichian</i> , <i>Rapeepan Pitakaso</i> (Ubonratchathani University, Thailand)	1626
TC1-4 (520)	<b>04</b> Heuristic Shift Scheduling for Airport Ground Staff <i>*Kong Wong Lee</i> (UNIMAS, Malaysia), <i>San Nah Sze</i> (Faculty of Computer Science and Information Technology Universiti Malaysia Sarawak, Malaysia), <i>Keat Keong Phang</i> (Faculty of Computer Science and Information Technology Universiti Malaysia, Malaysia)	1633
TC1-5 (192)	Optimization of Milk Productivity in Dairy Cattles by Genetic Algorithm <i>*Senol Altan</i> (Gazi University, Turkey), <i>Fatih Akbars</i> (Ulsan National Institute Of Science and Technology, Korea), <i>Emrecan Ozelen</i> (Republic of Turkey Ministry of Food, Turkey)	1639

## TC2 Inventory Modeling / Artificial Intelligence

Byang, 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 <i>*Wisut Supithak</i> (Kasetsart University, Thailand), <i>Sasiprapa Limpakan</i> (Kasetsart University, Thailand)	1647
TC2-2 (123)	A Stochastic Programming Model for Vendor Managed Inventory System of an Animal Feed Factory and Farm Network <i>*Thawee Nakrachata-Amon</i> (Faculty of Engineering, Thailand), <i>Supachai Pathumakul</i> (Khon Kaen University, Thailand)	1654
TC2-3 (101)	<b>110</b> Vendor Managed Inventory for Fresh Agricultural Products <i>*Mitsuyoshi Honkawa</i> , <i>Takeo Takeno</i> , <i>Mitsumasa Sugawara</i> (Iwate Prefectural University, Japan)	1659
TC2-4 (318)	Vehicle risk assessment in accidents using neural network <i>Yuri Castro</i> , <i>*Young Jin Kim</i> , <i>Baek An Sun</i> (Kyung Hee University, Korea)	1665

## TC3 Artificial Intelligence

Udo, 16:20-18:00

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

TC3-1 (182)	The Study of Tokai Cluster as a Leader of CFRP Industries in Japan <i>*Akihito Zenke</i> , <i>Nobutaka Otake</i> (Nagoya Institute of Technology, Japan)	1672
TC3-2 (260)	Agent-based Real-time Scheduling for Smart Household Appliances <i>Bobby Kurniawan</i> , <i>*Anggoro Pramudyo</i> , <i>Didik Aribowo</i> (Unlirta, Indonesia), <i>Anss Ma'nul</i> (Institut Teknologi Bandung, Indonesia)	1678
TC3-3 (391)	APPLICATION OF CLOUD-BASED KANBAN SYSTEM IN PROJECT MANEGEMENT <i>Chi-Wei Shih</i> , <i>*Chen-Yang Cheng</i> (Tungshai University, Taiwan)	1683
TC3-4 (490)	User's Free Time Estimation <b>32</b> when Using Smartphone <i>*Kohei Yamamoto</i> (Kanazawa Graduate School of Natural Science and Technology, Japan), <i>Tatsuhito Hasegawa</i> (Tokyo Health Care University, Japan), <i>Haruhiko Kimura</i> (Kanazawa University, Japan)	1688
TC3-5 (499)	Earned Value Management considering Milestone Weighting and Dependency Structure Matrix <i>*Ronaldo Polanco</i> (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 Sched <b>12</b> n Jobs m Machines Parallel Algorithm to Minimize Makespan <i>*Rifa Arisati</i> (University of Pembangunan Nasional Veteran Jakarta, Indonesia), <i>Aji P.</i>	1696
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	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 heterogeneous 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(Tungshai 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 Metzk(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 Hasuke(Osaka University, Japan)	1720
TC9-2 (546)	A Single-Producer Multi-Retailer Integrated Inventory System with Scrap in Production and Shortage in sale *Hiyoshi Hiyoko, 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 Parsangolad(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, Thilina Sommanapong(Kanagawa University, Japan), Hans Ehm(Infinion Technologies AG, Japan), Geraldine Yachi(Infinion Technologies AG, Japan)	1748

#### WA1 Inventory Modeling & Management

Mara, 08:30-10:10

Chair: Nobuaki Ishii (Bunkyo University, Japan)

WA1-1 (85)	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), Ikuro Arizono(Okayama University, Japan)	1762
WA1-3 (71)	Inventory Classification Involving Substitution Rules *Bou Jaku, Xinyi Zhang(Tokyo City University, Japan)	1769
WA1-4 (446)	Reducing Inventory using Inventory Management Models *Sakrasem Rattirongwong, 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, Sonja Irshad Mari(Hanyang University, Korea)	1779



**WA2 SCM and Forecasting 1**

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

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

**WA4 Scheduling & Sequencing 3**

Chuja, 08:30-10:10

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

- WA4-1  
(85) **Scheduling with 5-attribute setup times on unrelated parallel machines** 1859  
Ching-Jong Liao(National Taiwan University of Science and Technology, Taiwan), Hsiung-Lee(Chithee Institute of Technology, Taiwan), Hsing-Tzu Tsai, Ku-Jui Wu(National Taiwan University of Science and Technology, Taiwan)
- WA4-2  
(120) **Scheduling on parallel machines with mold constraints** 1867  
Haidan Zhao, \*Tsui-Ping Chung, Hongying Shen(Jilin University, China), Chien-Ming Chen(Harbin Institute of Technology Shenzhen Graduate School, China)
- WA4-3  
(177) **Transient Period Scheduling of Dual Armed Cluster Tools** 1874  
\*Nurhak Abbas, Taejun Yu, Tae-Eog Lee(KAIST, Korea)
- WA4-4  
(316) **Adaptive Hybrid Genetic algorithm for solving two-stage reentrant flexible flow shop with blocking constraint** 1880  
Chaturagob Sangsawang, \*Kanchana Sethanan(Research Unit on Advanced Productivity



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

- WA4-5  
(509) **Decision Support System for Order Online Delivery** 1888  
\*San-Nah Sze, Bui-Fai Thian, Kang-Leng Chien(University Malaysia Sarawak, Malaysia)

#### 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** 1894  
\*Rionel Caldo(Lyceum of the Philippines University - Laguna, Philippines)  
97
- WA5-2  
(58) **Fuzzy Logic Simulation of DC Boost Converter Using Matlab Fuzzy Logic Toolbox** 1902  
Rionel Caldo, \*Rionel Caldo(Lyceum of the Philippines University - Laguna, Philippines)  
159
- WA5-3  
(224) **Cost Effectiveness Analysis Comparing Mastectomy versus Lumpectomy with Fuzzy Logic** 1908  
Ayşın Aifas, \*gözde tutumcu(Izmir University of Economics, Turkey)  
141
- WA5-4  
(576) **Fuzzy AHP based Supplier Selection considering the Triple Bottom Line Concept** 1914  
Wannim Khampanya, Titas Laosinhorngthong(Thanmasat University, Thailand), \*Premaratne Samarasinghe(University of Western Sydney, Australia)

#### 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** 1920  
\*Usama Bin Perwez, Muhammad Fawaz, Amir Ahmed Baqai(National University of Sciences & Technology, Pakistan)  
123
- WA6-2  
(69) **Optimal Solar Photovoltaic (PV) Penetration in Secondary Distribution Network Using Genetic Algorithm** 1929  
Bryan Agapuro(Technological Institute of the Philippines, Philippines), \*Mancar Meola(Technological Institute of the Philippines-Quezon City, Philippines)  
89
- WA6-3  
(288) **Numerical Analysis of Three Rookies Assignment Optimization in Limited-Cycled Model with Multiple Periods -the case of Erlang Distribution** 1937  
\*Peiya Song, Xianda Kong, Hisashi Yamamoto(Tokyo Metropolitan University, Japan), Jing Sun(Nagoya Institute of Technology, Japan), Masayuki Matsui(Kanagawa University, Japan)
- WA6-4  
(577) **Optimal Ordering Policies under a Progressive Interest Scheme with Supplier's Quantity Discount** 1945  
Gary Chen, \*Daniel Siek, Hui Wee(Chung Yuan Christian University, Taiwan)  
212
- WA6-5  
(415) **An analysis on the influences of flat pricing for unlimited voice callings: the aspects of MNOs and consumers in Korea** 1951  
\*SEONGJUN LEE, SAESOL CHOI(Electronics and Telecommunications Research Institute, Korea)

#### 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** 1957  
\*Ridhiyono Ridhiyono(Islamic University of Indonesia, Indonesia)
- WB1-2  
(139) **A study for making standardized-work tables suited for enterprises of the engineering /plworking industry** 1962  
\*Masahiro Saito(Tokyo Metropolitan University, Japan), Kenichi Iida(Hokkaido Research Organization, Japan), Koki Mikami(Hokkaido University of Science, Japan)  
51
- WB1-3  
(256) **Implementation of methods and solutions for improving statistical thinking of non-English speaking students studying in Industrial Engineering field** 1967  
\*Huy Nguyen, Huy Nguyen, Huy Nguyen(International University - Vietnam National University)

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

**WB2 SCM and Forecasting 2**

Byang, 10:30-12:10

Chair: Kazuhiro Takeyasu (Tokoha University, Japan)

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

**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** 2007  
\*Imam Widada, Tio Sampurno(Islamic University of Indonesia, Indonesia)
- WB3-2  
(348) **A Study of Product Design Using Parts and Parts Structures Characterized by Reviews on Internet** 2012  
\*Masahiro Arakawa, Erika Katou(Nagoya Institute of Technology, Japan)
- WB3-3  
(350) **Derivation of design freeze sequence using Bayesian network framework** 2018  
Jihwan Lee, \*Yoo Hong(Seoul National University, Korea)
- WB3-4  
(93) **Investigation of PLA/PCL biocomposite scaffolds fabricated via SVM rapid prototyping** 2025  
Karnkorn Kamonrit, \*Thitikon Phattanasitkul(Kasetsart University (Srinacha Campus), Thailand)
- WB3-5  
(84) **Assessment of an ERP Graphical User Interface Design Related to Human Cognition** 2031  
\*Grace Lomala Intal, Catherine Briones(Mapua Institute of Technology, Philippines)

**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** 2040  
\*Katsumi Morikawa, Katsuhiko Takahashi(Hiroshima University, Japan), Daisuke Hirotsu(Prefectural University of Hiroshima, Japan)
- WB4-2  
(46) **Flexible Jobshop Scheduling Model Considering Production Cost and Tardiness Cost Simultaneously** 2048  
\*Davy Sari, Anas Ma'rif(Institut Teknologi Bandung (Bandung Institute of Technology), Indonesia)
- WB4-3  
(403) **Batch Scheduling for a Single Machine with Forgetting Effect to Minimize Total Actual Flow Time** 2055  
Rinto Yusriski, \*Sukoyo (Bandung Institute of Technology, Indonesia), T.M.Agung Samadhi(Institut Teknologi Bandung, Indonesia), Abdul Halim(Industrial Engineering (ITB, Indonesia)
- 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)  
44  
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 Establishment of a New Vietnam Production Model 2077  
(453) \*Shogo Miyashita, Kakuro Amasaka(Aoyama gakuin University, Japan)
- WB5-2 A taxonomy of 100 core rate indexes based on literature review 2083  
(508) se (100) won koh(Pohang University of Science and Technology, Korea), Kiwook jung, Bongjun  
(Pohang university of science and technology, Korea), \*Hyunbo Cho(POSTECH, Korea)  
11
- WB5-3 Comparative Study of SA algorithms of optimal arrangement problem in a Multi-state k-out- 2090  
(270) of-n-F system  
117 Ki Yoshida(Tokyo Metropolitan University, Japan), Koji Shingyochi(Jumonji 21 ersity, Japan),  
Hsashi Yamamoto(Tokyo Metropolitan University, Japan), Tomoaki Akiba(Chiba Institute of  
Technology, Japan), Xiao Xiao(Tokyo Metropolitan University, Japan)  
90
- WB5-4 A New Universal Generating Function Method to Search for all Minimal Paths Generate in 2098  
(517) Networks 3  
Wei-Chang Yeh(National Tsing Hua University, Taiwan), \*Hui-Wen Lee(National Tsing Hua  
University Hsinchu, Taiwan)
- WB5-5 Prioritizing the Factors for Quality Excellence Practices Using Analytic Hierarchy Process 2106  
(421) (AHP) Method 29  
\*Mehran Doulat Abadi(Universiti Teknologi Malaysia (UTM), Malaysia), Sha'ri Mohd  
Yusoff(Universiti Teknologi Malaysia, Malaysia)

#### WB6 Lean Manufacturing

Ramada-4, 10:30-12:10

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

- WB6-1 LINEASSEMBLY ANALYSIS FOR PC-250 PRODUCT TYPE WITH HEURISTIC METHOD 2107  
(129) AT PT. TIRTA INTIMIZU NUSANTARA  
\*Lina Gozali(Tarumanagara University, Indonesia), Silvi Anyanti(University of Meru Buana,  
Indonesia), Rendy (University of Tarumanagars, Indonesia)
- WB6-2 Waste Reduction in Work Processes Using Lean Tools and Simulation: A Case Study 2113  
(371) Logistics Service Providers  
Worakit Changluek(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)
- WB6-3 A Framework to Apply Cellular Manufacturing 2119  
(553) \*Wei Wang, Atsushi Fukui, Shigeru Fujimura(Waseda University, Japan)
- WB6-4 A Study on the E-Waste Generation and Management in the Philippines: It's Impact and 2126  
(110) Significance  
\*Weslor Ong(University of Santo Tomas, Philippines), Patricia Kamel Kindi, Angela Camille San  
Miguel, Charlene Mae Ramirez(Faculty of Engineering, University of Santo Tomas, Philippines)  
6
- WB6-5 A model for Designing Resilient and Sustainable Supply Chain under Disruptions 2134  
(516) Sonia Inshad Mar, \*Young Hae Lee, Muhammad Saad Memori(Hanyang University, Korea)

#### POSTER Poster Session

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

Chair: (, )

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



	*Chi-Yen Yao(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 Sedjo Oh, *Young-jin Kim(Kyung Hee University, Korea)	2156
POSTER-4 (204)	Ergonomically Designed Armchair for Both Left- and Right-Handed Students *Juan Tecson(Bulacan State University, Philippines)	2159
POSTER-5 (220)	Scheduling outpatient appointments in a neurosurgery department of a university hospital Youngmin Ki, *Byung-In Kim(POSTECH, Korea), Byung Kwan Choi(School of Medicine Pusan National University, Korea), Sung-Hong Kang(Hye University, Korea)	2165
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(Sekai University, Japan), Masahiro Nakamura(LEXER RESEARCH Inc., Japan)	2179
POSTER-9 (365)	A New approach in Fault Recognition using Mel Cepstrum Coefficients and Hidden Markov Models *Young Kim, Monica Chumay Castro(Kyung Hee University, Korea)	2183
POSTER-10 (366)	Differences in the perception of determining factors in inter-organizational relationships *An Young(ETRI (Electronics and Telecommunications Research Institute), Korea), Yanghon Chung(KAIST(Korea Advanced Institute of Science and Technology), Korea)	2188
POSTER-11 (382)	Do Young People Trust e-Government As Much As Their Internet Experiences? A Preliminary Study in Bandung City *Dea Marella(Bandung Institute of Technology, Indonesia), Nadinastiti Muladi(Institut Teknologi Bandung, Indonesia), Pravitarsi -(Universitas Indonesia, Indonesia)	2193
POSTER-12 (400)	Statistical Forecasting of Material Demand through Big Data Analysis JeongAh Yoon, MinJeong Park(UNIST, Korea), Anna Yang(Ulsan National Institute of Science and Technology, Korea), *Daeil Kwon(UNIST, Korea), Minseok Song(Ulsan National Institute of Science and Technology, Korea)	2198
POSTER-13 (414)	Prediction for Material Usage Using Decision Tree Minjeong Park, *Minseok Song, Daeil Kwon(Ulsan National Institute of Science and Technology, Korea)	2201
POSTER-14 (422)	Design and Development of an Automated Blood Typing Device Jhunlyn Lorenzo, *Jhunlyn Lorenzo(Cavite State University, Philippines)	2204
POSTER-15 (432)	Activate a depopulated district using POS data analysis Akira Matsuzaki, *Kohsuke Kato(Kanazawa Institute of Technology, Japan)	2212
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# LINE BALANCING ANALYSIS FOR PRODUCT TYPE PC-250 BIT WITH HEURISTIC METHOD AT PT TIRTA INTIMIZU NUSANTARA

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**Abstract.** PT. Tirta Nusantara Intimizu produces manufacturing industrial water pumps. Some parts of the water pump are produced at PT. Intimizu Tirta Nusantara, but there are some parts that come from suppliers within and outside of the country. The parts that are ready to be assembled on the assembly line but not smooth and many line stop in the assembly process become a major problem. It makes the time-consuming process of assembly process takes a long time. Therefore, to solve this problem which used several methods of line balancing are a Kilbridge Wester method, Helgeson Birnie method, J – Wagon method, and Moodie Young Method by time study and raw material management. The aim of these methods for assembly line is how to reduce the processing time on the assembly line. The current condition showed that the equilibrium line amounted to only 63.89 %, 36.11 % for the balanced delay, smoothness index of 124.61, and has a production capacity of only 11 units per month. After using the Moodie Young method the company obtains the higher efficiency of 84.57 %, balanced delay of 15.43 %, smoothness index of 52.21, and increase the production capacity of 2411 units per month to 2593 units per month.

**Keywords:** Line balancing, Killbridge Wester, Helgeson Birnie, J - Wagon, Moodie Young.

## 1. INTRODUCTION

PT. Tirta Intimizu Nusantara (TIN) is one of the manufacturing companies in Indonesia which is engaged in the field of water pumps. At the beginning PT. Intimizu Tirta Nusantara has been producing water pump as the main product, but after that some kind of water pump is produced to fulfill the needs of the people of Indonesia and export. PT. TIN still has some problems, especially with some elements of the work station at the assembly line. This has an impact on productivity is hampered and can't meet the sales planning targets.

In this research, discussing and analyzing the balancing line on the water pump type PC-250 BIT at PT. Intimizu Tirta Nusantara. The goal of this research is how to increase the production capacity and improve the line efficiency. In addition, it is expected to reduce the delay time and the bottleneck activities that occur on the assembly line too. The methods are used in this study are the Kilbridge Wester Method, Helgeson Birnie

Method, J-Wagon Methods, and Moodie Young Method.

## 2. LITERATURE STUDY

The line balancing method for job assignment is related to each other work stations in a production line where each station has a processing time that does not exceed the cycle time of each work stations. In general, planning for line balancing includes efforts to achieve an optimal capacity, which does not happen if there is too much idle time. It is interconnected between the jobs assignment and labors assignment. Therefore, the activities relationship is described with a relationship diagrams (precedence diagram), while the relationship between jobs is called job precedence or precedence network.

Time of each work element is obtained from initial calculations of motion time with normality test, uniformity test and adequacy of the data. Once the data is otherwise normal, pretty

uniform and subsequent, then calculate the normal time from standard time of each work element. Calculation of the normal time and standard time as below equation [Sutalaksana, 2006]:

$$\text{Normal Time} = \frac{\text{Average time measurement}}{\text{performance rating}} \quad (1)$$

$$\text{Standard time} = \text{Normal time} (1 + \text{Allowance}) \quad (2)$$

According to Kusnadi (2009), the cycle time is defined as the time required to produce one unit of product, in this case determined from the longest process (bottleneck), whether it is human or machine work. This will determine each method, the value of the cycle time to be obtained.

## 2.1. Line Balancing

According Gasperz (2000), line balancing is a balancing task assigned with work station elements in assembly line to minimize the amount of work station and minimize the total idle time on all stations for a certain level of output, which in this line balancing the processing time per unit of product at specified for each task and the sequential relationship should be considered.

## 2.2. Kilbridge-Wester Heuristic Method

Kilbridge-Wester is a method designed by M. Kilbridge and L. Wester as another approach to overcome the problems of equilibrium line [Irfan, 2010]. In this method, the performance of grouping elements into groups that have the same level of connectedness. The steps used method Kilbridge-Wester are as follows:

- Produce the precedence diagram from the problems.
- Grouping the precedence from left to the right in column area
- Grouping elements in many ways to reach the best grouping which has a best or almost the same time with the cycle time.
- If any elements of work station have no grouping yet and the grouping time is less the cycle time, continue to group with the element in the next precedence.
- Continue the grouping process until all the elements are grouped.

## 2.3. Helgeson-Birnie Method

This method more popular than as the the Ranked Positional-Weight Technique because this technique using ranked to make group elements and suggested by Helgeson and Birnie [Bedworth, 1987]. The steps in this method are as follows [Irfan, 2010]:

- Create a precedence diagram for each process.

- Determine the weight of the position for each element of work related to the operation time for the longest processing time from the beginning to the rest of the starting operation after operation.
- Rank each processing element is based on the weight of the position in step 2. Workmanship which has the greatest weight is placed on the first rank.
- Determine the cycle time (CT).
- Select the operating element with utmost weight i, allocated to a work station. If still viable, time station (ST) < (CT), allocate operation with the next highest weight, but this location should not make time station > CT.
- If the allocation of a station operating elements make time > CT, then the rest of the time (CT - ST) is filled with the allocation of the operating element with the greatest weight and the addition does not make ST < CT.
- If the operating element that allocated to make ST < CT is not there, go back to step c.

## 2.4. J-Wagon Method

This method prioritized the highest number of work elements, where the elements of the work will be prioritized in advance to be placed in a work station and was followed by work elements that have the smallest number of work elements (Aquilano & Chase, 407). Here are the steps of J-Wagon method:

- Calculate the summary of work elements from each operation base on number of operation time from precedence network.
- Rank the operation base on the biggest number of operation time
- Allocate the operation which has the beginning position from all the precedence diagram.
- Allocate the operation to the whole station.
- Allocate all station which total processing time not more than certain  $C_T$  (Cycle Time).

## 2.5. Moodie Young Method

Moodie Young method has two stages of analysis. Phase (phase) of the work station is made by grouping matrix elements of the relationship between work, such methods are not ranked like Helgeson-Birnie method. Phase two, to revise the results of phase one [Irfan, 2010].

Phase one: Elements of workmanship placed on successive work stations in assembly lines using Largest-candidate rules. Largest-candidate rule consists of the placement of the elements for the purpose of reduction of time. From here, when the two elements work are enough to be placed in the station, one of which with a larger time placed first. Purpose of placement for each element is to reduce the time for next arrangement. For example, matrix P indicates precursor workmanship of each element



and the matrix F workmanship followers for each element for each assignment procedure.

Phase two: In phase two, trying to distribute idle time (idle) evenly (same) for each station. The steps in step two are as follows:

- Determine the two elements of the shortest and longest time of rebalancing phase one station.
- Determine the half of differences between the two goal value
- $GOAL = (ST_{max} - ST_{min}) / 2$ .
- Determine single element in  $ST_{min}$  which is less than two goal value and not more than predecessor element
- Determine all the possible exchange of  $ST_{max}$  with single element of  $ST_{min}$  which reducing  $ST_{max}$  and get  $ST_{min}$  will smaller than 2 x GOAL Value.
- Perform onsite indicated by the candidate with the smallest absolute difference between the candidates with GOAL value.
- If there is no exchange or transfer is possible between the largest and smallest station, seeking exchange between rank on the following work: N (station N has ranked the greatest amount of idle time), N-1, N-2, N-3, ..., 3, 2, 1.

If exchange is not possible, do the restrictions on the value of GOAL and repeat steps a to f.

## 2.6. Line Balancing Evaluation

Trying to apply the method of line balancing, take a few steps. The steps that should be performed include:

- Collect data about the target output production each day and working hour per day.
- Collect data about jobs, number or production, working time for each element in production.
- Make the network of fabric cutting, sewing and packing.
- Calculate the cycle time with below equation:

$$CT = \frac{\text{Working hour per year (second)}}{\text{Demand per year (pcs)}} \quad (4)$$

- Calculate the minimal number of work elements (N) with equation:

$$N = \frac{\text{Total time of working element (second)}}{\text{cycle time (second)}} \quad (5)$$

- Applying each line balance method, these three methods are used such as Kilbridge-Wester Heuristic methods, Helgeson-Birnie method and Moodie Young method.
- After all of the calculation from each method, calculate the line efficiency with equation [Baroto, 2004]:

$$LE = \frac{\sum TSi}{(K)(CT)} \times 100\% \quad (6)$$

Which:

$TSi$  = Work element time -i

$K$  = Total number of work element

$CT$  = Longest cycle time

- Then calculate the balance delay (Balance Delay). Balance Delay is a measure of the inefficiency of the resulting trajectory of the actual time unemployed due to imperfect allocation between workstations. Balance Delay can be formulated as follows [Baroto, 2004]:

$$BD = 100\% - LE \quad (7)$$

- Smoothness Index is an index showing the relative smoothness of specific assembly line balancing. Furthermore Smoothness Index can be calculated by the formula:

$$SI = \sqrt{\sum (TSi_{max} - TSi)^2} \quad (8)$$

- This calculation results will be analyzed with the descriptive and the comparison with the original factory condition. So it can be applied to a method that improved its efficiency line of factory.

## 3. RESEARCH METHODOLOGY

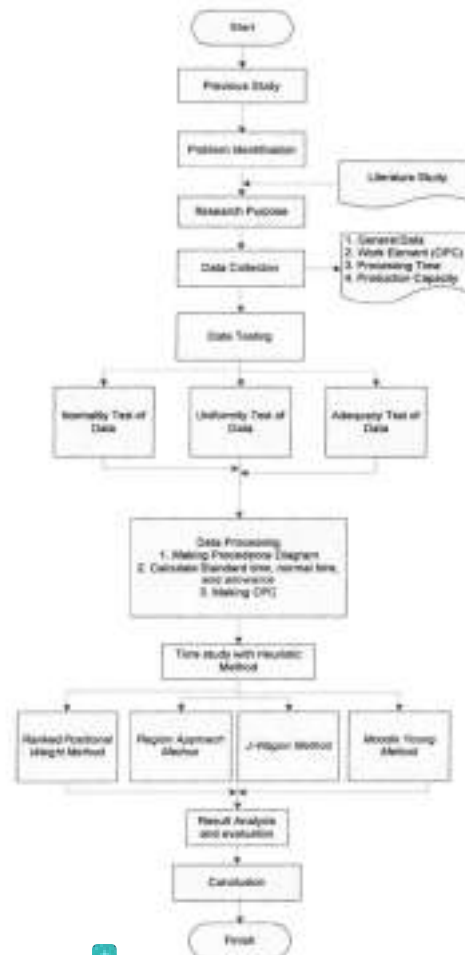


Figure 1. Research Methodology



#### 4. DATA COLLECTING AND DATA PROCESSING

After doing the normality test, uniformity test, and adequacy test of the data then performing calculations using line balancing methods that have been determined. Here is a precedence diagram or precedence network is as follows:

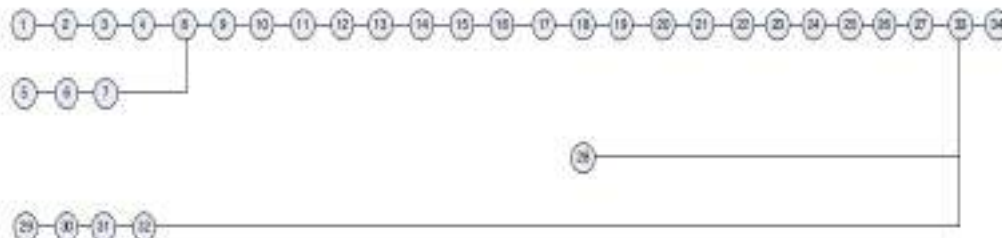


Figure 2. Precedence Diagram

In Table 1 shows the result of Line Balancing performance analysis of initial conditions. Furthermore, in Table 2, Table 3, Table 4 and Table 5 respectively are calculated using Kilbridge Wester Method, Helgeson Birnie Method, J-Wagon methods, and Moodie Young Method.

Table 1. Initial Condition of Assembly Line Balancing from the Company

Work Station	Work Element	Total Time
I	1,2,3,4	40.75
II	5,6,7	63.47
III	8,9,10,11	53.54
IV	12,13,14,15	48.76
V	16	18.88
VI	17	56.65
VII	18	36.79
VIII	19,20	58.78
IX	21	24.55
X	22,23	13.98
XI	24	16.84
XII	25,26,27	27.16
XIII	28	6.53
XIV	29,30,31,32	57.72
XV	33	48.01
XVI	34	32.53

Table 2. Assembly Line Balancing Calculation with Kilbridge Wester Method.

Work Station	Work Element	Total Time
I	1,5,29,2	19.1
II	6,30	61.44
III	3,7	50.19
IV	31,4,32,8	71.68
V	9,10,11	56.98
VI	12,13,14,15,16	67.64
VII	17	56.65
VIII	18,28	28.58
IX	19	58.78
X	20,21,22,23,24,25	72.56
XI	26,27	24.71
XII	33	48.01
XIII	34	32.53

Table 3. Assembly Line Balancing Calculation with Helgeson Birnie Method

Work Station	Work Element	Total Time
I	5,6	63.47
II	1,2,7,3	59.58
III	4,8,9,10	38.31
IV	11,12	69.18
V	13,14,15,16	38.77
VI	17	56.65
VII	18	22.05
VIII	19	58.78
IX	20,21,22,29,30	55.13
X	31,23,24,25	59.25
XI	26,32,28,27	47.14
XII	33	48.01
XIII	34	32.53

Table 4. Assembly Line Balancing Calculation with J-Wagon Method

Work Station	Work Element	Total Time
I	1,2,5	13.84
II	6,3	72.45
III	7,4,8,9	67.92
IV	10,11	47.46
V	12,13,14,15,16	67.64
VI	17	56.65
VII	18	22.05
VIII	19	58.78
IX	20,21,22,23,24	70.11
X	29,25,30,31,26	63.22
XI	32,28,27	28.19
XII	33	48.01
XIII	34	32.53

Table 5. Assembly Line Balancing calculation with Moodie Young Method

Work Station	Work Element	Total Time
I	1,2,3,4	40.75
II	18,5,8	30.21
III	6,7	59.02
IV	9,10,11	56.98
V	12,13	38.63
VI	14,15,16	29.01
VII	17	56.65
VIII	19	58.78
IX	20,21,22,23	53.27
X	24,25,26,27,28,29,30	58.21
XI	31,32	50.04
XII	33	48.01
XIII	34	32.53

The results of each line balancing methods are as follows:

Table 6. Result Comparison about Assembly Line Balancing between Kilbridge Wester Method, Helgeson Birnie Method, J-Wagon Method dan Moodie Young Method.

	Initial Condition	Kilbridge Wester	Hegelson Bernie	J Wagon	Moodie Young
Line Efficiency (%)	63.89	68.79	72.15	68.89	<b>84.57</b>
Balance Delay (%)	36.11	31.21	27.85	31.11	<b>15.43</b>
Smoothness Index	124.61	103.06	75.62	106.4	<b>52.21</b>
Longest Time (second)	63.47	72.56	69.18	72.45	<b>59.02</b>
Number work station	16	<b>13</b>	<b>13</b>	<b>13</b>	<b>13</b>
Production Capacity (Unit/Month)	2411	2109	2212	2112	<b>2593</b>
Idle Time (second)	410.58	321.34	321.34	321.34	<b>316</b>

From the results above it can be seen that the Moodie Young Method has higher efficiency (84.57%) than other methods, with balance delay 15.43%, smoothness index 52.21, 59.02 seconds for longest time, 13 station number, production capacity is 2593 units / month, and 316 seconds idle time. Comparing with the initial assembly line, line efficiency has increased by 20.68%, balance delay decreased by 20.68%, smoothness index reached the lowest value, the longest time decreased the number of stations to 13 stations, production capacity increased to 2593 units, idle time reduced to 94.58 second. It can be concluded that Moodie Young method is the best method.

## 5. CONCLUSION

The conclusions of this study are as follows:

- The best method is Moodie Young Method by reducing cycle time from initial condition from 63.47 seconds to 59.02 second and reducing idle time from 410.58 second to 316 second
- Moodie Young Method can improve line efficiency from 63.89% to 84.57%, reducing balance delay from 36.11% to 15.43%, reducing smoothness index from 124.61 to 52.21, reducing number of work station from 16 to 13, improve production capacity unit from 2411 unit to 2593 unit.

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