Message from the APIEMS President

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

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

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

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

Message from the General Chair

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

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

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

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Conference Committee

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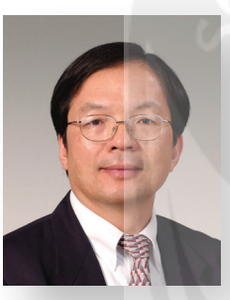
Keynote Speech I
Research Issues in Future Logistics

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

***Room:** Ramada-1*

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



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

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

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

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

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

***Room:** Ramada-1*

Ronald G. Askin
Arizona State University, USA

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

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

Keynote Speech

Keynote Speech III
Big Data Management

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

Room: Ramada-1

Sungzoon Cho
Seoul National University, Korea.

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

Detailed Program

MA1 Data Mining 1

Mara, 08:30-10:10

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

MA2 Management of Technology and Innovations 1

Biyang, 08:30-10:10

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

MA3 ERP/E-Business

Udo, 08:30-10:10

Chair: Kazuhiko Yasuda (Tohoku University, Japan)

MA4 Service Sciences 1

Chuja, 08:30-10:10

Chair: Kwang-Jae Kim (POSTECH, Korea)

MA5 Quality Engineering & Management 1

Ramada-1, 08:30-10:10

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

MA6 Production and Operations Management 1

Ramada-2, 08:30-10:10

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

MA7 Metaheuristics

Ramada-3, 08:30-10:10

Chair: Ching-Jung Ting (Yuan Ze University, Taiwan)

MA8 Financial Models & Engineering

Ramada-4, 08:30-10:10

Chair: Bong-Gyu Jang (POSTECH, Korea)

MA9 Uncertainty Theory (Session I)

Halla(8F), 08:30-10:10

Chair: Jinwu Gao (Renmin University of China, China)

MB1 Decision Support Systems & Expert Systems

Mara, 13:30-15:30

Chair: Hyerim Bae (Pusan National University, Korea)

MB2 Probability & Statistical Modeling

Biyang, 13:30-15:30

Chair: Junghye Lee (POSTECH, Korea)

MB3 Ergonomics/Human Factors 1

Udo, 13:30-15:30

Chair: Mao-Jiun Wang (National Tsing Hua University, Taiwan)

MB4 Service Sciences 2

Chuja, 13:30-15:30

Chair: Chen-Yang Cheng (Tunghai University, Taiwan)

MB5 Quality Engineering & Management 2

Ramada-1, 13:30-15:30

Chair: Shu-Kai Fan (National Taipei University of Science and Technology, Taiwan)

MB6 Production and Operations Management 2

Ramada-2, 13:30-15:30

Chair: Gyu M. Lee (Pusan National University, Korea)

MB7 Green Manufacturing/Management

Ramada-3, 13:30-15:30

Chair: Hsiao-Fan Wang (National Tsing Hua University, Taiwan)

MC1 Supply Chain Management 1

Mara, 15:50-17:50

Chair: Rainisa Heryanto (Maranatha Christian University, Indonesia)

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MC1-3 (279)	The Proposal of Applying Multi Echelon Inventory to Minimize Supply Chain Total Cost for Soft Drinks *Santoso -, Rainisa Heryanto(Maranatha Christian University, Indonesia)	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 *Rainisa Heryanto(Maranatha Christian University, Indonesia), Senator Bahagia(Bandung Institute of Technology, Indonesia)	630
MC1-5 (355)	Coordination of supply chains with risk-averse members under budget constraints *Ilkyeong Moon, Xuehao Feng(Seoul National University, Korea)	638
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MC2 Reliability & Maintenance

Biyang, 15:50-17:50

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MC2-3 (153)	Method of Minimizing Costs in Consideration of System Backup Intervals and Expected Costs *Shinya Mizuno(Center for Information Infrastructure, Japan), Naoki Kondo(Shizuoka Professional Training College of Industrial Technology, Japan), Haruki Inoue, Takahiro Hasegawa, Naokazu Yamaki(Center for Information Infrastructure, Japan)	667
MC2-4 (320)	Applied Algorithm for the Optimal Arrangement Problem of a Connected-(r, s)-out-of-(m, n):F System *Toru Omura, Hisashi Yamamoto(Tokyo Metropolitan University, Japan), Tomoaki Akiba(Chiba Institute of Technology, Japan), Xiao Xiao(Tokyo Metropolitan University, Japan)	673
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MC3 Ergonomics/Human Factors 2

Udo, 15:50-17:50

Chair: Zahari Taha (Universiti Malaysia Pahang, Malaysia)

MC4 Network Optimization

Chuja, 15:50-17:50

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

MC5 Quality Engineering & Management 3

Ramada-1, 15:50-17:50

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

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**Chia-Yu Hsu, Shih-Chang Chiu(Yuan Ze University, Taiwan)*

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**muhammad malik(Universiti teknologi Malaysia, Malaysia), Sha'ri Mohd Yusof(Universiti Teknologi Malaysia, Malaysia)*

MC6 Simulation 1

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Chair: Pudji Astuti (Trisakti University, Indonesia)

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MC7-4 (194) A Personalized Tele-home Care System for Solitary Elders 866
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MC8 Optimization Techniques 1

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*Yan-Han Lu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)*

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MC9 Educational Support System

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

Chair: Masahide Yamamoto (Kanazawa Seiryo University, Japan)

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Yumi Tatsushima(Kanazawa Seiryo University, Japan)

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TA1 Supply Chain Management 2

Mara, 08:40-10:40

Chair: Etsuko Kusukawa (Osaka Prefecture University, Japan)

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TA1-2 (59) — Analyzing the evolutionary stability for behavior strategies in green supply chain — 965
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TA1-5 (130) Research in Supply Chain Management: Issue and Area Development 988
*elisa kusrini(Department of Industrial Engineering, Indonesia), *siti Budijati(Faculty of Engineering, Indonesia), subagyo subagyo(Indonesian Islamic University, Indonesia), nuraini masruroh(Yogjakarta, Indonesia)*

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*James C. Chen(National Tsing Hua University, Taiwan), Janet Chen, Yun-Wei Hung(Industrial Technology Research Institute, Taiwan), *Muhammad Rinaldi Darmawan, Nadia Aulia Arifin, Hsin-Yu Shih(National Tsing Hua University, Taiwan)*

TA2 Communication Support

Biyang, 08:40-10:40

Chair: Sakiko Ogoshi (Kanazawa University, Japan)

TA2-1 (443) Discrimination of Positive / Negative Attitude Using Optical Flow 1003
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TA2-2 (535) Development of the support system for facial expression training 1010
Yusuke Amagata, Yasuhiro Ogoshi(University of Fukui, Japan), Sakiko Ogoshi(Kanazawa University, Japan), Tomohiro Takezawa(The National Institute of Vocational Rehabilitation, Japan), Yoshinori Mitsuhashi(Chiba, Japan)

TA2-3 (489) Discrimination of Micro-Expression with Subjective Assessments 1015
Kiyotaka nakashima(Graduate School of Natural Science, Japan), Munehiro Nakamura(Kanazawa Institute of Technology, Japan), Haruhiko Kimura(Graduate School of Natural Science, Japan)

TA2-4 (536) Facial electromyogram (FEMG) analysis of perception and rendering of facial expression 1020
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TA2-5 (480) Text extraction in natural image 1025
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TA2-6 (537) Electroencephalogram activity during imagined imitative learning 1030
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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 1035
*Jungmin Lee, Sungho Lee, *Jong-Seok Lee(Sungkyunkwan University, Korea)*

TA3-2 (147) Comparison of machine learning classifiers for glaucoma diagnosis using variable selection 1042
*Su-Dong Lee, Jihyung Lee, Heecheon You, *Chi-Hyuck Jun(POSTECH, Korea)*

TA3-3 (203) An iterative random sampling procedure for outlier detection 1049
*Jihyun Ha, Seulgi Seok, *Jong-Seok Lee(Sungkyunkwan University, Korea)*

TA3-4 (392) Development of Knowledge Management for Forecasting in Restaurant Using Association Rule Mining and Regression Analysis 1057
Annisa Khasanah, Agus Mansur, Yasser Ulil Albab(Universitas Islam Indonesia, Indonesia)

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*Jeonghwa Lee, *Chi-Hyuck Jun(POSTECH, Korea)*

TA3-6 (216) The moderating impact of employee's perceived self-efficacy on knowledge sharing intention 1071
Mei-Fang Chen, Ssu-Wei Huang(Tatung University, Taiwan), Pei-Ju Tung(National Chengchi University, Taiwan)

TA4 Tourism Management/ Topics in IE/MS

Chuja, 08:40-10:40

Chair: Hidetaka Nambo (Kanazawa University, Japan)

TA4-1 (472)	Evaluation for painting show of kindergartner on rout bus in Kaga City *Eri Ishikawa, Ayano Kawasaki, Izumi Yamasaki(Kanazawa Seiryo University, Japan), *Takashi Oyabu(Kokusai Business Gakuin College, Japan)*	1077
TA4-2 (444)	Utilization of historical materials and CGM for foreign visitors *Ayako Sawada(Hokuriku Gakuin Junior College, Japan), Taketoshi Yoshida(Japan Advanced Institute of Science and Technology, Japan)*	1084
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TA4-6 (225)	A Variables Multiple Dependent State Sampling Plan for Products with Unilateral Specification Limit Chih-Chieh Chang Chien, *Chien-Wei Wu, Yi-Feng Hung(National Tsing Hua University, Taiwan)*	1105

TA5 Sustainable Management

Ramada-1, 08:40-10:40

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

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TA5-4 (137)	Time of Use Electricity Pricing Optimization in a Monopolized Electricity Market Hsin-Yu Chiang, *Hsiao-Fan Wang(National Tsing Hua University, Taiwan)*	1131
TA5-5 (291)	Modeling and Optimization of Power Storage Strategy of Hybrid Renewable Energy System in Uncertainty Environments Chi-Kang Su, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)*	1136
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TA6 Simulation 2

Ramada-2, 08:40-10:40

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

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

TA7 Production & Operations Management 1

Ramada-3, 08:40-10:40

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

TA8 Logistics Management

Ramada-4, 08:40-10:40

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

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

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

TA9 Uncertainty Theory (Session II)

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

Chair: Xiaowei Chen (Nankai University, China)

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

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

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

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

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

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

TB1 Supply Chain Management 3

Mara, 14:20-16:00

Chair: Muhammad Rusman (Hasanuddin University, Indonesia)

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

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

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

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

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

TB2 Management of Technology and Innovations 2

Biyang, 14:20-16:00

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

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

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

TB2-3 (317) Development of Virtual Organisation Framework Model in Tourism Industry Using Axiomatic Design 1345
*Agus Fauzi, Eny Maftuchah, Nasrullah Setiawan, Bambang Suratno(Universitas Islam Indonesia, Indonesia)

TB2-4 (150) Supporting Technology Foresight for Disruptive Innovation: Keyword-based Visual Analysis for Futuristic Data 1352
Jieun Kim, *Yongtae Park(Seoul National University, Korea)

TB2-5 (22) Combining correspondence analysis with association rule mining to carry out market segmentation and product configuration 1358
*Chih Wang(National Chiao Tung University, Taiwan)

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) 1366
*Dennis Beng Hui, Emil Fernandez(De La Salle University Manila, Philippines)

TB3-2 (469) A Prediction Method based on Weighted Ensemble of Decision Tree on Alternating Decision Forests. 1375
*Shotaro Misawa, Naohiro Fujiwara(Graduate Student of Waseda University, Japan), Kenta Mikawa(Waseda University, Japan), Masayuki Goto Goto(Waseda University., Japan)

TB3-3 (486) Creating Attractive Digital Signage Content at Universities 1383
*RYO AKAIWA(Aoyama Gakuin University, Japan), RYUJI MAEKAWA, KAKURO AMASAKA(AOYAMA GAKUIN UNIVERSITY, Japan)

TB3-4 (502) A Data Mining Approach for Loan Marketing Response Model 1388
*Jen-Ying Shih(National Taiwan Normal University, Taiwan), Wun-Hwa Chen(National Taiwan University, Taiwan)

TB3-5 (581) The 7-Eleven Rule in the Simulation Output Analysis 1394
*Wheyming Song(professor, Taiwan)

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 1413
Lulu Hu, *Tsui-Ping Chung, Hongying Shan(Jilin University, China), Chien-Ming Chen(Harbin Institute of Technology Shenzhen Graduate School, China)

TB4-2 (233) Particle swarm Optimization for minimizing electrical consumption for flexible flowshop problem 1420
Krisanarach Nitisiri(Research Unit on Advanced Productivity Improvement and Logistics Management, Thailand), *Kanchana Sethanan(Faculty of engineering. Khon Kaen university, Thailand)

TB4-3 (284) Campaign Planning for Multi-Purpose Batch Plants: A Case Study from the Pharmaceutical Industry 1427
Mao-Kai Hsu, *Kuo-Hao Chang(National Tsing Hua University, Taiwan)

TB4-4 (287) Multi-Jobs Lot Streaming to Minimize the Mean Maximum Completion Time in Multi-Stages Hybrid Flow Shop Scheduling 1434
*Said Syahputra(Institut Teknologi Bandung, Indonesia, Indonesia), Anas Ma'ruf(Indonesia, Indonesia)

TB4-5 (309) Shift-Scheduling Characteristic Identification of Non-Star Hotel Industry in Yogyakarta Indonesia 1442
*Deny Yuniartha(Universitas Atma Jaya Yogyakarta, Indonesia), Ignatius Luddy Indra Purnama(Atma Jaya Yogyakarta University, Indonesia)

TB5 Knowledge & Information Management

Ramada-1, 14:20-16:00

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

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

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

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

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

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

TB6 Production & Operations Management 2

Ramada-2, 14:20-16:00

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

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

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

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

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

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

TB7 Healthcare Systems 2

Ramada-3, 14:20-16:00

Chair: Gino Lim (University of Houston, UnitedStates)

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

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

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

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

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

TB7-5 (76) Willingness to pay for BPJS Health Insurance: Findings from an Exploratory Study 1540
Aries Susanty(Lecturer, Indonesia), nia puspitasari(diponegoro university, Indonesia), Purnawan Wicaksono(Lecturer, India), Petty Primatury(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 Haris 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) Cellular Manufacturing System Model under Demand Uncertainty 1567
Muhammad Shodiq Abdul Khannan(Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia), Anas Ma'ruf(Indonesia, Indonesia), Rachmawati Wangsaputra(Institut Teknologi Bandung, Indonesia), sutrisno sutrisno(UPN Veteran Yogyakarta Indonesia, Indonesia)

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 Immawan (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 Batik in Jogja and Solo 1584
Taufiq Immawan(Islamic University of Indonesia, Indonesia)

TB9-3 (378) Evaluation Method of Information Value Applying for Website 1590
GaoYang Liang(Graduate School of Business Administration Daito Bunka University, Japan), Kiyoshi Nagata(Informatics Faculty of Business Administration and Department of Business Studies Daito Bunka University, Japan)

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), Kirin 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 Misola(Technological Institute of the Philippines- Quezon City, Philippines), *Ma. Cecilia Carlos(Mapua Institute of Technology, Philippines), Bryan Navarro(Philippine Institute of Industrial Engineers (PIIE), Philippines)*

TC1-2 (464) An Improved Differential Evolution Algorithm for Vehicle Routing Problem: An Application in Mobile Medical Equipment Maintenance Unit 1620
*Kanokwan Supakdee(Department of Industrial Management Technology, Thailand), Natthapong Nanthasamroeng(Faculty of Industrial Technology, Thailand), Rapeepan Pitakaso(Metaheuristics for Logistics Optimization Laboratory (MLO), Thailand)

TC1-3 (481) Heuristic for multi-stage capacitated p-median problem with supplier evaluation 1626
*Anurak Chaiwichian, Rapeepan Pitakaso(Ubonratchathani University, Thailand)

TC1-4 (520) Heuristic Shift Scheduling forAirport Ground Staff 1633
*Kong Weng Lee(UNIMAS, Malaysia), San Nah Sze(Faculty of Computer Science and Information Technology Universiti Malaysia Sarawak, Malaysia), Keat Keong Phang(Faculty of Computer Science and Information Technology Universiti Malaya, Malaysia)

TC1-5 (192) Optimization of Milk Productivity in Dairy Cattles by Genetic Algorithm 1639
*Senol Altan(Gazi University, Turkey), Fatih Akturk(Ulsan National Insttute Of Science and Technology, Korea), Emrecan Ozeler(Republic of Turkey Ministry of Food, Turkey)

TC2 Inventory Modeling / Artificial Intelligence

Biyang, 16:20-18:00

Chair: Wisut Supithak (Kasetsart University, Thailand)

TC2-1 (381) Multi-Item Economic Production Quantity Model with the Consideration of Raw Material Inventory Management Costs 1647
*Wisut Supithak(Kasetsart University, Thailand), Sasiprapa Limpakan(Kasetsart Uniersity, Thailand)

TC2-2 (123) A Stochastic Programming Model for Vendor Managed Inventory System of an Animal Feed Factory and Farm Network 1654
*Thawee Nakrachata-Amon(Faculty of Engineering, Thailand), Supachai Pathumakul(Khon Kaen University, Thailand)

TC2-3 (101) Vender Managed Inventory for Fresh Agricultural Products 1659
*Mitsuyoshi Horikawa, Takeo Takeno, Mitsumasa Sugawara(Iwate Prefectural University, Japan)

TC2-4 (318) Vehicle risk assessment in accidents using neural network 1665
Yuri Castro, *Young Jin Kim, Baek An Sun(Kyung Hee University, Korea)

TC3 Artificial Intelligence

Udo, 16:20-18:00

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

TC3-1 (182) The Study of Tokai Cluster as a Leader of CFRP Industries in Japan 1672
*Akihito Zenke, Nobutaka Odake(Nagoya Institute of Technology, Japan)

TC3-2 (260) Agent-based Real-time Scheduling for Smart Household Appliances 1678
Bobby Kurniawan, *Anggoro Pramudyo, Didik Aribowo(Untirta, Indonesia), Anas Ma'ruf(Institut Teknologi Bandung, Indonesia)

TC3-3 (391) APPLICATION OF CLOUD-BASED KANBAN SYSTEM IN PROJECT MANEGEMENT 1683
Chi-Wei Shih, *Chen-Yang Cheng(Tunghai University, Taiwan)

TC3-4 (490) User's Free Time Estimation When Using Smartphone 1688
*kohei Yamamoto(Kanazawa Graduate School of Natural Science and Technology, Japan), Tatsuhito Hasegawa(Tokyo Health Care University, Japan), Haruhiko Kimura(Kanazawa University, Japan)

TC3-5 (499) Earned Value Management considering Milestone Weighting and Dependency Structure Matrix 1692
*Ronaldo Polancos(De La Salle University, Philippines)

TC4 Scheduling & Sequencing 2

Chuja, 16:20-18:00

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

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

Gunoto(Universitas Pembangunan Nasional Veteran Jakarta, Indonesia)

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

TC9 Lean Production Management

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

Chair: Kenichi Nakashima (Kanagawa university, Japan)

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

WA1 Inventory Modeling & Management

Mara, 08:30-10:10

Chair: Nobuaki Ishii (Bunkyo University, Japan)

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

WA2 SCM and Forecasting 1

Biyang, 08:30-10:10

Chair: Kazuhiro Takeyasu (Tokoha University, Japan)

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

WA3 Production Design & Management 1

Udo, 08:30-10:10

Chair: Philip Ermita (PIIE, Philippines)

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

WA4 Scheduling & Sequencing 3

Chuja, 08:30-10:10

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

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

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

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

WA5-2 (58) — Fuzzy Logic Simulation of DC-DC Boost Converter Using Matlab Fuzzy Logic Toolbox — 1902
*Rionel Caldo, *Rionel Caldo(Lyceum of the Philippines University - Laguna, Philippines)*

WA5-3 (224) — Cost Effectiveness Analysis Comparing Mastectomy versus Lumpectomy with Fuzzy Logic — 1908
*Aysun Aktas, *gozde tutuncu(Izmir University of Echonomics, Turkey)*

WA5-4 (576) — Fuzzy AHP based Supplier Selection considering the Triple Bottom Line Concept — 1914
*Wannimit Khampanya, Tritos Laosirihongthong(Thammasat University, Thailand), *Premaratne Samaranayake(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 Faseeh Tahir, Aamir Ahmed Baqai(National University of Sciences & Technology, Pakistan)*

WA6-2 (69) — Optimal Solar Photovoltaic (PV) Penetration in Secondary Distribution Network Using Genetic Algorithm — 1929
*Bryan Navarro(Technological Institute of the Philippines, Philippines), *Maricar Misola(Technological Institute of the Philippines- Quezon City, Philippines)*

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)*

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
**Risdiyono Risdiyono(Islamic University of Indonesia, Indonesia)*

WB1-2 (139) — A study for making standardized-work tables suited for enterprises of the engineering / metalworking industry — 1962
**Masahiro Shibuya(Tokyo Metropolitan University, Japan), Kenichi Iida(Hokkaido Research Organization, Japan), Koki Mikami(Hokkaido University of Science, Japan)*

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*

HCMC, Viet Nam)

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

WB2 SCM and Forecasting 2

Biyang, 10:30-12:10

Chair: Kazuhiro Takeyasu (Tokoha University, Japan)

WB2-1 (52) — Improving Forecasting Accuracy in the Case of Intermittent Demand Forecasting — 1983
*Daisuke Takeyasu(The Open University of Japan, Japan), *Asami Shitara(Tax Corporation Arknet, Japan), Kazuhiro Takeyasu(Shizuoka City, Japan), Asami Shitara(Tax Corporation Arknet, Japan)*

WB2-2 (36) — Reformation of Production System Based Upon Demand Forecasting — 1991
*hirotake 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(Setsunan 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
**Shey-Huei Sheu, 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 Widodo, 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, Eriko 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
*Kanokporn Kamonchit, *Thittikorn Phattanaphibul(Kasetsart University (Sriracha Campus), Thailand)*

WB3-5 (84) — Assessment of an ERP Graphical User Interface Design Related to Human Cognition — 2031
**Grace Lorrain 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 Hirotani(Prefectural University of Hiroshima, Japan)*

WB4-2 (46) — Flexible Jobshob Scheduling Model Considering Production Cost and Tardiness Cost Simultaneously — 2048
**Devy Sari, Anas Ma'ruf(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)*

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

WB5 Quality Engineering & Reliability

Ramada-3, 10:30-12:10

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

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

WB6 Lean Manufacturing

Ramada-4, 10:30-12:10

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

WB6-1 (129)	LINEASSEMBLY ANALYSIS FOR PC-250 PRODUCT TYPE WITH HEURISTIC METHOD AT PT. TIRTA INTIMIZU NUSANTARA **Lina Gozali(Tarumanagara University, Indonesia), Silvi Ariyanti(University of Mercu Buana, Indonesia), Rendy .(University of Tarumanagara, Indonesia)*	2107
WB6-2 (371)	Waste Reduction in Work Processes Using Lean Tools and Simulation: A Case Study Logistics Service Providers *Worakit Changjutturas(Department of Industrial Engineering Faculty of Engineering of Khon Kaen University, Thailand), *Panitarn Peerapattana(Department of Industrial Engineering Faculty of Engineering of Khon Kean University, Thailand)*	2113
WB6-3 (553)	A Framework to Apply Cellular Manufacturing **Wei Weng, Atsushi Fukui, Shigeru Fujimura(Waseda University, Japan)*	2119
WB6-4 (110)	A Study on the E-Waste Generation and Management in the Philippines: It's Impact and Significance **Nestor Ong(University of Santo Tomas, Philippines), Patricia Kamil Kinol, Angela Camille San Miguel, Charlene Mae Ramirez(Faculty of Engineering, University of Santo Tomas, Philippines)*	2126
WB6-5 (516)	A model for Designing Resilient and Sustainable Supply Chain under Disruptions *Sonia Irshad Mari, *Young Hae Lee, Muhammad Saad Memon(Hanyang University, Korea)*	2134

POSTER Poster Session

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

Chair: (,)

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

Shift-Scheduling Characteristic Identification of Non-Star Hotels Industry in Yogyakarta Indonesia

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Abstract. Shift arrangement in developing work schedule become classical problem faced by non-star hotel in Yogyakarta. They have to maintain their service well by keep the workforce in good performance and give competitive facilities in order to survive in increasing number of hotel in Yogyakarta. However, as well as other non-star hotel, they override the balance between the work load and the workforce well-being factor. Most of non-star hotel in Yogyakarta develop their work schedule base on subjective consideration of the officer who responsible to arrange the schedule. The objective of this research is to identify the shift scheduling characteristics of non-star hotel in Yogyakarta and the weaknesses effect of the schedule. Based on identified parameters of shift scheduling characteristic, there are 27 models of shift scheduling for Front Office Department, 19 models of shift scheduling for Housekeeping Department, and 16 models of shift scheduling for Security Department. These models will be the basis for next stage of the research in developing shift scheduling for non-star hotels in Yogyakarta by considering the human factor to eliminate the weakness of the actual shift scheduling applied.

Keywords: shift scheduling, non-star hotel, characteristic identification

1. INTRODUCTION

Human resources are an important factor in hotel industry management since the workforce becomes a part of services that have direct interaction with the consumers. Requirement of operational time for 24 hours a day and 7 days a week is not in line with workforce availability in non-star hotel which limited by operational cost budget. Departments which operate for 24 hours, such as Front Office or Security, apply shift work which divided operational time into certain number of shifts. Available workforce is alternately assigned in each shift. Ideally, shift pattern assign to each workforce have to consider the balance between work load and working time duration, as well as family and social time needs. Therefore, the hotel management should be able to manage shift work schedule well in order to meet the workforce requirement according to the appointed standard, however still consider workforce personal needs, such as between-days break time, on leave, and weekend off-day. Meeting the workforce requirement and workforce personal needs in workforce scheduling for hotel industry become important factor because it have direct impact on the service quality provided by the workforce. Workforce in hotel industry is charged always have a good performance, in both physical appearance and servicing. A bad arrangement in shift scheduling for the workforce in hotel industry may influence the workforce performance. Chiang *et al.* (2010) in their research have founded that job demands in hotel and catering industry are not necessarily stressful, particularly when employees have control over their job responsibilities and receive sufficient support from their organizations (e.g., work-life balance policies). It requires active support from the organization in utilizing human resource management strategies to increase the level of well-being at work. And one of work-life balance application in human resource management

strategies is flexible scheduling and work arrangements.

On the other hand, workforce scheduling has a significant proportion of operational cost in hotel industry. Payroll and related expenses are sometimes over 30% of the operating cost of a hotel. A reduction in this by even 1% represents considerable cost savings (Ernst *et al.*, 2004). So that staff scheduling in hotel industry become a complex problem to determine optimal solution that fulfill the staff requirement and minimize cost, meet the staff preferences, and distribute shifts equitably among staffs.

Limited financial resources and number of staffs owed by non-star hotel becomes additional constraint in developing the workforce schedule. Commonly they override the balance between working times and break time, even less family and social time needs. The resulting workforce schedule become inflexible due to limited workforce available while the workforce requirement is fixed even increasing in certain period, such as holiday or long week-end. Therefore, workforce schedule developing in non-star hotel should be compromise between workforce requirements, limited workforce available, and workforce personal needs, to obtain schedule that fulfill the workforce requirement.

However in developing the workforce schedule, non-star hotel sometimes override the balance between the work load and the workforce well-being factor, i.e. physiological, psychological, and psychosocial factor. Kroemer *et al.* (2001) stated that several researches have shown that statistically, workforce who work in shift more have health problems than workers who work in normal hours, morning to evening. They also experience negative psychosocial effects, which interfere their family activities and other social activities. Wright Jr. *et al.* (2013) have shown there are increasing evidences that indicates negative influence of shift-work schedules to worker physiology, health, and safety. Moreover, shift workers are at risk for shift work disorder (SWD), which is a circadian rhythm sleep disorder. This circumstance needs a management strategies include approaches to promote sleep, wakefulness, and adaptation of the circadian clock to the imposed work schedule. Shift work is also reported have negative effect in associated with increased work to family conflict (Halbesleben, 2009; Tuttle and Garr, 2012), as negative effect to social life (Loudoun, 2008).

Besides the negative effect for the workforce, shift work also reported has negative effect to the hotel organization itself. Lee *et al.* (2011) have found that hotel workers' overall job satisfactions are influence by their schedule flexibility satisfaction and the decreased turnover intent is a consequence of schedule flexibility satisfaction. The managerial approach offered for this circumstance is to arrange the work schedule as flexible as possible. Therefore, the work schedule developing in the form of a combination of shift arrangements imposed on workforce who work with operating hours of 24 hours have to consider the balance of workforce physiological, psychological, and psychosocial factors.

Shift arrangement in developing work schedule also become classical problem that faced by non-star hotel in Yogyakarta. They have to maintain their service well by keep the workforce in good performance and give competitive facilities in order to survive in increasing number of hotel in Yogyakarta. As one of tourist destination in Indonesia, the tourism industry in Yogyakarta continues to develop. The tourism development in Yogyakarta also followed by the tourism supporting-facilities development, such as hotels, restaurants, souvenir shops, travel agencies, etc. One of the tourism supporting-facilities industries which are currently growing rapidly is the hotel industry. The development of hotel industry is shown by the increasing number of hotels in Yogyakarta. Data of Central Statistics Agency showed that the number of hotels in Yogyakarta increasing every year (Central Statistics Agency of Special District of Yogyakarta, 2013). Increasing number of hotels in Yogyakarta prosecute the hotels management to improve services provided as the competitiveness of their business.

Yogyakarta is famous as low cost with remain qualified tourist destinations so that there are many small scale hotel with low rates in Yogyakarta. Data of Ministry of Tourism and Creative Economy of Republic of Indonesia showed that in 2011 there are 42 star hotels and 1058 non-star hotels in Yogyakarta. The non-star hotels include the budget hotels, lodging, cottage, and other accommodation services (Ministry of Tourism and Creative Economy of Republic of Indonesia, 2013). In general, non-star hotels in Yogyakarta are professionally managed although they have limited resources, so that management must be capable in managing its limited resources to obtain quality and profit. However, as well as other non-star hotel, they override the balance between the work load and the workforce well-being factor. Most of non-star hotel in Yogyakarta develop their work schedule base on subjective consideration of the officer who responsible to arrange the schedule.

Therefore, we need a method that facilitates the management of non-star hotels in Yogyakarta for arranging work schedules of its workforce which use shift system. This scheduling method must consider the limited resources constraints, which is a major problem of the non-star hotel in Yogyakarta. The proposed scheduling methods should be easy to use and accessible by the hotel management, given its have various limitation. Hence, it is necessary to have software for helping the management in developing workforce scheduling that considering the balance between workload and the workforce well-being factor. The proposed workforce scheduling software will be

developed in on-line form (web-based), so it will be easy to be accessed and used by the non-star hotel management. The proposed web-based workforce scheduling software is expected to be a tool for the non-star hotel in Yogyakarta to manage its workforce in order to improve the quality of services provided to consumers.

This research is the first part of research in developing the web-based workforce scheduling software for the non-star hotel in Yogyakarta. The objective of this research is to identify the shift scheduling characteristics of non-star hotel in Yogyakarta and the weaknesses effect of the schedule. Hereinafter, the result of this research will be used for next research in developing the shift scheduling model which considering the balance between workload and workforce well-being and eliminate the weaknesses effect of the schedule.

2. RESEARCH METHODOLOGY

Data used in this research are obtained from observation using questionnaires to 35 Front Office Department, 25 House Keeping Department, and 21 Security Department of non-star hotel in Yogyakarta. The questions in the questionnaire are in form of open question, i.e.:

1. Managerial
   a. Authority to develop the schedule
   b. Schedule period
   c. Starting time to develop the schedule
   d. Dynamic or static schedule
2. Shift type
   a. Number of shifts in 24 hours
   b. Start and end times of each shift (overlapping or continuous)
3. Workday and off-day
   a. Work-stretch and off-day
   b. Consecutive day-off
   c. Off-day allocation
   d. Weekend-off consideration
   e. National holiday replacement
4. Shift pattern allocation
   a. Fixed shift pattern allocation
   b. Cyclic shift pattern
   c. Between-days break-time consideration
   d. Shift allocation policy for female workforce
   e. Workforce preference consideration
5. Managerial and technical reason in developing the schedule
6. Problem arising from the application of the schedule
   a. Physical
   b. Productivity
   c. Relationship between workers
   d. Social and family relationship

Data resulted from questionnaire then analyzed to identify the operational profile using question number 1 and 5, the parameters of the shift scheduling characteristics using question number 2 to 4, and the problem arise from the application of the schedule using question number 6. The analysis use hierarchical clustering in SPSS 15.0 to determine number of groups. In hierarchical clustering, we use between-groups linkage cluster method and squared-euclidean distance measure interval. Then we use K-means clustering in SPSS 15.0 to determine the group members. The method used is iterate and classify. As the input for number of clusters is result of hierarchical clustering in previous step.

3. RESULT AND DISCUSSION

3.1 Operational Profile

The data shows that the official worker that responsible in developing the schedule is the supervisor of the department. For a few number of workers, the supervisor of all the observed departments is given to one person, sometimes directed by the manager. The schedule period is for a week until a month and mostly the schedule is prepared 2 until 15 days in advance. The schedule is performed as static schedule, but in reality if there is incidental condition, the worker can deal with other worker to switch the shift allocated to him/her. This condition will not change the applicable schedule and should be approved by the supervisor.

3.2 Identification of Shift Scheduling Characteristics

The results of shift scheduling characteristic identification for non-star hotel in Yogyakarta are shown in the Table 1 to Table 3. The identified parameters of shift scheduling characteristic are:

1. Schedule period (A)
2. Number and type of shift in 24 hours (B)
3. Shift allocation (H)
4. Work-stretch and off-day pattern (F)
5. Shift allocation policy for female workforce (C)
6. Distinctive shift allocation (D)
7. Distinctive work-stretch (E)

Parameter of schedule period consists of a week (A1), 2 weeks (A2), 4 weeks (A3), or a month (A4). Number and type of shift is denoted by letter B followed 1 or 2 digit number. The first digit shows the number of shift in 24 hours, 1 for 1 shift, 2 for 2 shifts and so forth. Two digit numbers is just owned by 3 shifts, consists of continuous shift type denoted by 1 and 2 for overlapping. Continuous means that the starting time of a shift is equal to the end

time of previous shift. Overlapping shift type is for condition that starting time of a shift is a few hours before the end of the previous shift. It means there are a few hours that coincide between 2 consecutive shifts. For 3 shifts application, it may in form of continuous or overlapping, but for more than 3 shifts application, it absolutely in form of overlapping.

Table 1: Shift Scheduling Characteristic of Non-Star Hotel in Yogyakarta for Front Office Department

Group (Number of Hotel)	Shift Scheduling Characteristic Parameter						
	A	B	H	F	C	D	E
FO1 (1)	A1	B31	H0	F3	C0	D0	E1
FO2 (1)	A1	B31	H32	F3	C2	D0	E0
FO3 (1)	A2	B32	H0	F0	C0	D0	E0
FO4 (3)	A4	B1	H11	F1	C0	D0	E0
FO5 (1)	A4	B1	H21	F5	C0	D0	E0
FO6 (1)	A4	B1	H51	F6	C0	D0	E1
FO7 (3)	A4	B2	H0	F0	C0	D0	E0
FO8 (1)	A4	B2	H0	F3	C0	D1	E0
FO9 (1)	A4	B31	H0	F0	C2	D0	E0
FO10 (1)	A4	B31	H0	F3	C2	D0	E0
FO11 (1)	A4	B31	H0	F0	C1	D0	E0
FO12 (1)	A4	B31	H0	F0	C1	D1	E0
FO13 (3)	A4	B31	H0	F0	C2	D0	E0
FO14 (2)	A4	B31	H0	F0	C2	D1	E0
FO15 (1)	A4	B31	H0	F0	C0	D0	E0
FO16 (1)	A4	B31	H0	F2	C2	D1	E0
FO17 (1)	A4	B31	H21	F2	C0	D0	E0
FO18 (1)	A4	B31	H22	F2	C2	D0	E0
FO19 (2)	A4	B31	H22	F2	C2	D1	E0
FO20 (1)	A4	B31	H22	F2	C2	D1	E1
FO21 (1)	A4	B31	H32	F3	C2	D0	E0
FO22 (1)	A4	B31	H32	F3	C0	D1	E1
FO23 (1)	A4	B32	H32	F3	C2	D1	E0
FO24 (1)	A4	B4	H0	F0	C2	D0	E0
FO25 (1)	A4	B4	H0	F3	C2	D0	E0
FO26 (1)	A4	B4	H0	F3	C2	D0	E1
FO27 (1)	A4	B4	H72	F7	C0	D0	E0

Shift allocation consists of 2 conditions, i.e. cyclic and non-cyclic. Cyclic condition means that shift allocation on the schedule forms a certain pattern that repeated for a fixed period. Inversely, there is no certain pattern of shift allocation in non-cyclic condition; the shift can differ for each worker or each period. Shift allocation parameter is denoted by letter H followed by 1 or 2 digits number. One digit number is only for non-cyclic condition using number 0. Cyclic condition uses 2 digit numbers. The first digit shows the code for the cyclic period, i.e. number 1 to 7 for 2 days, 3 days, 6 days, 7 days, 18 days, 2 weeks, 1 month, respectively. The second digit is denoted by 1 for the same shift pattern allocation for each worker, and 2 for different pattern allocation for each worker. The type of cyclic period in shift allocation should be relevant with pattern of work-stretch and off-day. In cyclic shift pattern, off-day is commonly placed at the end of period. Work-stretch and off-day pattern shows pattern of consecutive workday and off-day. This parameter is denoted by letter F followed by 1 digit number. Number 1 to 8 is for work-stretch and off-day pattern 1-1, 2-1, 5-1, 6-1, 7-1, 4-2, 13-1, 30-1, respectively. Number 0 following letter F means that no certain pattern for work-stretch and off-day.

Table 2: Shift Scheduling Characteristic of Non-Star Hotel in Yogyakarta for House Keeping Department

Group (Number of Hotel)	Shift Scheduling Characteristic Parameter					
	A	B	H	F	C	D
HK1 (1)	A1	B4	H0	F4	C0	D1
HK2 (1)	A2	B2	H0	F0	C1	D0
HK3 (1)	A3	B31	H0	F0	C0	D1
HK4 (2)	A4	B1	H0	F0	C0	D0
HK5 (1)	A4	B1	H42	F4	C0	D0
HK6 (1)	A4	B1	H62	F7	C0	D0
HK7 (1)	A4	B2	H0	F0	C0	D0
HK8 (1)	A4	B2	H0	F5	C0	D1
HK9 (1)	A4	B2	H42	F3	C0	D0
HK10 (1)	A4	B3	H0	F3	C0	D1
HK11 (1)	A4	B3	H52	F3	C0	D0
HK12 (3)	A4	B31	H0	F0	C0	D0
HK13 (2)	A4	B31	H31	F3	C0	D0
HK14 (3)	A4	B31	H32	F3	C0	D0
HK15 (1)	A4	B32	H0	F3	C0	D1
HK16 (1)	A4	B32	H32	F3	C0	D0
HK17 (1)	A4	B32	H42	F4	C0	D0
HK18 (1)	A4	B4	H31	F6	C0	D0
HK19 (1)	A4	B5	H0	F3	C2	D0

For safety reason, hotels will apply particular shift allocation for female workforce. Shift allocation policy for female workforce parameter is denoted by letter C followed with 1 digit number. Number 1 shows that female worker is assigned for morning shift only, number 2 for female worker assigned in morning and evening shift, number 0 means there are no female worker. Distinctive shift allocation shows that for specific worker, as supervisor, senior worker, or casual worker, usually assigned in specific shift, different with other workers. It is also applies for distinctive work-stretch. Distinctive shift allocation and distinctive work-stretch parameter is denoted by letter D

and E, respectively, followed with number 0 or 1. Number 0 means there is no specific shift allocation or work-stretch for a specific worker and 1 for otherwise.

Data in the Table 1 to Table 3 shows that most of non-star hotel in Yogyakarta develop their workforce schedule for a month for all the 3 departments observed, even they use cyclic shift allocation with cyclic period less than a month. Schedule period of 4 weeks is different with schedule period of a month, because a month is not exactly equal with 4 weeks. End of period for 4 weeks schedule period may not coincide with end of period for a month.

Table 3: Shift Scheduling Characteristic of Non-Star Hotel in Yogyakarta for Security Department

Group (Number of Hotel)	Shift Scheduling Characteristic Parameter					
	A	B	H	F	C	E
SC1 (1)	A1	B31	H0	F4	D0	E0
SC2 (1)	A3	B2	H21	F2	D0	E0
SC3 (1)	A4	B1	H62	F7	D0	E0
SC4 (1)	A4	B2	H0	F6	D0	E0
SC5 (1)	A4	B31	H0	F0	D1	E0
SC6 (1)	A4	B31	H0	F3	D1	E0
SC7 (3)	A4	B31	H0	F4	D0	E0
SC8 (1)	A4	B31	H0	F4	D1	E0
SC9 (1)	A4	B31	H31	F3	D1	E1
SC10 (3)	A4	B31	H31	F3	D0	E0
SC11 (2)	A4	B31	H32	F3	D0	E0
SC12 (1)	A4	B31	H42	F4	D0	E0
SC13 (1)	A4	B32	H0	F0	D0	E0
SC14 (1)	A4	B4	H0	F0	D0	E0
SC15 (1)	A4	B4	H31	F3	D0	E0
SC16 (1)	A4	B4	H32	F3	D1	E1

For hotels labeled with B1 means that the hotels apply 1 shift for 24 hours. The worker will assigned for 24 hours a day during the work-stretch and will have off-day at the end of cyclic period for cyclic pattern application or any day with approval from the supervisor in advance for non-cyclic pattern. This condition results in the workers have long working hours. Data in Table 1 to 3 also show that there are hotels that have long cyclic period, 2 weeks to a month. Consequently, the worker will have long workday and one day-off every 2 weeks for 2 weeks cyclic period, instead one day-off every a month for monthly cyclic period.

The data in Table 1 to 3 shows that most of the hotels have no distinctive shift allocation and distinctive work-stretch. It is because most of non-star hotel in Yogyakarta have no hierarchy of positions between workers in Front Office, House Keeping, and Security Department. The workers of three department observed are directly supervised by owner or workers who have responsibilities as general manager.

For each department observed, hotels having the same parameter of shift scheduling characteristic will be grouped into one group. Each of the group constitutes as a model of shift scheduling of non-star hotel in Yogyakarta. The grouping process is performed using cluster analysis in SPSS 15.0. We use hierarchical clustering to determine number of groups. The output of hierarchical clustering for Front Office Department data shows that there are bigger jump in step 8, then we deducted this value to number of data to get number of groups, i.e. 27 groups. This number of group is used in K-means clustering to determine members of group. The same procedure is applied for data of Housekeeping and Security Department. The result is there are 27 groups of shift scheduling model for Front Office Department, 19 groups of shift scheduling model for Housekeeping Department, and 16 groups of shift scheduling model for Security Department. These models will be the basis for next stage of the research in developing shift scheduling for non-star hotels in Yogyakarta.

3.3 The Problem Arise from The application of The Schedule

Most of the workers of observed hotels reveal that there is no specific problem arises due to their schedule. However, the actual shift scheduling applied in observed hotels results in some of problems. The application of one shift in 24 hours causes the workers have long working hours. The working long hours may give negative impact on workers' health (de Castro *et al*., 2010). The researchers have observed that there is relation between increased risk of injury with consecutive workdays and longer cumulative working hours (Hopcia *et al*., 2012).

The shift pattern assignment applied in the observed hotels also results in weakness of short hours in between-shifts. Most of observed hotels have less than 15 hours in between-shift. For Front Office Department, there are 83% hotels have less than 15 hours in between-shift, 76% for Housekeeping Department, and 87% for Security Department. Short hour in between-shift results in quick return for working. This condition can lead insomnia, excessive sleepiness, excessive fatigue, and shift work disorder for the workers (Eldevik *et al*., 2013; Di Milia *et al*. 2013).

The observed hotels also have weakness in assignment night shift in more than 2 consecutive days. The data shows that 49% of Front Office Department, 38% of Housekeeping Department, and 52% of Security Department have night shift more than 2 consecutive days.

Researchers have reported that working in consecutive night sleep may cause negative effect on psychomotor performance (Haire *et al*., 2012). Working in night shift also may cause high cardiovascular risk (Esquirol *et al*., 2011; Pimenta *et al*., 2013; Haus & Smolensky, 2013), obesity (Antunes *et al*., 2010; Chen *et al*., 2010; Haus & Smolensky, 2013), and cancer (Haus & Smolensky, 2013).

The weaknesses founded in the applied shift scheduling of observed hotels become important element that have to be considered in developing the shift scheduling for non-star hotels in Yogyakarta for the next research. The development of shift scheduling in next research should be eliminate the weaknesses of the actual shift scheduling applied by considering the human factor to optimize human performance and well-being (Lodree, Jr. 2009)

4. CONCLUSION

This research has been founded that shift scheduling used by non-star hotels in Yogyakarta has weaknesses of long working hours, short hours in between-shift, and night shift in more than 2 consecutive days. This research also results in mapping of shift scheduling characteristic of non-star hotels in Yogyakarta. Based on identified parameters of shift scheduling characteristic, there are 27 models of shift scheduling for Front Office Department, 19 models of shift scheduling for Housekeeping Department, and 16 models of shift scheduling for Security Department. These models will be the basis for next stage of the research in developing shift scheduling for non-star hotels in Yogyakarta by considering the human factor to eliminate the weakness of the actual shift scheduling applied.

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