





ISSN: 1978-774X

PROCEEDING

The 7th International Seminar on Industrial Engineering and Management (7th ISIEM)

Sanur Paradise Hotel, Bali, Indonesia March 11th – 13th, 2014

Organized by :

Industrial Engineering Department of

Al Azhar University •Pasundan University•Trisakti University•
•Atma Jaya Catholic University of Indonesia •Esa Unggul University•
•Tarumanagara University•Mahendradatta University•

ismi



Supported by :



PREFACE

Dear Collegues,

On behalf of the Organizing Committee, I am honored to welcome you to the 7th International Seminar on Industrial Engineering and Management (ISIEM). This seminaris organized by the Industrial Engineering Department from seven Universities, namely Trisakti, Esa Unggul, Atma Jaya Jakarta, Al Azhar Indonesia, Pasundan, Tarumanagara and Mahendradatta Universities. The purpose of this seminar is to provide an effective forum for distinguished invited speakers, academicians, engineers, professionals and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in industrial engineering and management and other related fields in dealing with the dynamics and challenges of the 21st century. The seminar is also expected to foster networking, collaboration and joint efforts among the conference participants to advance the theory and practice as well as to identify major trends in Industrial Engineering and Management field.

The main theme of this seminar is "Green Technology on Industrial Engineering, Information and Management". Under this theme, we will explore sustainable innovation in industrial technology, information, and management concerning global issues. We also discuss approaches to collect, manage, and use any information efficiently and effectively, thus the results will be able to upgrade industrial competitiveness and value in facing the global challenges in industrial environment.

This year we received 93 paper submissions from various universities, research centers, and its affiliations. The Technical Program Committee accepted 84 selected papers that will be presented in this seminar. The accepted papers are categorized into four groups; Supply Chain Management, Production System, Operation Research, Ergonomic, Industrial Management, Quality Engineering and Management, and Decision Support System and Artificial Intelligent. And finally, the success of this seminar is due to the hard efforts of many people who we gratefully acknowledge. We also thank the authors whose papers are presented, invited keynote speakers, and all parties that we are not able to mention here.

We hope you all will enjoy the three days of discussion through this seminar and enjoy the beauty of Bali Island. We hope to see you again next year, in the 8th International Seminar on Industrial Engineering and Management (ISIEM).

Bali, March 11th, 2014

Chairman of The 7th ISIEM

Nunung Nurhasanah, ST., M.Si

COMMITTEE

STEERING COMMITTEE

- 1. Dr. Ir. Syarif Hidayat, M.Eng.Sc, M.M.
- 2. Dr. Lamto Widodo S.T., M.T.
- 3. Dr. Dadang Surjasa, S.Si., M.T.
- 4. Ir. Arief Suwandi, M.T.
- 5. Hotma A. Hutahaean, S.T., M.T.
- 6. Ir. Toto Ramadhan, M.T.
- 7. Ir. I Ketut Simpen, M.T.

(Al Azhar University) (Tarumanagara University) (Trisakti University) (Esa Unggul University) (Atma Jaya Catholic University of Indonesia) (Pasundan University) (Mahendradatta University)

OPERATING COMMITTEE

Chairman

Nunung Nurhasanah, S.T., M.Si.

Co-Chairman :

Dr. Lamto Widodo S.T., M.T.

Secretary

Rahmi Maulidya, S.T., M.T.

Treasury

Iphov Kumala Sriwana, S.T., M.Si.

Leaflet :

Dr. Lamto Widodo S.T., M.T.
Rahmi Maulidya, S.T., M.T.

Sponsorship :

Sponsorsnip

- Dr. Rina Fitriana, S.T., M.M. **Proceeding :**
- 1. Rahmi Maulidya, S.T., M.T.
- 2. Endro Wahyono

Seminar :

- 1. Dr. Ir. Nofi Erni, M.M.
- 2. Ir. Roesfiansjah R., M.T.
- 3. Andre Sugioko, S.T., M.T.
- 4. Ir. Yogi Yogaswara, M.T.
- 5. Lina Gozali, S.T., M.M.
- 6. I Putu Agus Mahendra, S.T., M.Sc.
- 7. Luh Merry Dyanthi, S.T.
- 8. I Nyoman Sudipa, S.T., M.Si.

Acomodation :

- 1. Vivi Triyanti, S.T., M.Sc.
- 2. Marsellinus Bachtiar, ST., MM.
- 3. I Wayan Sukania, S.T., M.T.

Website :

- 1. Ir. Wahyu Katon, M.T.
- 2. Dr. Ir. Chevy Herli SA, M.T.

(AI Azhar University)

(Tarumanagara University)

(Trisakti University)

(Esa Unggul University)

(Tarumanagara University) (Trisakti University)

(Trisakti University) (Tarumanagara University)

(Esa Unggul University) (Esa Unggul University) (Atma Jaya Catholic University of Indonesia) (Pasundan University) (Tarumanagara University) (Mahendradatta University) (Mahendradatta University) (Mahendradatta University)

(Atma Jaya Catholic University of Indonesia) (Atma Jaya Catholic University of Indonesia) (Tarumanagara University)

(Pasundan University) (Pasundan University)

(Trisakti University)

REVIEWER

1.	Asst. Prof. Natcha Thawesaengskulthai	(Chulalongkorn University, Thailand)
2.	Prof. Ahmad Syamil, Ph.D.	(Arkansas University, USA)
3.	Fajar Kurniawan, S.T., M.Si	(Saint Mary's University of Hong Kong)
4.	Dr. Ir. Tiena G. Amran	(Trisakti University, Indonesia)
5.	Dr. Ir. Triwulandari SD, M.M.	(Trisakti University, Indonesia)
6.	Dr. Ir. Lily Amelia, M.Agr	(Esa Unggul University, Indonesia)
7.	Dr. Ir. Nofi Erni, M.M	(Esa Unggul University, Indonesia)
8.	Prof. Ir. Hadi Sutanto, MMAE., Ph.D.	(Atma Jaya Catholic University of Indonesia)
9.	Prof. Dr. Wegie Ruslan	(Atma Jaya Catholic University of Indonesia)
10	.Prof. Dr. Ir. S. Sardy, M.Eng.Sc	(Al Azhar University, Indonesia)
11	.Dr. Ir. Syarif Hidayat , M.Eng.Sc, M.M.	(Al Azhar University, Indonesia)
12	.Dr. Ir. Hj. Tjutju Tarliah Dimyati, MSIE.	(Pasundan University, Indonesia)
13	.Dr. Ir. Hj. Arumsari, M.Sc.	(Pasundan University, Indonesia)
14	.Dr. Lamto Widodo, S.T., M.T.	(Tarumanagara University, Indonesia)
15	.Dr. Adianto, M.Sc.	(Tarumanagara University, Indonesia)

AGENDA

Day 1 (March 11th, 2014)

18:00 - 18:30	Registration
18:30 - 19:30	Dinner
19:30 - 19:45	Opening Ceremony: Representation of Al Azhar Indonesia, Esa Unggul, Trisakti, Atma Jaya, Pasundan, Tarumanagara, and Mahendradatta University's greeting
19:45 - 21:00	Keynote # 1 Dr. Ramesh Shastry (International Visiting Lecturer of Mahendradatta University)
21:00 - 21:15	Photo Session with all participants

Day 2 (March 12th, 2014)

6:30	- 8:00	Breakfast and Registration
8:00	- 9:15	Keynote # 2
		Asst. Prof. Natcha Thawesaengskulthai
		(Deputy Dean of Engineering Faculty, Chulalongkorn
		University, Bangkok, Thailand)
9:15	- 9:30	Coffee and Tea Break
9:30	- 12:00	Parallel session #1
12:00	- 13:00	Lunch break
13:00	- 15:30	Parallel session #2
15:30	- 15:45	Coffee and Tea Break

18:15 - 20:00 Dinner

Day 3 (March 13th, 2014)

- 6:30 8:30 Breakfast
- 8:30 10:00 Parallel session #3
- 10:00 17:00 City Tour

MARCH 12TH SESSION 1 ROOM 2 (DSS, IM)

Moderator : Dr. Ir. Triwulandari SD, MM

Time	Paper	Code	Paper Code
11.15-11.30	IMPLEMENTATION SAK-ETAP, MANAGEMENT CONSULTATION, BUSINESS GOING CONCERN AND EASINESS OF CAPITAL ACQUISITION ON SMALL AND MEDIUM ENTERPRISES (SME's) IN BANDUNG Liza Laila Nurwulan and Budi Septiawan Pasundan University	IM	031
11.30-11.45	BUSINESS MODEL INNOVATION in INDONESIAN JAMU COMPANY Jahja Hamdani Widjaja Maranatha Christian University	IM	009
11.45-12.00	PROPOSAL OF KEY PERFORMANCE INDICATOR WITH INTEGRATION OF BALANCED SCORECARD AND PRISM FRAMEWORK (Case Study : PT TU) I Dewa Made Ari Dananjaya, Triwulandari S. Dewayana Trisakti University	IM	076

MARCH 12TH SESSION 1 ROOM 3 (ER, PS)

Moderator : Ir. Lina Gozali, MM

Time	Paper	Code	Paper Code
9.30-9.45	STATIC BACK STRENGTH - A STUDY AMONG YOUNG ADULTS Anisah. H, Hardianto Iridiastadi, Zulfa Fitri Ikatrinasari Universitas Mercu Buana & Institut Teknologi Bandung	ER	059
9.45-10.00	EFFECT OF THE WORK ENVIRONMENT, LEADERSHIP, WORKPLACE DESIGN, AND WELFARE FACILITIES ON WORK PERFORMANCE Abdul Djalal, Adrianus IIra, Amalia Azka Rahmayani, Hartomo Islamic University of Indonesia	ER	062
10.00-10.15	DESIGNING ERGONOMIC TOOTHBRUSH, TOOTHBRUSH REFILL, AND TOOTHBRUSH CAP Andriyani Theresia, Novi, Christina Maranatha Christian University,	ER	038
10.15-10.30	INVENTORY DETERMINATION MODEL FOR PACKAGING MATERIALS WITH VARIOUS DEMMAND DATA DISTRIBUTIONS IN CHEMICAL COMPANY Inaki Maulida Hakim, Putri Larassati University of Indonesia	PS	047
10.30-10.45	INVENTORY CONTROL SYSTEM ANALYSIS OF GOODS AT COMPANY X'S MODERN TRADE Victor Suhandi, Lydiawari Silalahi, Vivi Arisandhy Maranatha Christian University	PS	043
10.45-11.00	INVENTORY PLANNING FOR FAST MOVING CONSUMER GOODS USING PERIODIC-REVIEW ORDER-UP-TO- LEVEL (R,S) SYSTEM IN RETAIL X BANDUNG La Nashia, Mira Rahayu, Budi Santosa C, Telkom University	PS	023

MARCH 12TH SESSION 1 ROOM 3 (ER, PS)

Moderator : Ir. Lina Gozali, MM

Time	Paper	Code	Paper Code
11.00-11.15	PREVENTIVE MAINTENANCE SCHEDULING BASED ON SERVICE CENTER AND CUSTOMER'S PERSPECTIVE (CASE STUDY: CAR TYPE X OF COMPANY Y) Yudha Prasetyawan, Mita Musoffa Asti Institut Teknologi Sepuluh Nopember (ITS)	PS	027
11.15-11.30	PERFORMANCE COMPARISON OF HEURISTIC LOT- SIZING MODELS Jason Baculinao, Hui-Ming Wee, Yang Ching Chow Chung Yuan Christian University Taiwan	PS	051
11.30-11.45	GENERATE AND TEST ALGORITHM DEVELOPMENT FOR JOB SCHEDULING IN PARALLEL MACHINES WHICH CONSIDERING SETUP TIME FOR MINIMIZING TARDINESS AND MINIMIZING MAKESPAN FOR ALTERNATIVE SEQUENCES THAT HAVE SAME TARDINESS Victor Suhandi , Melissa Septina Ismanto Maranatha Christian University	PS	020
11.45-12.00	SCHEDULING ANALYSIS AND METALLURGY TESTING RESOURCE ALLOCATION AT METALLURGY LABORATORY B4T BANDUNG Moh. Syarwani, Wahyukaton, Viani Ezra Azizah Pasundan University	PS	063

MARCH 12TH SESSION 2 ROOM 1 (QC, OR)

Moderator : Dr. Ir. Syarif Hidayat, M.Eng.Sc, MM

Time	Paper	Code	Paper Code
13.00-13.15	APPLICATION OF QUALITY FUNCTION DEPLOYMENT AND SERVQUAL FOR DESIGN SERVICE INNIVATION Waraporn Yothinsirikul, Natcha Thawesaengskulthai Chulalongkorn University	QC	011
13.15-13.30	DESIGN OF QUALITY PROCESS STANDARD BASED ISO 9001:2008 CLAUSE 7.5.1 FOR TRADITIONAL BATIK CAP INDUSTRY Dida D Damayanti , Sri Widaningrum, Luciana Andrawina, Irma Pramudya A Telkom University	QC	040
13.30-13.45	DESIGNING SETTING PARAMETER OF TABLET COMPRESSION PROCESS TO MINIMALIZE WEIGHT VARIATION Teuku Yuri Zagloel, Kinanti Rakayantias University of Indonesia	QC	048
13.45-14.00	QUALITY OF COMPUTER MUSIC USING MIDI LANGUAGE FOR DIGITAL MUSIC ARRANGEMENT Pandan Pareanom Purwacandra , Ferry Wahyu Wibowo Informatics Engineering, STMIK AMIKOM	QC	032

MARCH 12TH SESSION 2 ROOM 1 (QC, OR)

Moderator : Dr. Ir. Syarif Hidayat, M.Eng.Sc, MM

Time	Paper	Code	Paper Code
14.00-14.15	QUALITY IMPROVEMENT EFFORT USING TRIZ METHOD CASE STUDY IN CV 'X', A METALCASTING INDUSTRY Christina Wirawan , Maria Sari Desiana Maranatha Christian University	QC	005
14.15-14.30	PARAMETER IDENTIFICATION OF SCANNING QUALITY IN <i>3D LASER SCANNER</i> : HARDWARE AND LIGHT INTENSITY SETTINGS Catharina Badra Nawangpalupi, Hanky Fransiscus, Bagus Arthaya, Adiyoga I Putra Catholic University Parahyangan	QC	037
14.30-14.45	THE APPLICATION OF OVERALL EQUIPMENT EFFECTIVENESS (OEE) TO ANALYZE LEAN SIX SIGMA CAPABILITY OF SHRINK LABELS PRODUCTION AT COMPANY X David Sungkono, Yurida Ekawati Ma Chung University	QC	006
14.45-15.00	THE MEASUREMENT OF WORKLOAD AND OPTIMAL NUMBER OF EDUCATION PERSONNEL USING WORK SAMPLING AND TASK PER JOB METHODS (A CASE STUDY AT PT X.) SYAMSUL ANWAR, JASRIL AKADEMI TEKNOLOGI INDUSTRI PADANG	OR	018
15.00-15.15	DEMAND FORECASTING FOR SALES ORDER AND DISTRIBUTION REQUIREMENTS PLANNING SYSTEM (CASE STUDY : IKM XYZ) Winangsari Pradani, Cut Nuraini, Anela Septieni Zulkifli, Nida'ul Hasanati, Nunung Nurhasanah, Syarif Hidayat University Al Azhar Indonesia	OR	072
15.15-15.30	COMPARING TRANSPORTATION COST IN CPO TENDER USING GENETIC ALGORITHM AND OPERATIONS RESEARCH TOOLS Syarif Hidayat, Rizky Betadi Putra University of Al Azhar Indonesia	OR	001

MARCH 12TH SESSION 2 ROOM 2 (PS, ER)

Moderator : Dr. Lamto Widodo, ST, MT

Time	Paper	Code	Paper Code
13.00-13.15	REENGINEERING PROCESS FOR REDUCING TIME OF PROCUREMENT AND INVENTORY PROCESS IN TELECOMMUNICATION TOWER COMPANY WITH IDEF0 TOOLS AND ESIA METHOD Indramawan, Rahmat Nurcahyo, Yadrifil, M.Dachyar University of Indonesia	PS	065
13.15-13.30	MULTI-LEVEL INVENTORY MANAGEMENT CONSIDERING TRANSPORTATION COST AND QUANTITY DISCOUNT Eko Pratomo, Hui Ming Wee, Sukoyo Chung Yuan Christian University	PS	054

The 7th International Seminar on Industrial Engineering and Management (7th ISIEM) Sanur Paradise Hotel, Bali, Indonesia, March 11th-13th, 2014

MARCH 12TH SESSION 2 ROOM 2 (PS, ER)

Moderator : Dr. Lamto Widodo, ST, MT

Time	Paper	Code	Paper Code
13.30-13.45	REFURBISHMENT OF USED MACHINE ELEMENTS FOR MAKING 2 ¹ / ₂ AXES MILLING MACHINE PROTOTYPE Bagus Arthaya, Ali Sadiyoko, Oke Setiawan Parahyangan Catholic University	PS	004
13.45-14.00	THE REDESIGN OF BAJAJ STUDY CASE FOR THE OLD BAJAJ IN JAKARTA Indra Gunara Rochyat, Andre Hambali, Esa Unggul University	ER	079
14.00-14.15	ANALYSIS OF CULTURAL ATTRIBUTE IN PRODUCT DESIGN OF CRAFT TO INCREASE PURCHASE INTENTION Lusia Permata Sari Hartanti, Dian Trihastiuti University of Pelita Harapan	ER	041
14.15-14.30	ANALYSIS AND IMPROVEMENT PROPOSAL OF SDN 7 KIARACONDONG BASED ON DIKNAS AUDIT VIEWED FROM ERGONOMICS ASPECT Dina Magdalena, Elty Sarvia, Winda Halim University of Kristen Maranatha,	ER	046
14.30-14.45	DEVELOPMENT OF MATHEMATICAL MODEL AND SOFTWARE FOR DIGITAL CIRCUMFERENCE ANTHROPOMETRIC MEASUREMENT Benedikta Anna H Siboro, Herianto Riau Kepulauan University	ER	049
14.45-15.00	PSYCHOMOTOR VIGILANCE TASK AS A MEASURE OF PERFORMANCE-BASED FATIGUE Rida Zuraida, Hardianto Iridiastadi Binus University, Bandung Institut of Technology	ER	081
15.00-15.15	PRODUCT CONCEPT OF RECHARGEABLE BATTERY FOR ENVIRONMENTALLY FRIENDLY TOWARD ELECTRONIC COMMUNICATIONS EQUIPMENT TO FACILITATE THE USER Geggy Gamal Surya, Efrhenrycx Esa Unggul University	ER	083
15.15-15.30	DESIGNING OF CARTON BOX STACKING TOOL TO INCREASE THE EFFICIENCY OF POND MACHINE AT PT. SUPREME TIRTA LARISINDO Lamto Widodo, Silvi Ariyanti, Alvin Khumara Tarumanagara University & Mercubuana University	ER	077

MARCH 12TH SESSION 2 ROOM 3 (SCM, IM)

Moderator : Ir. Lina Gozali, MM

Time	Paper	Code	Paper Code
13.00-13.15	POLICY ANALYSIS ON SMEs VEHICLE COMPONENTS IN ORDER TO IMPROVE ITS SUPPLY CHAIN ABILITY WITH SYSTEM DYNAMICS APPROACH M. Nurman Helmi Pasundan University	SCM	073

MARCH 12TH SESSION 2 ROOM 3 (SCM, IM)

Moderator : Ir. Lina Gozali, MM

Time	Paper	Code	Paper Code
13.15-13.30	SUPPLIER BUYER RELATIONSHIP SELECTION USING SUPPLY POSITIONING MODEL METHOD Ramadian Puspitasari, Mira Rahayu Telkom University	SCM	022
13.30-13.45	BIO-DIGESTER INSTALLATION PROGRAM TO IMPROVE ENERGY SECURITY: INITIATING VALUE CHAIN MODEL FOR DAIRY FARMERS IN CIATER Catharina Badra Nawangpalupi, Meity Martaleo, Loren Pratiwi, Yani Herawati Catholic University Parahyangan	SCM	067
13.45-14.00	STRATEGIC PROCESS DESIGN FOR FISH – BASED SMEs Sitnah Aisyah Marasabessy Ambon University of Darussalam	IM	045
14.00-14.15	CUSTOMER CRITERIA ANALYSIS FOR EDUCATIONAL ORGANIZATION DESIGN Hartomo, Catur Siwi Handayaningtyas Islamic University of Indonesia	IM	061
14.15-14.30	CRM DIMENSIONAL ANALYSIS AND ANP METHOD FOR SUB-CONTRACTOR COMPANY OF OIL AND GAS INDUSTRY IN ORDER TO REDUCE CUSTOMER COMPLAINTS Doddy Prasetyo Nugroho, Rahmat Nurcahyo, Yadrifil, M.Dachyar University of Indonesia	IM	064
14.30-14.45	HOW TO OBTAIN STUDENTPRENEURSHIP THROUGH ENTREPRENEURSHIP-BASED CURRICULUM JajaSuteja Pasundan University	IM	030
14.45-15.00	HIGHER EDUCATION INSTITUTION XYZ PERFORMANCE MEASUREMENT USING MBCfPE BASED ON KPKU- BUMN APPROACH Sugih Arijanto, Ambar Harsono Institut Teknologi Nasional (Itenas) Bandung; Indonesia Quality Award (IQA) Examiners; KPKU-BUMN Evaluator (1)	IM	053
15.00-15.15	ANALYSIS OF THE RELATIONSHIP BETWEEN LECTURER TEACHING METHOD FOR QUANTITATIVE COURSES AND STUDENTS' LEARNING MOTIVATION (Case Study: Industrial Engineering Department, Maranatha Christian University, Bandung-Indonesia) Yulianti, Jimmy Gozaly Maranatha Christian University	IM	010
15.15-15.30	BUSINESS PROCESS IMPROVEMENT: ORDER FULFILLMENT PROCESS Vivi Triyanti, Savina Salim Atma Jaya Catholic University of Indonesia	IM	085

MARCH 13TH SESSION 3 ROOM 1 (QC, PS) Moderator : Dr. Rina Fitriana, ST, MM

Time	Paper	Code	Paper Code
8.30-8.45	DESIGN OF INSPECTION AND CLASSIFICATION PROTOTYPE FOR CERAMIC TILES BASED ON THE DIGITAL IMAGE PROCESSING Yudha Prasetyawan, Maria Christina Institut Teknologi Sepuluh Nopember	QC	026
8.45-9.00	PARTICLE SWARM OPTIMIZATION BASED ON BOTTLENECK MACHINE FOR JOBSHOP SCHEDULING Rahmi Maulidya Trisakti University	PS	078
9.00-9.15	DYNAMIC MODIFIED SPANNING TREE ALGORITHM FOR SINGLE-ROW DYNAMIC FACILITY LAYOUT PROBLEM Yogi Yogaswara Pasundan University	PS	074
9.15-9.30	INCREASE OF EFFICIENCY OF WORKSTATION DESIGN THROUGH PRODUCTION SCHEDULING FOR MOSLEM CLOTHES IN SME "XYZ" Nunung Nurhasanah, Laksmi Saraswati, Syarif Hidayat, Nida'ul Hasanati, Winangsari Pradani, Muhammad Aulia Taqwa, Anela Septiani Zulfikar, Cut Nuraini, Munawir Biki University of Al-Azhar Indonesia	PS	028
9.30-9.45	MACHINE SCHEDULING PROPOSED FOR MINIMIZING MAKESPAN AT PT ADIPERKASA ANUGRAH PRATAMA Lina Gozali , Silvi Ariyanti , Febrina Lesley Natali Tarumanagara University	PS	002
9.45-10.00	IMPROVEMENT WORK EFFICIENCY AND MANUFACTURING PRODUCTIVITY AT PT. XYZ WITH LINE BALANCING ANALYSIS Arief Suwandi, Prianggara NAL Esa Unggul University	PS	090
10.00-10.15	IMPLEMENTATION SIX SIGMA AND DATA MINING TO IMPROVE DIE CASTING PRODUCTION PROCESS AT PT. AB Rina FItriana, Johnson Saragih, Sitta Sarasaty Trisakti University	QC	058
10.15-10.30	SELECTION OF OPEN SOURCE ENTERPRISE RESOURCE PLANNING (ERP) SYSTEM FOR FURNITURE MANUFACTURING SMEs AS A COMPETITIVE STRATEGY Wiwid Dolianto, Zulfa Fitri Ikatrinasari University of Mercu Buana	DSS	080
10.30-10.45	QUALITY STUDY OF WASTE WATER PROCESSING I Nyoman Sudipa Mahendradatta Mercu Buana	QC	093

PS-	– Produ	ction System	
No	Paper	Title and Author	Page
1	02	Machine Scheduling Proposed For Minimizing Makespan At PT Adiperkasa Anugrah Pratama <i>Lina Gozali, Silvi Ariyanti, Febrina Lesley Natali</i>	PS – 1
2	04	Refurbishment Of Used Machine Elements For Making 2½ Axes Milling Machine Prototype Bagus Arthaya, Ali Sadiyoko, Oke Setiawan, Filemon N.T., Sebastian T.	PS – 7
3	20	Generate And Test Algorithm Development For Job Scheduling In Parallel Machines Which Considering Setup Time For Minimizing Tardiness And Minimizing Makespan For Alternative Sequences That Have Same Tardiness <i>Victor Suhandi, Melissa Septina Ismanto</i>	PS – 15
4	23	Inventory Planning For Fast Moving Consumer Goods Using Periodic-Review Order-Up-To-Level (R, S) System In Retail X Bandung <i>La Nashia, Mira Rahayu, Budi Santosa C.</i>	PS – 23
5	27	Preventive Maintenance Scheduling Based On Service Center And Customer's Perspective (Case Study: Car Type X Of Company Y) Yudha Prasetyawan, Mita Musoffa Asti	PS – 32
6	28	Increase Of Efficiency Of Workstation Design Through Production Scheduling For Moslem Clothes In SME "XYZ" <i>Nunung Nurhasanah, Laksmi Saraswati, Syarif Hidayat, Nida'ul</i> <i>Hasanati, Winangsari Pradani, Muhammad Aulia Taqwa, Anela Septiani</i> <i>Zulfikar, Cut Nuraini, Munawir Biki</i>	PS – 42
7	43	Inventory Control System Analysis Of Goods At Company X's Modern Trade Victor Suhandi, Lydiawari Silalahi, Vivi Arisandhy	PS – 49
8	47	Inventory Determination Model for Packaging Materials with Various Demand Data Distributions in Chemical Company <i>Inaki Maulida Hakim, Putri Larassati</i>	PS – 58
9	51	Performance Comparison Of Heuristic Lot-Sizing Models Jason Baculinao, Hui-Ming Wee, Yang Ching Chow	PS - 65
10	54	Multi-Level Inventory Management Considering Transportation Cost And Quantity Discount <i>Eko Pratomo, Hui Ming Wee, Sukoyo</i>	PS – 72
11	63	Scheduling Analysis And Metallurgy Testing Resource Allocation At Metallurgy Laboratory B4T Bandung <i>Moh. Syarwani, Wahyukaton, Viani Ezra Azizah</i>	PS – 78
12	65	Reengineering Process For Reducing Time Of Procurement And Inventory Process In Telecommunication Tower Company With IDEF0 Tools And Esia Method Indramawan, Rahmat Nurcahyo, Yadrifil, M.Dachyar	PS – 83
13	74	Dynamic Modified Spanning Tree Algorithm For Single-Row Dynamic Facility Layout Problem Yogi Yogaswara	PS – 90
14	78	Particle Swarm Optimization Based On Bottleneck Machine For Jobshop Scheduling <i>Rahmi Maulidya</i>	PS – 100
15	90	Improvement Work Efficiency And Manufacturing Productivity At PT. XYZ With Line Balancing Analysis <i>Arief Suwandi, Prianggara NAL</i>	PS – 105



MACHINE SCHEDULING PROPOSED FOR MINIMIZING MAKESPAN AT PT ADIPERKASA ANUGRAH PRATAMA

Lina Gozali¹⁾, Silvi Ariyanti²⁾, Febrina Lesley Natali³⁾

 ¹⁾ Lecturer of Industrial Engineering Department, Universitas Tarumanagara
²⁾ Lecturer of Industrial Engineering, Universitas Mercu Buana
³⁾ Student of Industrial Engineering, Universitas Tarumanagara ligoz@ymail.com

ABSTRACT

PT Adiperkasa Anugrah Pratama is a manufacture company that processes raw materials such as brasses and metals to become finish goods. The company has been operating for 3 years from 2009 and it's been growing quite fast, which can be found with the growing number of incoming orders. A big total number of incoming orders cause the company to use semi-manual scheduling production processes that is less effective in scheduling production processes. PT AAP hasn't applied a suitable and correct method in scheduling production. because the PPC division is planning the scheduling production by longest time needed for completing production processes or the largest number of time in incoming orders. So the effective method for scheduling production must be made and applied. The methods that been used are Campbell, Dudek and Smith ; Nawaz, Enscore and Ham, and the Gupta Heuristic method. These three methods are used for minimalizing makespan by choosing the best sequence of production processes. After comparing with the original makespan of the company, which is 1.245.000 seconds, CDS method produces makespan of 1.238.234 seconds, NEH method which produces makespan of 1.217.366 seconds, and Gupta Heuristic method which produces makespan of 1.245.200 seconds. The conclusion is that the NEH method produces smallest makespan and the original makespan of the company can be reduced by 27.834 seconds.

Keywords : makespan, CDS, NE, Gupta Heuristic

1. INTRODUCTION

PT. Adiperkasa Anugrah Pratama is located in Tangerang was founded in 2009, the company's managing raw materials such as brass and metal to be processed into various products, such as cashing cover, burner, body valve, drain case, and spare parts for Honda. From this wide range of products that are made, the main product which has so much demand is always been made by factory is cashing cover.

To produce products effectively and efficiently, then the company needs to establish appropriate scheduling method, but the company already did production scheduling based only on the longest processing time or the high demand for most products. This high risk condition of the company because of the lack certainty of scheduling methods. Based on these considerations, the research conducted to establish how proper scheduling method for companies to product completion time can be reduced by using the method of Campbell, Dudek, and Smith, Nawaz method, Enscore, and Ham, and Gupta Heuristic methods

The limitation of the study for the production scheduling for cashing cover consist of: cashing cover 1 (job 1), cashing cover 2 (job 2), cashing cover 3 (job 3), cashing cover 4 (job 4). Demand data is captured and processed requests in September 2012, the cycle time is taken directly on the production floor with stopwatch, the state of the machine and the operator works under normal circumstances, the transfer time of goods is excluded because the items are available to be processed before process takes place, the level of accuracy that is used by 5%, and the confidence level used is 95%.

By knowing the background of the problem and the extent of the problem, it is expected that this study can reduce the production time of cashing cover to determine the most optimum job sequence using three proposed methods, because the main focus of this study was to compare the initial makespan with three makespan using CDS, NEH method, and the method Heuristic Gupta.

2. LITERATURE STUDY

There are some scheduling definitions, one of which defines a scheduling adjustment activity with limited resources to maximize customer satisfaction, utilization of production, and minimize operating costs. Decisions made in the scheduling of jobs includes sequencing (sequencing), start time and end time job (release and timing), and the sequence of operations of a job (routing). Scheduling problem is always related to the production sequencing (sequencing) so scheduling is defined as the determination of the sequences of the arrival of a variety of work to be completed within a specified period. (Morthon 1993) Meanwhile, according to Baker, scheduling is defined as a process of resource allocation / existing machinery to carry out the tasks that exist within a certain time (Baker 1974).

Some of the objectives to be obtained with the implementation of scheduling is (Baker 1974).:

- 1. Increase Productivity of machine, namely by reducing idle time o machine.
- 2. Reduce the work in process product with reducing average number of waiting time which queue of busy machine.
- 3. Reduce delays due to have exceeded the time limit by:
 - a. Reducing the maximum delay.
 - b. Reducing the number of late jobs

Some of Terminology used in the scheduling problems (Daihani, 2001) :

- 1. Processing time $= t_j$ is time span needed to finish an operation at job **j**.
- Ready Time (r_j) is a start time of job j to be done.
- Due Date (d_j) is a finish time of a job to be done. If overdue, the job can be stated as a tardy job.
- Completion time = C_j) time needed until job j has finished.
- 5. Flow time = F_j) time need from job j in the production floor.

- 6. Lateness (L_j) deviation finished job time from the job due date job. Lateness calculated wih equation $L_j = C_j - d_j$.
- 7. L_j < 0, finished the job in time (earliness).
- 8. $L_j > 0$, finished the job over due (tardiness).
- Slack (SL_j) available time for a job. The value of slack can be calculated in equation SL_j = d_j t_j.
- 10. Tardiness (\mathbf{T}_j) is overdue time for a job compare to the job due date.
- 11. Makespan (**Ms**) span of a whole processing time to be finished in the production floor.

Campbell, Dudek, and Smith method is a scheduling method for series machines with Johnson rules. Procedure of CDS's method as follows (Daihani, 2001):

- 1. Determine the some alternative steps as much as n machines -1
- 2. In each alternative step, then calculated the processing time for t_1 dan t_2 .
- 3. In all scheduling jobs, determine the smallest processing time from each jobs.
- 4. With Johnson's rules, place the sort of jobs in the left side for the smalles processing time machine 1 (t₁), and if the smallest processing time for machine 2 (t₂), place it in the right side.
- 5. Made a series sort jobs in each available alternative
- 6. Then calculated makespan in every available alternatives.
- 7. Choose the alternative with the smallest makespan dan flowtime.

Nawaz, Enscore, and Ham Method is being used to calculate every processing time for every job job and to reduce production time. Procedures for NEH are as follows (Herjanto, 1991):

- 1. Calculated processing time for every job.
- 2. Do sort jobs based on Longest Processing Time rule.
- 3. Then try 2 job sort from LPT rule (J1, J2) and (J2, J1). Calculate makespan from this 2 job sort and choose the smallest makespan between those two job sort, for example (J2, J1)
- Continue the calculation based next job, for example J3, so the new sort job could be such as (J2, J1, J3), (J2, J3, J1), (J3, J2, J1), then calculate makes pan from

the new value of three job sort, choose the smallest makespan.

5. Do all the possible calculations and choose the smallest makespan.

Heuristik Gupta Method was found by Gupta 1972. The procedure of Gupta Method are as follows:

- 1. Calculate the processing time for every job in every work station.
- Totalize the processing time every job between 2 sort machine. For example (P_{1j} + P_{2j}), (P_{2j} + P_{3j}),...until (P_{(m-1)i}, P_{mi}) When, P_{ij} = job j time at i machine. m = total work station
- 3. Choose the smallest value from all the calculations.
- 4. Determine the value of $_{ei}$: If P_{i1} , P_{im} , then $e_i = 1$ If $P_{i1} \ge P_{im}$, then $e_i = -1$
- Calculate the value of S_i from every job with devide the value of e_i at the above procedure no 4 with minimal value has been chosen at the procedure no 3
- Do sort S_i value from every job. Job with the biggest S_i value get the first job sort, and continue until the latest job with smallest S_i value.
- 7. From all sort job calculation, then calculate the makespan value for every new sort.
- 8. Choose the smallest makespan.

3. RESEARCH METHODOLOGY

The methodology for this research is as figure 1.



Figure 1 : Research Methodology

4. DATA CALCULATION AND DATA ANALYSIS

The calculation data starts with normality test, uniformity test and adequacy test for cycle time data. Normality test has been done with SPSS 20 software with Kolmogorov Smirnov technique, uniformity test done with manual calculation with Upper control limit (UCL), and lower control limit (LCL), and adequacy test with N' equation (if N' < N, then all the data needed are enough) (Askin, 2003).

After all the data tests, then calculate the cycle time to normal time with

Westinghouse adjustment, then calculate the normal time to standard time with 8 allowances. After having the standard time, then calculate the processing time for every job by multiply the demand with standard time. All the standard time and processing time can be seen at Table 1 (in second).

Table 1 Standard processing time for every job											
	Sta	Standard time (second)					Processing time (second)				
Department	Job 1	Job 2	Job 3	Job 4		Job 1	Job 2	Job 3	Job 4		
Cutting (P1)	8,57	7,50	8,57	8,57		77430	45300	20868	5442		
Forging (P2)	12,68	12,89	11,91	14,50		114978	78222	29493	9603		
Triming (P3)	5,35	5,70	7,94	7,94		48154	34176	19046	4762		
Restric (P4)	5,81	5,38	5,39	6,87		52301	32256	12933	4124		
Shotblash (P5)	4,00	4,00	4,00	4,00		36000	24000	9600	2400		
Machining OP 1 (P6)	7,81	7,47	9,91	10,97		70295	44806	23774	6584		
Machining OP 2 (P7)	70,74	70,59	66,08	79,87		636651	423520	158587	47922		
Boring (P8)	11,12	11,53	11,91	12,91		100120	69182	28592	7746		
Champer (P9)	7,48	7,41	8,14	8,77		67338	44474	19544	5262		
Painting (P10)	16200	16200	16200	16200		14101	9400	3760	940		
Demand (pcs)	9000	60000	2400	600							

Table 2. Initial makespan Calculation

	P1 (2 M	lachine)	P2 (2 M	lachine)	P3 (2 M	P3 (2 Machine)		lachine)	P5 (2 Machine)	
Job	Start	Finish	Start	Finish	Start	Finsih	Start	Finish	Start	Finished
	0		105264		220242		268395		320696	
1	(M1)	77430	(M2)	220242	(M1)	268395	(M2)	320696	(M2)	356696
	0		45300		123522		157698		189954	
2	(M2)	45300	(M1)	123522	(M2)	157698	(M1)	189954	(M1)	213954
	45300		66168		95661		114708		127641	
3	(M2)	66168	(M2)	95661	(M1)	114708	(M2)	127641	(M2)	137241
	66168		95661		105264		110026		114150	
4	(M2)	71610	(M2)	105264	(M2)	110026	(M1)	114150	(M1)	116550

Continue	Table	2
		_

P6 (2 N	lachine)	P7 (2 N	P7 (2 Machine)		Machine) P9		P8 (2 Machine)		lachine)	P10 (1 M	achine)
Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish		
356696		426990		1063641		1163761		1231099			
(M2)	426990	(M2)	1063641	(M2)	1163761	(M2)	1231099	(M1)	1245200		
213954		258760		682279		751462		795936			
(M1)	258760	(M1)	682279	(M1)	751462	(M1)	795936	(M1)	805336		
137241		161015		319603		348194		367738			
(M2)	161015	(M2)	319603	(M2)	348194	(M2)	367738	(M1)	371498		
116550		123133		171056		176317		181579			
(M1)	123133	(M1)	171056	(M1)	176317	(M1)	181579	(M1)	182519		
								Makespan	1245200		
								FlowTime	2604554		

Time at painting department for processing 10.340 pieces is 16.200 second, so the processing time for each pieces for job 1 = (9000/10.340) X 16.200 second = 14.101 second, and so on with the others.

After having processing time, calculate the makespan value for company based on sort job, is job 1,2,3,4. Makespan value = 1.245.200 second, flowtime = 2.604.554 second, mean flowtime (2.604.554/4) =

651.138,5 second. All the makespan value can be seen at Table 2.

Makespan calculation at table 2 is based on available machine. Job sort at the company is 1,2,3,4. Then all of the calculations are as follows:

- 1. For P1 available 2 machines, job 1 enter machine 1 (M1) at P1 process at 0, then job 2 enter to M2 at P2 process at 0.
- 2. At job done totalize the starting time with processing time, until the job 1 done = 77.430 second, and job 2 = 45.300 second
- 3. Select both time, which one is smallest and finished earlier at P1 process.
- 4. Job 2 has a smallest time than job 1, until M2 enter job 3 at 45.300 second, job 3 done = 66168 second.
- If job 1 done at M1 is smallest from job 3 at M2, then job 5 can be process at M1, unfortunately the time done M1 > M2, so job 4 enter M2 at 66.168 second, or after job 3 finished at M2 processing.
- 6. Repeat step 1 until 5 for each job and each machine.

Determine the sort job with the smallest CDS method based on literacy procedure. After all of the procedures the alternative job sort Y = m-1, Y = 10-1, Y = 9. The calculation result of makespan = 1.238.234 second with the job schedule 4,3,2,1. The makespan summary with CDS method can be seen at Table 3.

Next, we calculate makespan with NEH method based on literature procedure. With

3 iteration, at 1^{st} iteration calculate the makespan for job 1,2, and job 2,1, the result is the same makespan, then the selection come out randomly with job 1,2. The 2^{nd} iteration for job 1,2,3, job 1,3,2, dan job 3,1,2, then smallest makespan is job 1,3,2. The 3^{rd} iteration for job 1,3,2. The 3^{rd} iteration for job 1,3,2. Then the best result are job 1,4,3,2 or job 4,1,3,2 with smallest makespan = 1.217.366 second and flow time = 618.859,25 second. Makespan summary with NEW Method can be seen at Table 4.

Table 4. Makespan Summa	ary with NEH
Method	

		mounou		
Job sort	1,3,2,4	1,3,4,2	1,4,3,2	4,1,3,2
Makespan (second)	1.221.148	1.217.366	1.217.366	1.217.366
Mean Flowtime	633.626	622.715,75	618.859,25	618.859,25

Then we sort the job with Gupta Method and show a new makespan. With all the Gupta Method's Procedure, we can calculate total 2 processing time sorted job, based on value of ei and Si. Processing time with Heuristic Gupta Method can be seen at table 5.

After calculating all the above components, then all jobs can be sorted from the biggest Si value to the smallest Si value. The result of Job sorted is 1,2,3,4 job. The new sorted is the same with initial company's makespan = 1.245.200 second.

	Table 5. Makespart Summary with CDS Method								
Y	Y=1	Y=2	Y=3	Y=4	Y=5	Y=6	Y=7	Y=8	Y=9
Job sort	1,2,3,4	1,2,3,4	1,2,3,4	4,3,2,1	4,3,2,1	4,3,2,1	1,2,3,4	1,2,3,4	1,2,3,4
Makespan	1.245.200	1.245.200	1.245.200	1.238.234	1.238.234	1.238.234	1.245.200	1.245.200	1.245.200
Flowtime	2.604.554	2.604.554	2.604.554	2.469.995	2.469.995	2.469.995	2.604.554	2.604.554	2.604.554

Table 3. Makespan Summary with CDS Method

Table 5. Summary of Pro	cessing time with I	Heuristik Gupta Method
-------------------------	---------------------	------------------------

abio	0.0	GITTING		11100	0000	ing un				apta mit	
Job	P1	+P2	P2	2+P3	P3	+P4	P4	4+P5	P5+P6	P6+I	7
1	19	2408	16	3131	10	0454	8	8301	106295	706	946
2	12	3522	11	2398	6	6432	5	6256	68806	468	325
3	5	0361	4	8540	3	1980	2	2533	33374	182	362
4	1	5045	1	4364		8886		6524	8984	54	506
P7+l	P8	P8+	P9	P9+	P9+P10		٦	ei	Si		
7367	771	1674	158	81	439	814	39	-1	-1,2279	92E-05	
4927	702	1136	657	53	875	538	75	-1	-1,8561	6E-05	
1871	179	48′	135	23	304	225	33	-1	-4,4379	91E-05	
556	69	130	800	6	202	62	02	-1	-0,0001	61244	

Table 6. Summary of Three Methods Comparison									
Scheduling Method	Job Sort	Makespan (second)	Mean Flowtime (second)						
CDS	4,3,2,1	1.238.234	617.498,75						
NEH	1,4,3,2 or 4,1,3,2	1.217.366	618.859,25						
Gupta	1,2,3,4	1.245.200	651.138,50						

Table 6. Summary of Three Methods Comparison

In Table 6 shows the best method for machine scheduling is NEH Method that gives the best makespan time. The comparison from NEH Method and Company's initial makespan can be found at Table 7.

Table 7. Makespan and Flowtime comparison from Company Real time and NEH Method

INET Method		
Job	Makespan	Mean
Sort	(second)	Flowtime
		(second)
1,2,3,4	1.245.200	651.138,50
1,4,3,2	1.217.366	618.859,25
or		
4,1,3,2		
	Job Sort 1,2,3,4 1,4,3,2 or 4,1,3,2	Job Makespan Sort (second) 1,2,3,4 1.245.200 1,4,3,2 1.217.366 or 4,1,3,2

NEH method gives the best result reducing makespan at 2.24% and reducing mean flowtime at 5%.

5. CONCLUSION

All the calculation prove that initial makespan from PT AAP = 1.245.200 second, initial mean flowtime = 651.138,50 second and the the best method from CDS, NEH and Gupta is NEH method. NEH method shows new makespan = 1.217.366 second, reducing makespan = 27.834 second or 2,24%, new mean flowtime 618.859, 25 second, reducing mean flowtime = 32.278 second or 5 %.

6. LITERATURE

 (a) Morthon, Thomas E., David W.Pentico.
(1993). Heuristic Schedulling Systems : With Application in Manufacturing and Services. John Willey and Sons Int. New York

- (b) Baker, Kenneth R. (1974). Introduction to Sequencing and Schedulling. John Willey and Sons Int. New York
- (c) Daihani, Dadan Umar. (2001). Komputerisasi Pengambilan Keputusan. Jakarta : PT. Elex Media Komputindo.
- (d) Herjanto, Eddy. (1991). Manajemen Produksi dan Operasi. PT Gramedia Widiasarana Indonesia. Jakarta
- (e) Askin, Ronald. (2003). Design and Analysis of Lean Production System. John Willey and Sons Pte. Ltd. Singapore
- (f) Sutalaksana, Iftikar Z., Ruhana Anggawisastra., Jann H. Tjakraatmadja. (1979).Teknik Perancangan Sistem Kerja Edisi Kesatu. ITB Bandung. Bandung