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8th INTERNATIONAL SEMINAR ON INDUSTRIAL ENGINEERING AND MANAGEMENT (8th ISIEM)

*Technopreneurship as The Spirit of Innovation-Based
Industrial Development
Towards Global Competitiveness*



ISIEM

**Atria Hotel & Conference
Malang, East Java, Indonesia
March 17 – 19, 2015**

*Tarumanagara University, Trisakti University,
Al Azhar Indonesia University, Esa Unggul University,
Atma Jaya Catholic University of Indonesia,
Pasundan University, Telkom University,
& University of Muhammadiyah Malang*

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- Tarumanagara University • Trisakti University •
- Esa Unggul University • Al Azhar Indonesia University •
- Atma Jaya Catholic University of Indonesia • Pasundan University •
- Telkom University • University of Muhammadiyah Malang •

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PREFACE

Dear Presenters and Delegates,

On behalf of the Organizing Committee, I am honored to welcome you to the 8th International Seminar on Industrial Engineering and Management (ISIEM). This seminar is organized by the Industrial Engineering Department from eight Universities, namely Tarumanagara University, Trisakti University, Esa Unggul University, Pasundan University, Atma Jaya Catholic University of Indonesia, Al Azhar Indonesia University, Telkom University and University of Muhammadiyah Malang.

This seminar is held to provide an effective forum for distinguished invited speakers, academicians, engineers, professionals and practitioners from Universities, research institutions, government agencies and industries to share or exchange ideas, experiences and recent progress in Industrial Engineering and Management.

We are very convinced that our presenter and delegates will gain many shared ideas and great experiences from this conference. Furthermore, our participants will enjoy additional insights from our plenary sessions' speakers, i.e., Associate Prof. Dr. Montalee Sasananan from Thammasat University, Thailand and Prof. Younghwan Lee, Ph.D from Kumoh National Institute of Technology, South Korea.

Through this seminar, we are committed to promote sustainable innovation in industrial technology, information and management in order to increase industrial competitiveness in facing the global challenges in industrial environment. Once again, it is my great honor to welcome you to the 8th International Seminar on Industrial Engineering and Management (ISIEM) 2015 in the great cultural city of Malang, Indonesia.

Best wishes,

Chair of the 8th ISIEM 2015
Dr. Ir. Lamto Widodo, M.T.

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TABLE OF CONTENT

Preface
 Committee
 Reviewer
 Agenda
 Parallel Session
 Table Of Content

DSS-Decision Support System and Artificial Intelligence

No	Paper code	Title and Author	Page
1	08	Application Analytic Hierarchy Process (AHP): a case study of e-waste management in Surabaya, Indonesia Dino Rimantho, Bambang Cahyadi, Denny Dermawan	DSS-1
2	19	The Design Of Knowledge Management System In PT Asmin Bara Bronang Dadan Umar Daihani, Riana Elisabeth Swastika	DSS-11
3	20	Planning Route Distribution of IKM DM Using The Methods Vehicle Routing Problem (VRP) And Shortest-Route Algorithm Nunung Nurhasanah, Syarif Hidayat, Devi Utami Agustini, Ajeng Putri Listianingsih, Faikar Zakky Haidar, Nida'ul Hasanati	DSS-21
4	42	Decision Support System for Potential Sales Area of Product Marketing using Classification and Clustering Methods Evasaria M. Sipayung, Cut Fiarni, Randy Tanudjaya	DSS-33
5	48	Design of Knowledge Acquisition Model in Glaucoma Medical Treatments Recommender System Cut Fiarni	DSS-40
6	58	Knowledge Management Achieving Strategy Business Alignment in Higher Education Riya Widayanti	DSS-47
7	60	Development of Expert System-Based Computer Aided Process Planning for Production Cost Estimation Muhammad Ridwan Andi Purnomo	DSS-56
8	66	Management Information System for Printing Machine Assignment Process with Tabu Search Algorithm Evasaria M. Sipayung, Arief Samuel Gunawan, Teofilus	DSS-61
9	67	Assessing Knowledge Management Systems' Success Based on Technical and Social Factors Amalia Yuli Astuti, Kadarsah Suryadi	DSS-67
10	68	ICT Ecosystem in Open Government Data Initiative in Indonesia Meldi Rendra	DSS-75
11	70	Analysis of Web-Based Integrated Information System on Production Planning and Control for Small And Medium Scale Garment Industry Nida'ul Hasanati, Dody Haryadi, Nunung Nurhasanah, Syarif Hidayat, Ajeng Listianingsih, Faikar Zakky Haidar, Devi Utami Agustin	DSS-81

DSS-Decision Support System and Artificial Intelligence

No	Paper code	Title and Author	Page
12	83	Knowledge Management Enablers for the Assessment of KMS Readiness Implementation Gilang Ramadhan, Luciana Andrawina	DSS-88
13	90	3D Solar System Visualization With OpenGL Feby Fitria, Riri Safitri	DSS-94
14	92	Identification of Knowledge Management System for Quality Improvement of Natural Fiber Craft Industry Nofi Erni, Iphov Kumala S., Riya Widayanti	DSS-100

ER-Ergonomics

No	Paper code	Title and Author	Page
1	04	The Influence of Font Type, Font Size, Line Spacing and Text Background Colour on Visual Search of Web Pages Yanto, Chih-Wei Lu	ER-1
2	06	Elementary School Student's Anthropometry for The Purpose of School Furniture Yanto, Chih-Wei Lu	ER-9
3	17	User-Designer Interaction in Culture-Based Products : A Review Literature Ratih Setyaningrum, Andi Rahadiyan Wijaya, Subagyo	ER-15
4	26	Warning Display Design for the Transjakarta Bus Cockpit to Minimize the Driver's Error Behavior Dian Mardi Safitri, Astari Malinda, Nora Azmi, Pudji Astuti	ER-23
5	28	Design Tool for Transferring Patient to Improve Nurses Working Posture with Ergonomic Approach Muhammad Iqbal, Eva Zaliha S, Amanda Puspita P, I Gede Wisuda	ER-28
6	29	Product Design of Chili Cutter Muhammad Iqbal, Hilman Syahir, Yogi Purnama Putra, Dian Ayu Aprianti, Fiky Ryan Darmawan, Diki Elfan Reksawana	ER-34
7	31	The Analysis of Health and Safety Aspects by Using Hazard Identification and Risk Assessment (HIRA) Method Dian Palupi Restuputri, Mochammad Fakhri	ER-37
8	37	Development Study of SWAT Software (<i>Subjective Workload Assessment Technique</i>) To The Operating System Windows-Based 64-Bit (Case study at Ergonomic Labs Industrial Engineering Bandung Pasundan University) Erwin Maulana Pribadi, Agung Kurniawan	ER-45
9	44	Framework Development And Measurement of Operator Workload Using <i>Modified Cooper Harper Scale Method</i> (Case Study in PT Sinar Terang Logamjaya Bandung West Java) Rizki Wahyuniardi, M. Yani Syafei, Wahyukaton	ER-49
10	46	Analysis of Noise Level and Its Effects on Workers in A Cement Plant Syamsul Anwar, Musliyardi Ilham	ER-55
11	50	Development of <i>Cost-Benefit</i> Calculation Model in Handling Low Back Pain from The Ergonomic Perspective Istianah Muslim, Sri Gunani Partiw	ER-61

ER-Ergonomics

No	Paper code	Title and Author	Page
12	53	Sprinkler System Evaluation to Meet Fire Protection Facility at The Main Laboratory at PT. Pupuk Kujang Cikampek Moh. Syarwani, Wahyukaton	ER-71
13	65	Habitual Effects in Elevator Wulan Meiniar, Fitrah Azizah, Rifqi Muhammad, Korry Azrina, Dessy Indah Savitri	ER-76
14	73	Inovative Design of Wheelchair by Using User Centered Design Approach Hartomo Soewardi, Bagus Tri Ajie, R. Abdul Jalal	ER-81
15	74	Design of Kansei Laundry Bag by Using Fiber of Water Hyacinth (<i>Eichhornia Crassipes</i>) Hartomo Soewardi, Amarria Dila Sari, Ginanjar Maulana Anom	ER-87
16	75	Design of Satchel Bag from The Fibers of Pineapple Leaves by Using Kansei Engineering Method Hartomo Soewardi, Riska Aminatun Zahroh, Hudaya	ER-92
17	76	Prototype of Book Preview Using Augmented Reality on Android Smartphones Riri Safitri, Aldi Oktavianto, Fahrul Rozi	ER-97
18	87	The Ergonomic Design Of A Mini Hotel For Indonesian Travellers Lamto Widodo, Nashir Setiawan, Kevin Leo Winata	ER-103
19	91	Analysis of Human Error Probability Using Human Error Assessment & Reduction Technique (HEART) in Dyeing Department PT. XYZ Fildzah Amimah Abbas and Budi Aribowo	ER-108
20	93	Development of Anthropometry Gauge Vivi Triyanti, Catherine Hadiwiyono	ER-111
21	100	Wall Mounted Storage For Home Appliance Design Indra Gunara Rochyat, Geggy Gamal Surya	ER-119

IM-Industrial Management

No	Paper code	Title and Author	Page
1	07	Business Process Improvement Using Quality Function Deployment Feliks Prasepta S. Surbakti, Rinakso Pramarta	IM-1
2	12	Design and Making of Television Advertisement of PD. BPR Bank Jogja With <i>Visual Effect</i> Mei Parwanto Kurniawan, Agus Purwanto, Hafidh Rezha Maulana	IM-6
3	16	The Algorithm for Negotiating Prices in A Palm Oil Supply Chain Syarif Hidayat	IM-12
4	18	Design of It Governance Model in XYZ College Rizqi Sukma Kharisma, Anggit Dwi Hartanto	IM-21
5	27	Ebola Virus Disease Prevention - A Problem Solving Strategy Based On Sars Case Study From Taiwan Simon Wu	IM-27
6	34	Frugal Innovation Characteristics: Market, Product and Business Perspective Teddy Sjafrizal	IM-38

IM-Industrial Management

No	Paper code	Title and Author	Page
7	47	Labwork Management Information System Satisfaction Measurement in Industrial Engineering Study Program Telkom University Rayinda Pramuditya Soesanto, Amelia Kurniawati, Muhammad Iqbal	IM-44
8	57	Designing A Multidimensional Data Warehouse for Procurement Processes Analysis Using Business Dimensional Lifecycle Method (Case Study on PT. ABC) Ari Yanuar Ridwan	IM-49
9	59	Brand Equity as A Higher Standard of Living and Wealth in Development Country: The Strategic Role of Integrative Model on Consumer-Based Brand Equity to Reduce Indonesian Poverty Maria Mia Kristanti	IM-55
10	61	Customers Clustering Based on RFM Score Using Genetic Algorithm Muhammad Ridwan Andi Purnomo, Nur Riana Fajarwati	IM-66
11	78	Proposed Business Process Using Business Process Improvement at Emergency Departement of Dustira Hospital Fadhila Rachmawati, Sri Widaningrum, Mira Rahayu	IM-74
12	79	Business Model Generation and Lean Startup Method as The Basis for Business Development Feasibility Study, Case Study of Po. Gajah Mungkur Sejahtera Wisnu Sakti Dewobroto, Julisa Siagian	IM-80
13	81	Design of Performance Measurement System in Engineering Department Based on Maintenance Scorecard Framework and Omax Model: A Case Study of Global Sanitary Ware Company Wilson Kosasih, Silvi Ariyanti, Nathan Sukamto	IM-90
14	95	System Dynamic for Acceleration Modeling Policy in Disadvantage Areas Development Fajar Kurniawan, Iphov Kumala Sriwana	IM-102
15	96	Review Of Current Recruitment Process (Case Study : PT. X) Mellisa Taswin, Marsellinus Bachtiar, Vivi Triyanti	IM-107
16	99	Designing Business Process to Support Balanced Scorecard-Based Performance Measurement (Case Study: Faculty of Engineering, Atma Jaya Catholic University Of Indonesia) Vivi Triyanti, Nixon William Kumala	IM-116
17	101	Study of <i>Ability to Pay</i> and <i>Willingness to Pay</i> for Passanger of Commuter Line Jakarta-Bogor Pudji Astuti, Vania Tertia	IM-123
18	104	Analysis of Organizational Performance with 360 Degree Feedback Method (Case Study: Department of Industrial Engineering University Of XYZ) Ahmad Chirzun, Zahra Fitria	IM-128

PS-Production System

No	Paper code	Title and Author	Page
1	01	Factory Plastic Bag Layout Design In Elite Recycling Indonesia Extension Lina Gozali, Iveline Anne Marie, Prisca Andriani	PS-1
2	03	Comparing Alternative Plant Layouts Based On CRAFT and Blocplan Algorithms Leonardo, Hotma Antoni Hutahaeen, Hui-Ming Wee	PS-10
3	13	Store Layout For Virtual Retailing: A Literature Review Ilyas Masudin, Mukhlis Fuadi	PS-15
4	23	Optimization of Preventive Maintenance Program and Total Site Crew for Base Transceiver Station (BTS) Using Reliability Centered Maintenance (RCM) and Life Cycle Cost (LCC) Method Rd. Rohmat Saedudin, Judi Alhilman, Fransiskus Tatas Dwi Atmaji	PS-21
5	24	The Production Planning for Profit Maximization (A Case Study At A Cocoa Processing Industry) Syamsul Anwar, Yunizurwan, Jasril	PS-28
6	25	Framework for E-Learning Content Development On Facility Planning Subject Muhammad Iqbal, Devi Pratami, Ika Arum Puspita	PS-35
7	35	Group Replacement Model for Scheduling of Tools Replacement Considering Quality Cost, Preventive And Failure Replacement Cost Dadang Arifin, Rinto Yusriski, Dwi Putri Ramasari	PS-41
8	43	EMS-SCADA Design of AC Usage on A Building Haris Rachmat, Rino Andias Anugraha, Tatang Mulyana	PS-45
9	45	Improvement of Kanban System Using Constant Quantity Withdrawal System to Fulfill Buffer Stock Replenishment on Single Aisle Project at PT. XX Hadi Muqti, Pratya Poeri Suryadhini, Widia Juliani, Dida Diah Damayanti	PS-50
10	55	Safety Stock Determination Based on Disturbance Control Model at PT DEE Iveline Anne Marie, Fahmi M. Prasetyo, Nora Azmi	PS-59
11	62	Implementation Of Queing Theory And Heuristic Method For Shceduling System of XYZ Auto Service Center Cut Fiarni, Sonna Kristina, Julia Rintjap	PS-66
12	71	Electricity Planning Through Renewable Energy Utilization in North Kalimantan Yudha Prasetyawan, Suparno, Imam Baihaqi	PS-71
13	72	Production Target Achievement Model Development Using Binary Logistic Regression Method in PT. Hansae Karawang Indonesia Ade Momon S., Ikbal Wijaya	PS-76
14	89	Cost Based Elevator Scheduling in University of Al Azhar Indonesia Niken Parwati, Clamaya Arin Nurpraja, Firza Ibrahim Kartohadiprodjo, Ainun Jariyah, Dimas Ayu Mardhika	PS-83
16	103	Spinning Machine Maintenance Scheduling And Cost Planning Unit Using Markov Chains Method at Argo Pantas Puspa Puspitasari, Ahmad Juang Pratama	PS-88

PS-Production System

No	Paper code	Title and Author	Page
15	102	Lean Manufacturing Approach with Particle Swarm Optimization-Line Balancing Rahmi Maulidya, Parwadi Moengin, Nisa Andama	PS-94

QM-Quality Engineering and Management

No	Paper code	Title and Author	Page
1	11	Quality Analysis Using FMEA Method on Assembly Processes of Washing Machine (Case Study In Panasonic Manufacturing Indonesia) Rifa Arifati, Ardika Rismayana	QM-1
2	22	Designing The Attributes of Food Products Using Quality Function Deployment (QFD) Phase II Muhamad Bazarado, Yurida Ekawati	QM-6
3	32	Development of Creative Coloring Technique in Electroplating Paryana Puspaputra, Kamariah	QM-11
4	38	Chrome Recycling Process of Tannery Leather Industry Waste Using Limes Rosad Ma'ali El Hadi, Rino Andias A., Haris Rachmat	QM-17
5	41	Implementation of Poka Yoke on Administration of The Palm Oil Mill M. Hudori	QM-21
6	63	Quality Engineering of Crude Palm Oil (CPO): Using Multiple Linear Regression to Estimate Free Fatty Acid M. Hudori, Muhammad	QM-26
7	64	Implementation Failure Mode And Effect Analysis (FMEA) Method and Knowledge Map (Case Study PT. GSB) Rina Fitriana, Dorina Hetharia, Vella Denisha	QM-34
8	77	Reliability Analysis of Blood Leakage Detection System Pratondo Busono	QM-41
9	80	Analysis To Determine The Suitable Coating Materials For Environmental Friendly Composites From Oil Palm Empty Bunch Fibers Dorina Hetharia, Andy Cahyaputra Arya, Indra Surjati, Rully Ario Dewanto Soeriaatmaja, Doni Putra Almi	QM-46
10	82	Content Analysis Silica (SiO ₂) in Process Water Determeralisation with 4M Method Sukanta, Hendra Janaka, Rian Arie Permana	QM-51
11	94	The Holistic Model of New Product Development Process Ronald Sukwadi	QM-57
12	97	Designing Quality Assurance System for Raw Material Acceptance Process in Batik Industries Using Business Process Improvement Method Dida Diah Damayanti, Luciana Andrawina, Sri Widaningrum, Handarujati	QM-64

SCM-Supply Chain Management

No	Paper code	Title and Author	Page
1	05	Supplier Selection with The Integration of DEMATEL (Decision Making Trial And Evaluation Laboratory) and AHP (Analytic Hierarchy Process): A Literature Review Wahyu Eko Setiawan, Ilyas Masudin, Fien Zulfikarijah	SCM-1
2	09	The Application of Green Supply Chain Management in Electronic Industry Indonesian: A Literature Review Akhmad Jakfar, Fien Zulfikarijah, Ilyas Masudin	SCM-6
3	10	The Role of Manufacturing Supply Chain Analysis in Meeting Customer Needs Of <i>Batik</i> Shirt Sutarman, Refa Septiyanto	SCM-12
4	14	The Drivers of Choosing Third-Party Logistic (3PL) Providers: A Framework Model Using Structural Equation Modeling Ilyas Masudin, Suci Dewi Ayurarasati, Dana Marsetya Utama	SCM-18
5	30	Supply Chain Model Design For “Wedang Uwuh” Small and Medium Enterprise (SME) in Daerah Istimewa Yogyakarta (Case Study on Progress Jogja SME) Vembri Noor Helia, Dwi Handayani	SCM-27
6	36	Determination of Supplier Selection Criteria Using Analytical Hierarchy Process in The Food Company Winarno, Hendra Janaka, Suryani	SCM-34
7	39	The Study of Third Party Logistic Usage in East Java Annisa Kesy Garside	SCM-41
8	51	Design of Cold Chain Third-Party Logistics (3PL) for Halal Food in Indonesia Tiena Gustina Amran	SCM-49
9	52	Route and Transportation Costs Analysis Considering The City Logistics System for Single Depot Problem (Case Study: Jababeka Industrial Area Companies) Yogi Yogaswara	SCM-56
10	69	Analysis of Information Sharing Impact in Two Level Supply Chain With Multiple Retailers (Case Study in Two Manufacturing Companies, PT XY And PT YZ) Nurul Chairany, Imam Baihaqi, Noerhayati Amirullah	SCM-62
11	88	Risk Identification of Cacao Agroindustry Supply Chain Iphov Kumala Sriwana, Yandra Arkeman, Dahrul Syah, Marimin	SCM-71
12	98	Lean and Green Approach in Devising Optimization Program to Determine Distribution Routes by Using Tabu Search Method Christine Natalia, Andre Sugioko, Clara Anne	SCM-76

IMPROVEMENT OF KANBAN SYSTEM USING CONSTANT QUANTITY WITHDRAWAL SYSTEM TO FULFILL BUFFER STOCK REPLENISHMENT ON SINGLE AISLE PROJECT AT PT. XX

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ABSTRACT

PT. XX, is a state-owned company that engage in aircraft manufacturing. Nowadays, this company facing a problem in Single Aisle Project, which is to fulfill demand with appropriate time. Problem occur because of line stop take place in assembly. Line stop happen because lack of parts that needed in component assembly which make assembly process not running properly. Main cause that create lack of parts problem is amount of buffer stock are not comply with amount that needed and replenishment schedule for buffer stock not well-timed. According to that reason, a system that comply with buffer stock replenishment schedule is required.

In this research will be designan idea about Kanban System that consist of Kanban card calculation, Kanban Post, mechanism of using Kanban System and calculation amount of Kanban card that used in fulfilling schedule for buffer stock replenishment.

Result of this research is a Kanban System that has buffer stock amount more than amount of units that needed during replenishment and buffer stock replenishment that well-timed when buffer stock almost complete consumed, thus the amount of buffer stock is not less or over than needed.

Keywords : Kanban, Buffer Stock Replenishment, Constant – Quantity Withdrawal System, Pull System.

1. INTRODUCTION

1.1. Background

Indonesian Aerospace or IAe is a state-owned company that engage in aircraft manufacturing. One of business unit in Indonesian Aerospace is Aerostructure. Business unit Aerostructure engage in design, component manufacture, and subassembly airframe with high quality and competitive price.



Figure 1 Illustration of Components Dnose, Pylon and Skin

In Single Aisle Project consist of 3 component that manufacture in Indonesian

Aerospace company which is Dnose, Pylon and Skin as illustrate on figure 1.

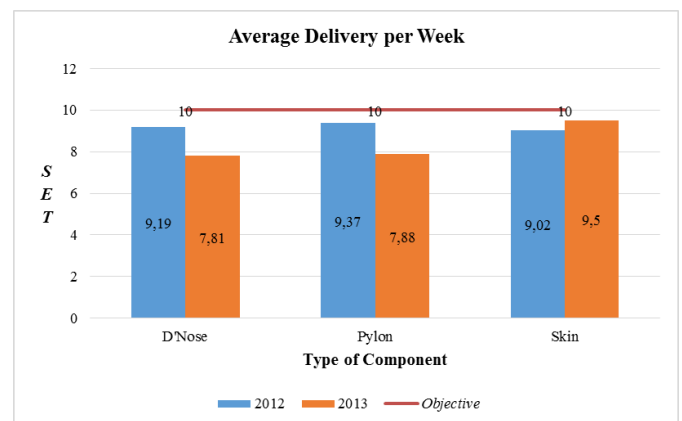


Figure 2 Average Delivery per Week from Total Delivery per Year

Now, Indonesian Aerospace Company facing problem in Single Aisle Project, IAe can not fulfill the demand timely. Based on data on Figure 2, average amount of 3 aircraft component that have been delivered still not fulfill the demand. In 2012 Indonesian Aerospace only deliver around 9

set per week for three component, and in 2013 there is significant reduction from 2012 especially for D'Nose component and Pylon component until 7 set per week. The data show that Single Aisle Project can not fulfill the demand from customer which is 10 set per week for each component. According to supervisor and logistic in assembly, this problem occur because of line stop in assembly line. Line stop occur by reason of assembly line not running properly because of lack of parts that needed in component assembly. Main cause that create lack of parts problem because some rejected parts are still continue to next process so that rework is needed, this means there is waiting activity until parts come, also amount of buffer stock are not comply with amount that needed and replenishment schedule are not well-timed.

From all the factors above, the dominant factor that cause line stop is amount of buffer stock are not comply with the amount that needed and replenishment schedule for buffer stock are not well-timed. In overcoming that problem there is a system that can be implemented which is Kanban System. Kanban System is a system running as a pull system that use Kanban card as a tool for information flow to control production process so amount of product that produce corresponding with demand and appropriate time when customer needed. Therefore, pulling information about amount of product that will be produce and amount of parts that needed start from ending process based on demand from customer until beginning process in production process. Hence, this reason become background why in this research only in assembly line because ending of production process before delivery on Single Aisle Project is assembly process. Kanban System use to coordinate every process in the production system by controlling work in process (WIP) for every process with appropriate amount and maintain communication and flow of information to make it running properly. In order to fulfill the replenishment schedule on time and create a good communication and good flow of information, Indonesian Aerospace has to plan and design new Kanban System with planning amount of Kanban card, designing Kanban post,

designing Kanban card and implementation mechanism of Kanban System on Single Aisle Project.

1.2. Problem Formulation

How to design improvement of Kanban System to fulfill buffer stock replenishment on Single Aisle Project in assembly?

1.3. Research Benefit

1. Because of this research, cost from Single Aisle Program on Indonesian Aerospace Company can be reduce especially reducing penalty cost because of delay when component being deliver.
2. Become idea for Indonesian Company in implementing Kanban System which is in order to decide time and amount of production order and amount of inventory.
3. Production System and flow of information in assembly will work harmonically in every process.
4. Easy to find problem on production floor when needed.

2. THEORETICAL BACKGROUND

BASIC THEORY

2.1. Just In Time

Basic concept production system Just In Time (JIT) is producing the product that needed, when needed by customer, with appropriate amount based on customer needs, with excellent quality, from every process in production system, with most economically or most efficient way using waste elimination and continuous process improvement.^[1]

2.2. Pull System

On Pull System, production process will running based on actual demand. "Pull" means a company that doing production process not push the product to customer, but produce the product based on demand from customer. Benefit from this method is low amount of inventory.^[2]

2.3. Type of Waste

There are seven waste that do not have added value in business process or manufacture, it is include unnecessary work.

Although the factory produce different product, but type of waste in industrial environment relatively the same^[3] all the seven type of waste are :

1. Overproduction
2. Waiting time / delay
3. Unnecessary transportation
4. Unnecessary Process
5. Over stock
6. Unnecessary movement
7. Reject product

2.4. Value Stream Mapping

Value Stream Mapping is a tools that used to represent flow of production process. Value Stream Mapping is a tool that have been develop to simplify the understanding of value stream, facilitate to make improvement about waste. Value Stream Mapping also an approach using weighting waste, then use that weighting to choose tools with matrix^[4]

2.4.1. Kanban System

1. Kanban Type

Two type of Kanban that usually used are Withdrawal Kanban and Production – Ordering Kanban.^[5]

2. Kanban Rule

Ideal tools is one way to accomplish effective purpose. If used appropriately, Kanban sytem can be an effective work hour surveillaince.^[5]To accomplish Just In Time(JIT) purpose, This rules should be follow :

- a. Following process should take the product that needed from previous process with appropriate amount and appropriate time based on needs.
 - b. Previous process should produce the product comply with amount of product that taken from following process.
 - c. Rejected product should not hand over to following process.
 - d. Amount of Kanban should be a little as possible.
 - e. Kanban should use to adapt with little fluctuation in demand (production control with Kanban).
- ###### 3. Deciding number of Kanban
- a. Constant – Cycle Withdrawal System^[5]

Necessary number of parts during the lead time of withdrawal Kanban
 = Lead time of withdrawal Kanban
 × Hourly average quantity of parts needed for subsequent process

Remark :

Lead time of withdrawal Kanban =
 Withdrawal interval + Production lead time

Withdrawal interval = Time between pulling/taking at time t and pulling/taking at time t+1 in constant – cycle withdrawal system

Production lead time = Time between Withdrawal Kanban released into next process then produce number of part that comply with amount of part that must be produced which written in released Kanban and time for next process already have the same parts and ready to use.

Safety inventory = Usually 10% from necessary number of parts during lead time of withdrawal Kanban

b. Constant – Quantity Withdrawal System^[5]

Necessary number of parts during the lead time of withdrawal Kanban
 = Lead time of withdrawal Kanban
 × Hourly average quantity of parts needed for subsequent process

Number of Withdrawal Kanban

$$= \frac{\text{Necessary number of parts during the lead time of withdrawal Kanban} + \text{Safety inventory}}{\text{Capacity of one box}}$$

Remark :

Lead time of withdrawal Kanban =
 Production lead time

c. Computation of Reorder Point^[5]

Necessary number of parts during the lead time of Signal Kanban
 = Lead time of Signal Kanban
 × Hourly average quantity of parts needed for subsequent process

Number of Signal Kanban

$$= \frac{\text{Necessary number of parts during the lead time of Signal Kanban} + \text{Safety inventory}}{\text{Capacity of parts box}}$$

d. Determination of Lot – Size^[5]

Lot – Size

$$= (\text{Daily average usage of parts} / \text{Times of setup per day}) + \text{Safety inventory per day}$$

2.4.2. TaktTime

Takt in Deutsch language means rhythm or meter. Takt Time is amount of time that allocated to produced one unit or a part based on allocated operational time compare to amount of product that needed..^[5]

$$Takt\ Time = \frac{Effective\ Operational\ Time}{Daily\ Demand}$$

3. RESEARCH METHOD

3.1. Conceptual Model

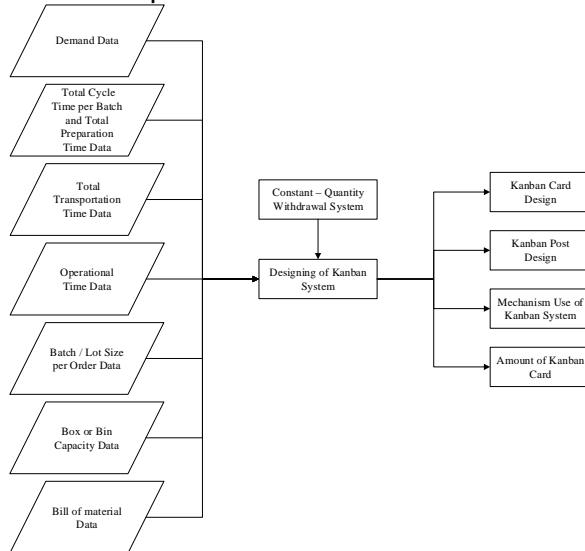


Figure 3 Conceptual Model

4. RESULT AND DISCUSSION

4.1. Designing Kanban System

4.1.1. Creating Value Stream

In Single Aisle project, there are 3 aspects that not related, thus Value stream mapping (current state) will divided into 3, which is VSM for Dnose, Pylon and Skin.

In this three VSM there are total lead time and time process that has value added. Based on VSM current state, total lead time for making 1 set Dnose component is 29 days with value added 44.212 hour. Same with Pylon, total lead time for creating 1 set component is 35.5 days with value added 40.501 hour dan Skin component have total lead time is 18.5 days with value added 8.031 hour.

4.1.2. Kanban Card Calculation

- a. First step – Calculation lead time of withdrawal Kanban.
- b. Second step – Calculation amount of part or unit that needed by next process
- c. Third step - Calculation of number of parts or units required for the lead time of withdrawal Kanban.
- d. Fourth step – calculation amount of Kanban card.

4.1.3. Designing Kanban Card

There are two type of Kanban Card, Signal Kanban Card and Production Kanban Card as shown by Figure 4 and Figure 5.

SIGNAL KANBAN CARD				
* D57250330208 *	PART NUMBER	D57250330208	PROCESS	SHEET METAL FORMING * 100006 *
	PART NAME	BRACKET		
	BATCH SIZE	72 UNIT		
	STANDARD LEAD TIME	122 HOUR		
	REORDER POINT	2 \ 4 NUMBER OF KANBAN		

Figure 4 Signal Kanban Card

PRODUCTION KANBAN CARD				
* D57250800204A *	PART NUMBER	D57250800204A	PROCESS	MACHINING * 100007 *
	PART NAME	DOOR F-S ROOT		
	BATCH SIZE	15 UNIT		
	STANDARD LEAD TIME	183 HOUR		
	KANBAN NO.	1 \ 4 NUMBER OF KANBAN		

Figure 5 Production Kanban Card

4.1.4. Designing Kanban Post

a. Kanban Post Whiteboard

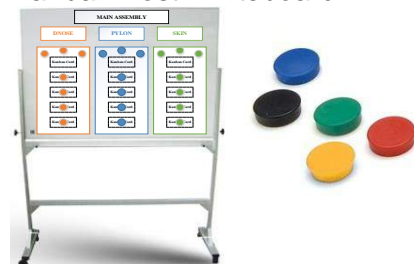


Figure 6 Whiteboard and Magnetic Pin

b. Kanban Post Hanger



Figure 7 Hanger and Plastic/Wood Clamp

4.1.5. Design of Mechanism Using Kanban System

Based on the results of Kanban card design post and the results of the calculation of the number of Kanban cards, the following needs to be designed as a guide in performing the procedure of Kanban system is a mechanism the use of Kanban System that contains Kanban flow and proposed a

Figure 12 Kanban Input Form

	PART NUMBER		PROCESS
	PART NAME		
	BATCH SIZE		
	STANDARD LEAD TIME		
	REORDER POINT		

Figure 15 Kanban Card template

Figure 13 Kanban Received Form

c. Kanban Record Database

Kanban database record is a record of the data stored automatically when Kanban form has been filled. The usefulness of this form Kanban record is as a tool to monitor the performance of the Kanban system as a reference for adjusting the number of Kanban cards and have shown indications of a problem by looking at the ratio of the standard lead time with the actual lead time. In other words, Kanban database record is used as historical data that will be useful as continuous improvement or continual improvement of the Kanban system.

Kanban ID	Part Number	Part Name	Process	Batch Size	Standard Lead Time	Reorder Point	Actual Lead Time	Ratio
00001	01	01	01	10	10	10	10	1.0
00002	01	01	01	10	10	10	10	1.0
00003	01	01	01	10	10	10	10	1.0
00004	01	01	01	10	10	10	10	1.0
00005	01	01	01	10	10	10	10	1.0
00006	01	01	01	10	10	10	10	1.0
00007	01	01	01	10	10	10	10	1.0
00008	01	01	01	10	10	10	10	1.0
00009	01	01	01	10	10	10	10	1.0
00010	01	01	01	10	10	10	10	1.0

Figure 14 Kanban record Database

d. Kanban Card template

Kanban card template is a template of the Kanban card designs that have been designed previously that is still empty as shown in Figure 15. All of the information that will be loaded on the Kanban card template will be filled automatically according to the part number that is filled when filling in the form Kanban obtained or invoked from the database Kanban.

4.1.5.3. Designing Kanban Flow

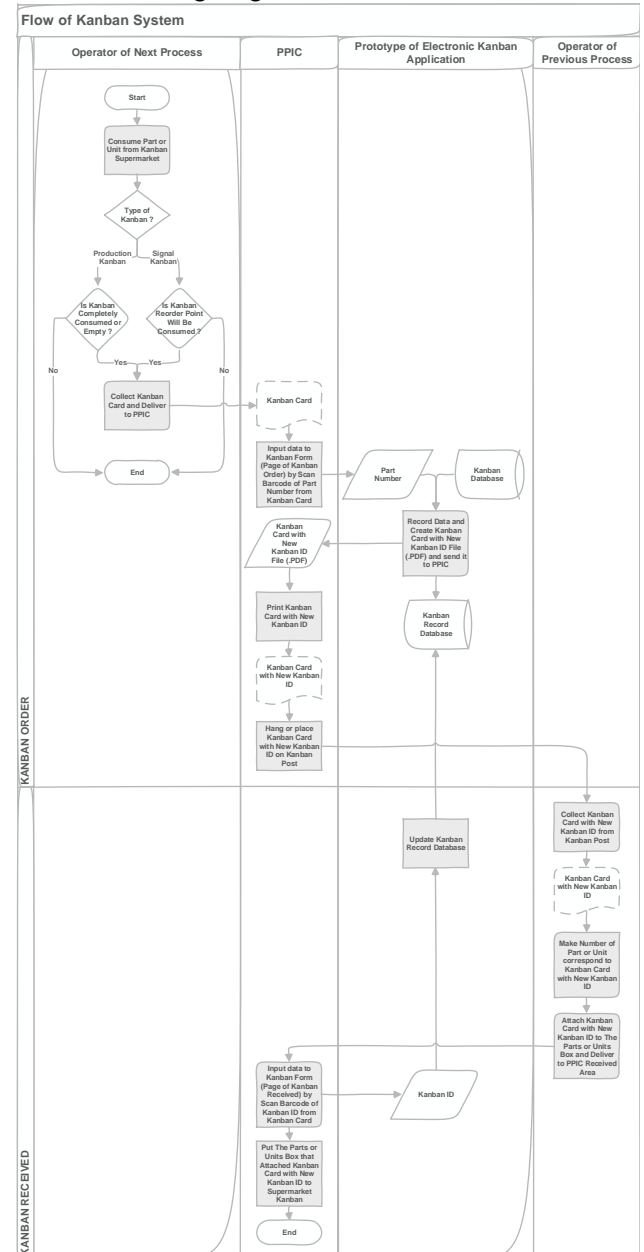


Figure 16 Kanban Flow

4.2. Discussion

4.2.1. Analysis of Advantages and Disadvantages Results Kanban System Design

Table 1 Advantages And Disadvantages Analysis of Design Kanban System

Element of Kanban System	Advantages	Disadvantages
Desagn Kanban Card	<ol style="list-style-type: none"> All information displayed on Kanban card is complete and clear as required. Has the information in the form of a barcode that is useful in facilitating the data input. It has been integrated with a prototype application of electronic Kanban. Using the visual aspect of the colors that are distinguished by the intended process or department. 	The possibility of damage to the Kanban cards such as bent or torn because of the materials used are paper.
Mechanism Using Kanban System	<ol style="list-style-type: none"> Useful as procedures or guidelines in the use of Kanban cards, Kanban post, and trigger point or reorder point. Shows the flow of Kanban are all activities that must be performed by the parties involved in the use of Kanban System. Using a prototype application that is useful in making the recording of orders placed on the Kanban system and also in the manufacture or Kanban card printing. 	It takes adaptation to apply Kanban system to workers, because of differences in the procedures of the old system with a new system procedures (Kanban system).
Amount of Kanban Card	<ol style="list-style-type: none"> The number of Kanban cards are in accordance with the capability of the production process at PT. Indonesian Aerospace. There is a trigger point or reorder point corresponding to the lead time in making a part number or replenishment time. There will be no shortage amount of buffer stock due to the amount of buffer stock is in conformity with the required amount of buffer stock at the time of replenishment or the buffer stock replenishment time There can be no excessive amount of buffer stock for Kanban card number that counts is the boundary or limit the amount of buffer stock may be saved. 	The need for adjustment or setting the layout of a buffer stock in a storage area for the number of Kanban cards.
Design of Kanban Post (Whiteboard)	<ol style="list-style-type: none"> Function as a stopover place Post Kanban Kanban cards can be achieved. Easy to be made, all the necessary materials in the manufacture of Kanban Post can be purchased. Costs incurred in making Kanban Post was not too expensive. 	Require additional activity by operators in arranging the order of Kanban cards.
Design	<ol style="list-style-type: none"> Function as Kanban Post 	Possible damage to

Table 1 Advantages And Disadvantages Analysis of Design Kanban System

Element of Kanban System	Advantages	Disadvantages
of Kanban Post (Hanger)	<ol style="list-style-type: none"> that as a stopover place Kanban cards can be achieved. With a downward sloping hanging, Kanban card sequence settings will regularly without operator assistance or eliminate the activity of the sequence settings Kanban Cards. 	the Kanban cards are used due to the clamp.

4.2.2. Schedule Analysis of Buffer Stock Replenishment On Kanban System

In addition to adjusting the amount of buffer stock to the amount needed, Kanban system also works in scheduling replenishment time or replenishment the buffer stock for each part number. Based on the results of the calculation of the number of Kanban cards are performed on data processing, there are two types of Kanban is used, namely signal Kanban and production Kanban . Both of these have different types of Kanban replenishment schedule for buffer stock. In Kanban signal types used in the part number that has a number of units required for replenishment time is smaller than the number of units in a single replenishment (batch size). While the part number that has a number of units required for replenishment time is greater than the number of units in a single replenishment (batch size), the type that will be used is Kanban production.

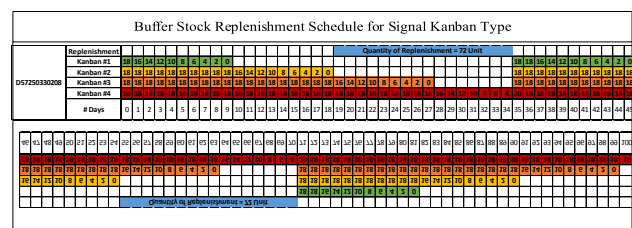


Figure 17 Buffer Stock Replenishment Schedule for Signal Kanban

Buffer Stock Replenishment Schedule for Production Kanban Type																																									
D57250330208	Kanban #1	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40														
	Replenishment																																								
	Kanban #2	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40														
	Replenishment																																								
	Kanban #3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40														
	Replenishment																																								
	Kanban #4	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40														
	Replenishment																																								
	# Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	Quantity of Replenishment = 15 Unit																																								
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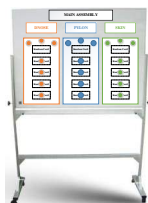

Figure 18 Buffer Stock Replenishment Schedule for Production Kanban

5. CONCLUSION

The results of this study are a Kanban system that is able to meet the schedule buffer stock replenishment. The elements of the Kanban system is designed is:

1. Kanban Post Design

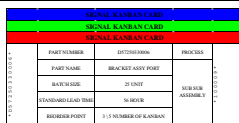
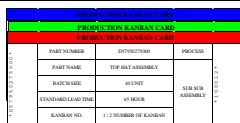
Table 2 Result of Kanban post

Kanban Post	
Kanban Post Whiteboard	Kanban Post Hanger
	

There are 2 types of Kanban post designed in this study are shown in Table that are Kanban post whiteboard and Kanban post hanger.

2. Kanban Card Design

Table 3 Result of Kanban Card

Kartu Kanban	
SignalKanban	Production Kanban
	

In the Kanban card designed shown in Table 3, there are two types of cards that signal Kanban and production Kanban. In addition, there are also differences in the colors used on the Kanban cards by type of process in making a part number, which is blue for sheet metal forming process, green for the

machining process, and red for the assembly process.

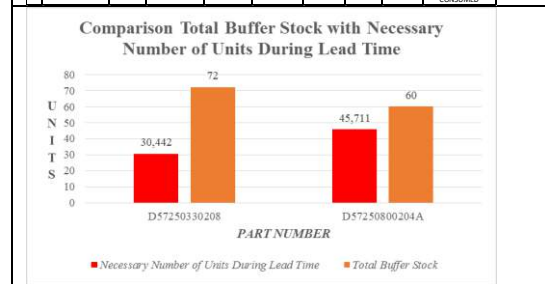
3. Amount of Kanban Card

In the calculation of the number of Kanban cards that are performed in this study, obtained necessary number of units during the lead time, the number of Kanban cards, the total buffer stock and buffer stock replenishment schedule. In the Kanban system designed, found the number of buffer stock that is greater than the number of units required for replenishment time, so there will be no shortage of buffer stock when replenishment is done. Here is a sample Table 4 that displays the results of the calculation of the number of Kanban cards and a comparison between the total buffer stock on the Kanban system with the number of units required for replenishment time.

Table 4 Sample of Results Calculation Kanban Card Number and Comparison Total Buffer Stock with Necessary Number of Units During Lead Time

Sample of Calculation Amount Kanban Card Result for Signal Kanban dan Production Kanban

No	Part Number	Batch Size	Lead Time / Replenishment Time	Necessary Number of Units During Lead Time	Kanban Type	Capacity of Bin or Box	Number of Kanban	Total Buffer Stock	Reorder Point / Trigger Point
1	D57250330208	72	121.76611 hour (16 days)	30.442	SIGNAL KANBAN	18	4	72	ORDER WHEN KANBAN #3 WILL BE CONSUMED
2	D57250800204A	15	182.84458 hour (23 days)	45.711	PRODUCTION KANBAN	15	4	60	ORDER EACH OF KANBAN THAT HAVE BEEN COMPLETELY CONSUMED



Moreover, according to the analysis of the buffer stock replenishment schedule on Kanban Systems designed, replenishment will be done just as a buffer stock will be depleted, so there will be no shortage or excess amount of buffer stock owned. Buffer stock replenishment schedule distinguished by type of Kanban that used. In Kanban signal types, buffer stock will begin to be replenished again when the reorder point began to be consumed. While on the type of production Kanban, buffer stock will be

replenished at each Kanban that has been used or when the Kanban is empty.

4. Mechanisms use of Kanban System

Mechanism designed using Kanban system is in the form of a Kanban Flow that describes the overall process is done in running Kanban System. In general, there is the Kanban process flow is divided into two phases, namely Kanban order phase and Kanban received phase. In Kanban order phase will be shown all the processes performed in an order for replenishment of the Kanban system start from Kanban card removed until Kanban card with the new Kanban ID printed and hung on the Kanban post. While the Kanban received phase, will be shown all the processes carried out in the reception back Kanban replenishment has been completed which include Kanban card making Kanban is hung on a post and made a number of parts or components that are listed on the Kanban card until the process of recording the time when Kanban back in the storage area.

In the mechanism of the use of Kanban systems there is an electronic Kanban application prototype modeled using visual basic that exist in Microsoft Excel are useful as supporting applications in doing recording orders placed on Kanban system and also in the Kanban card manufacture or Kanban card printing.

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