

MACHINE SCHEDULING PROPOSED FOR MINIMIZING MAKESPAN AT PT ADIPERKASA ANUGRAH PRATAMA

by Lina Gozali

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Proceeding

7th INTERNATIONAL SEMINAR ON INDUSTRIAL
ENGINEERING AND MANAGEMENT (7th ISIEM)

with theme: *“Green Technology on Industrial Engineering,
Information and Management”*

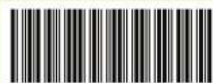
*Sanur Paradise Hotel, Bali, Indonesia
March 11th– 13th, 2014*



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PROCEEDING

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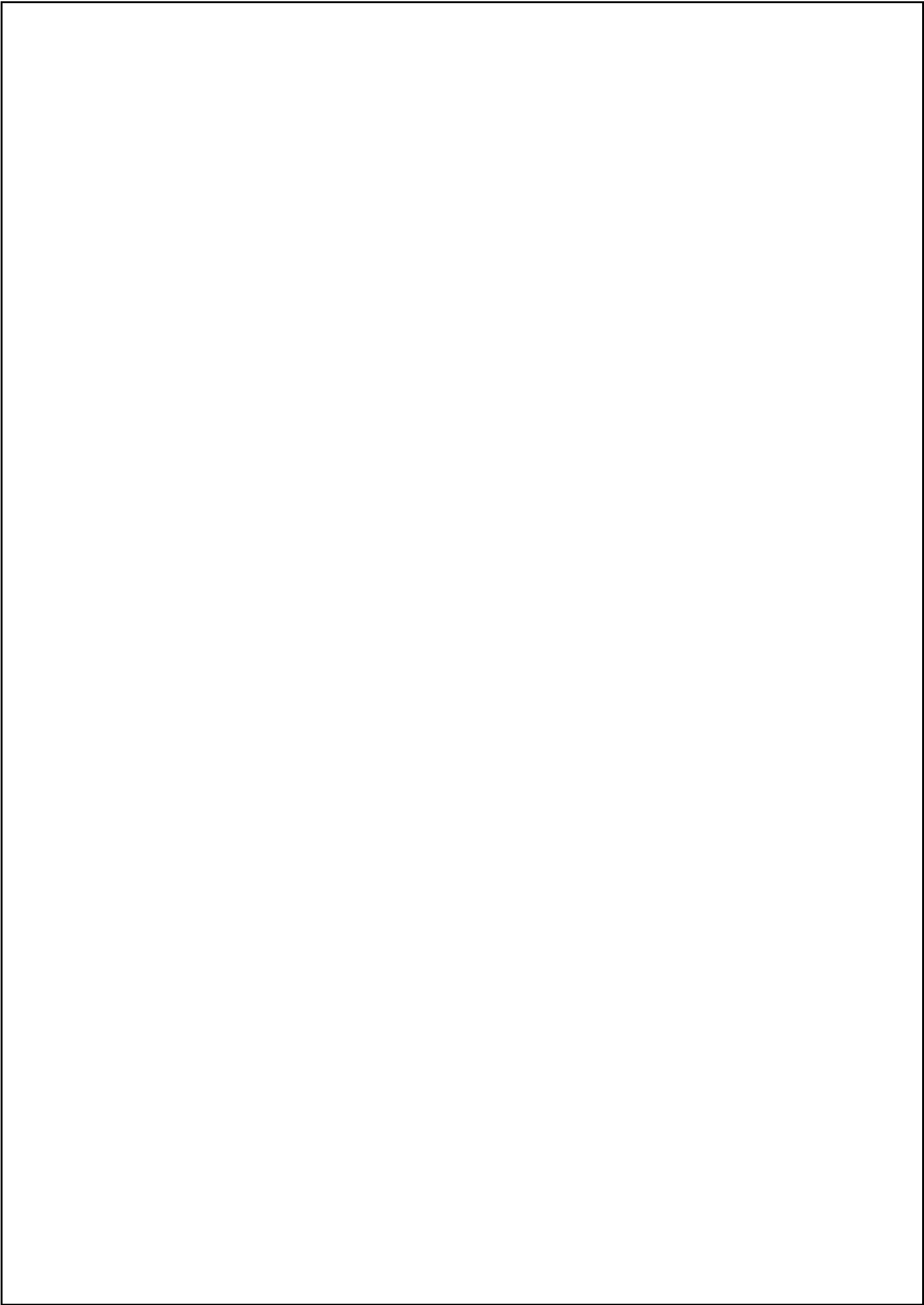
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PREFACE

Dear Colleagues,

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On behalf of the Organizing Committee, I am honored to welcome you to the 7th International Seminar on Industrial Engineering and Management (ISIEM). This seminar is 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

¹
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Sanur Paradise Hotel, Bali, Indonesia, March 11th-13th, 2014

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

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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 Shastri
(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

PARALLEL SESSION

MARCH 12TH SESSION 1 ROOM 1 (DSS)

Moderator : Iphov Kumala, ST, MSi

Time	Paper	Code	Paper Code
9.30-9.45	11 HUMAN RESOURCE DECISION SUPPORT SYSTEM DESIGN IN MAINTENANCE DEPARTMENT OF XXL COMPANY USING WATERFALL METHOD Rayinda Pramuditya Soesanto , Amelia Kurniawati, Nia Ambarsari Telkom University	DSS	017
9.45-10.00	DEVELOPMENT OF DECISION SUPPORT SYSTEM FOR SELECTING QUALITY MANAGEMENT SYSTEMS AND MANAGEMENT TOOLS Saranya Sukkam , Natcha Thawesaengskulthai 7thulalongkorn University	DSS	012
10.00-10.15	SIMULATION MODEL DESIGN OF REFUELING SYSTEM AT PERTAMINA ALAM SUTERA GAS STATION Abel Anthony, Eric Jobiliong, Enda D. Layuk Allo 14 Universitas Pelita Harapan	DSS	060
10.15-10.30	HELPDESK SYSTEM DESIGN AND DEVELOPMENT IN A UNIVERSITY BASED ON ITIL V3 FRAMEWORK (CASE STUDY: AL AZHAR INDONESIA UNIVERSITY) Endang Ripmiatin, Arum Fitriati University Al Azhar Indonesia,	DSS	070
10.30-10.45	CARBON MONOXIDE POLLUTION DETECTION AND MEASUREMENT USING KNOWLEDGE-BASED AND PROBABILITY APPROACHES Ferry Wahyu Wibowo, Pandan Pareanom Purwacandra Informatics Engineering, STMIK AMIKOM	DSS	007
10.45-11.00	EXPERT SYSTEM DEVELOPMENT FOR IMPROVING QUALITY AT RICE MILLING UNIT Dedy Sugiarto , Dadang Surjasa, Binti Solihah, Nirdukita Ratnawati, Jimmy Susanto 7thisakti University	DSS	035
11.00-11.15	ANALYSIS OF USABILITY OPCS SOFTWARE A TEST 7D THE STUDENT Rizky Junianto, Laurence, Agustina Christiani, Helena J. Kristina University of Pelita Harapan	DSS	052
11.15-11.30	HOW RFID TECHNOLOGY SUPPORTS E-BUSINESS PROCESSES Sudarmawan, Ferry Wahyu Wibowo, Rizqi Sukma Kharisma Informatics Engineering, STMIK AMIKOM	DSS	008
11.30-11.45	MANUFACTURING INFORMATION SYSTEM FOR SMALL AND MEDIUM ENTERPRISE (CASE STUDY TEXTILE SME) Nida'ul Hasanati, Munawir Biki, Muhammad Aulia Taqwa, Laksmi Saraswati, Winangsari Pradani, Nunung	DSS	071

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The 7th International Seminar on Industrial Engineering and Management (7th ISIEM)
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MARCH 12TH SESSION 1 ROOM 1 (DSS)

Moderator : Iphov Kumala, ST, MSi

Time	Paper	Code	Paper Code
	Nurhasanah, Syarif Hidayat University Al Azhar Indonesia,		
11.45-12.00	WASTE REDUCTION IN THE PRODUCTION PROCESS PLATE PRODUCT TYPE Pc 27 C USING VALUE STREAM MAPPING METHOD AT PT XYZ Iphov Kumala Sriwana, Arie Wijaya Esa Unggul University	DSS	086

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

Moderator : Dr. Ir. Triwulandari SD, MM

Time	Paper	Code	Paper Code
	11		
9.30-9.45	FRAMEWORK FOR MEASURING KNOWLEDGE MANAGEMENT PERFORMANCE USING KM BALANCE SCORECARD Luciana Andrawina , Amelia Kurniawati Telkom University	DSS	016
9.45-10.00	ANALYSIS OF PHILIPPINES 37 INFORMATION TECHNOLOGY BUSINESS PROCESS OUTSOURCING (IT-BPO) INDUSTRY Jason Baculinao, Yang Ching Chow 40 ung Yuan Christian University	DSS	050
10.00-10.15	INTEGRATED SYSTEM DESIGN FOR ORDER RELEASE AT MACHINING DEPARTMENT PT. ABC Pratya Poeri Suryadhini, Dida Diah Damayanti, Widia Juliani Telkom University	DSS	025
10.15-10.30	AN ANALYSIS OF SERVICE PERFORMANCE INFLUENCE TOWARDS CUSTOMER SATISFACTION IN SHAPING CUSTOMER LOYALTY (CASE STUDY AT X RESTORANT) Eka KA Pakpahan, Roland YH Silitonga, Metta Erikka. Institut Teknologi Harapan Bangsa	IM	015
10.30-10.45	ETHICAL ASPECTS IN GREEN MARKETING; AN META ANALYSIS APPROACH Erni Rusyani Pasundan University	IM	029
10.45-11.00	BLUE OCEAN STRATEGY WITH CONJOINT ANALYSIS APPROACH TOWARDS THE COOKING SPICE PRODUCTS Tiena Gustina Amran 3 isakti University	IM	024
11.00-11.15	DESIGNING BUSINESS STRATEGY TO IMPROVE THE SCALE OF FOOD AND BEVERAGES INDUSTRY IN MOJOKERTO THROUGH INNOVATION WITH CLUSTER APPROACH Sri Gunani Partiwi, Anny Maryani, Agung Subyakto Institut Teknologi Sepuluh Nopember	IM	068

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

Moderator : Dr. Ir. Triwulandari SD, MM

Time	Paper	Code	Paper Code
11.15-11.30	¹² 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 ¹⁸ aranatha 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 Ilra, 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 ⁸ aranatha 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 ¹ aranatha Christian University	PS	043
10.45-11.00	⁶ 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 INNOVATION Waraporn Yothinsirikul, Natcha Thawesaengskulthai Uralongkorn 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 Elkom University	QC	040
13.30-13.45	DESIGNING SETTING PARAMETER OF TABLET COMPRESSION PROCESS TO MINIMIZE 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 3D LASER SCANNER: 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 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 ADEMI 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 IDEFO 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

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 2½ 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, 28a 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 13us 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 6sa 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	⁶ 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 Handayaniingtyas 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 ²⁹ sundan University	IM	030
14.45-15.00	HIGHER EDUCATION INSTITUTION XYZ PERFORMANCE MEASUREMENT USING MBCfPE BASED ON KPU- BUMN APPROACH Sugih Arijanto, Ambar Harsono Institut Teknologi Nasional (Itenas) Bandung; Indonesia Quality Award (IQA) Examiners; KPU-BUMN Evaluator (1)	IM	053
15.00-15.15	ANALYSIS OF THE RELATIONSHIP BETWEEN LECTURER TEACHING METHOD FOR QUANTITATIVE COURSES AND ³⁹ 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 ²⁶ i 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	3 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 27 sakti University	PS	078
9.00-9.15	DYNAMIC MODIFIED SPANNING TREE ALGORITHM FOR SINGLE-ROW DYNAMIC FACILITY LAYOUT PROBLEM Yogi Yogaswara 21 sundan University	PS	074
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MACHINE SCHEDULING PROPOSED FOR MINIMIZING MAKESPAN AT PT ADIPERKASA ANUGRAH PRATAMA

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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, Enscoe 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, Enscoe, 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 .
2. Ready Time (r_j) is a start time of job j to be done.
3. 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.
4. 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 with 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).
9. 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 (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 t_1 s in the left side for the smallest processing time machine 1 (t_1), and if the smallest processing time for machine 2 (t_2), 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, Ensore, 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 (J_1, J_2) and (J_2, J_1). Calculate makespan from this 2 job sort and choose the smallest makespan between those two job sort, for example (J_2, J_1)
4. Continue the calculation based next job, for example J_3 so the new sort job could be such as (J_2, J_1, J_3), (J_2, J_3, J_1), (J_3, J_2, J_1), 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.
2. Totalize the processing time every job between 2 sor³² machine.
For example $(P_{1j} + P_{2j}), (P_{2j} + P_{3j}), \dots$ until $(P_{(m-1)j}, P_{mj})$
When, P_{ij} = job j time at i machine.
 m = total work station
3. Choose the smallest value from all the calculations.
4. D³²etermine the value of e_i :
If P_{i1}, P_{im} , then $e_i = 1$
If $P_{i1} \geq P_{im}$, then $e_i = -1$
5. 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
6. 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.

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3. RESEARCH METHODOLOGY

The methodology for this research is as figure 1.

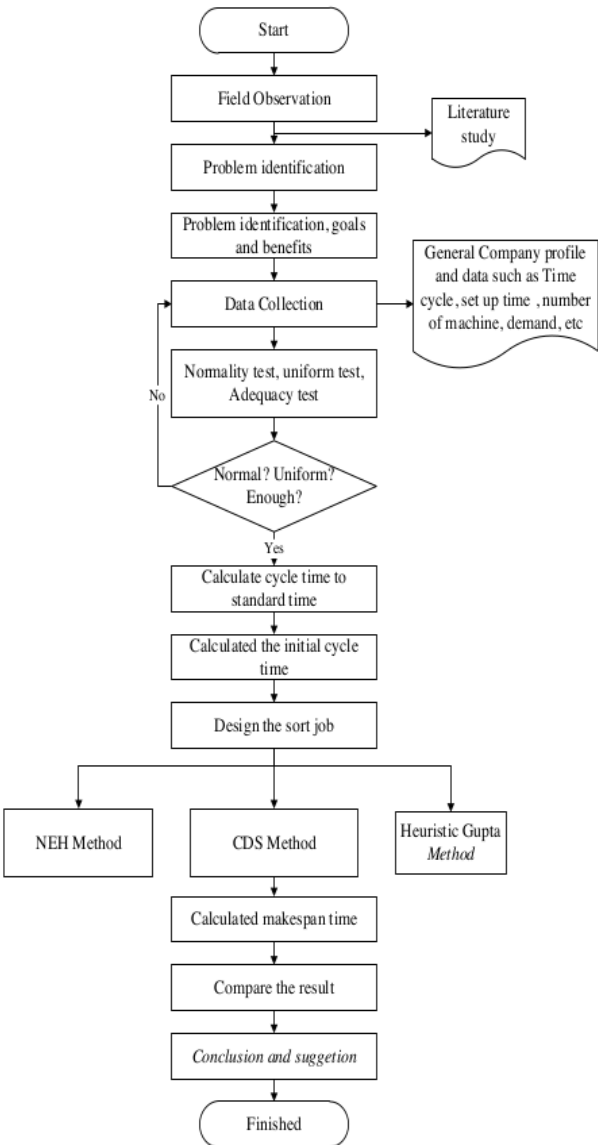


Figure 1 : Research Methodology

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,⁵⁰ 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

Department	Standard time (second)				Processing time (second)			
	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

Job	P1 (2 Machine)		P2 (2 Machine)		P3 (2 Machine)		P4 (2 Machine)		P5 (2 Machine)	
	Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish
1	0 (M1)	77430	105264 (M2)	220242	220242 (M1)	268395	268395 (M2)	320696	320696 (M2)	356696
2	0 (M2)	45300	45300 (M1)	123522	123522 (M2)	157698	157698 (M1)	189954	189954 (M1)	213954
3	45300 (M2)	66168	66168 (M2)	95661	95661 (M1)	114708	114708 (M2)	127641	127641 (M2)	137241
4	66168 (M2)	71610	95661 (M2)	105264	105264 (M2)	110026	110026 (M1)	114150	114150 (M1)	116550

Continue.... Table 2

P6 (2 Machine)		P7 (2 Machine)		P8 (2 Machine)		P9 (2 Machine)		P10 (1 Machine)	
Start	Finish	Start	Finish	Start	Finish	Start	Finish	Start	Finish
356696 (M2)	426990	426990 (M2)	1063641	1063641 (M2)	1163761	1163761 (M2)	1231099	1231099 (M1)	1245200
213954 (M1)	258760	258760 (M1)	682279	682279 (M1)	751462	751462 (M1)	795936	795936 (M1)	805336
137241 (M2)	161015	161015 (M2)	319603	319603 (M2)	348194	348194 (M2)	367738	367738 (M1)	371498
116550 (M1)	123133	123133 (M1)	171056	171056 (M1)	176317	176317 (M1)	181579	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 = $(9000/10.340) \times 16.200$ 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.
5. 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 1st 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 2nd iteration for job 1,2,3, job 1,3,2, dan job 3,1,2, then smallest makespan is job 1,3,2. The 3rd iteration for job 1,3,2,4, job 1,3,4,2, job 1,4,3,2, job 4,1,3,2. 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 Summary with NEH Method

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 e_i and S_i . 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 S_i value to the smallest S_i 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 3. Makespan 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 5. Summary of Processing time with Heuristik Gupta Method

Job	P1+P2	P2+P3	P3+P4	P4+P5	P5+P6	P6+P7
1	192408	163131	100454	88301	106295	706946
2	123522	112398	66432	56256	68806	468325
3	50361	48540	31980	22533	33374	182362
4	15045	14364	8886	6524	8984	54506
P7+P8	P8+P9	P9+P10	min	ei	Si	
736771	167458	81439	81439	-1	-1,22792E-05	
492702	113657	53875	53875	-1	-1,85616E-05	
187179	48135	23304	22533	-1	-4,43791E-05	
55669	13008	6202	6202	-1	-0,000161244	

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

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

Scheduling Method	Job Sort	Makespan (second)	Mean Flowtime (second)
Company's real data	1,2,3,4	1.245.200	651.138,50
NEH Method	1,4,3,2 or 4,1,3,2	1.217.366	618.859,25

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, intial 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 %.

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