



ITS
Institut
Teknologi
Sepuluh Nopember



ABSTRACT BOOK

**9th International Conference on
Operations and Supply Chain Management (OSCM)**

15 – 18 December 2019
Ho Chi Minh City, Vietnam

ABSTRACT BOOK

9th International Conference on Operations and Supply Chain Management (OSCM)

15 – 18 December 2019
Ho Chi Minh City, Vietnam

The 9th International Conference on Operations and Supply Chain Management (OSCM) is hosted by the collaboration of RMIT University, Vietnam and Institut Teknologi Sepuluh Nopember (ITS), Indonesia



www.rmit.edu.vn www.its.ac.id

Message from the conference chairs

The 9th International Conference on Operations and Supply Chain Management (OSCM) is hosted in Vietnam by RMIT University, Vietnam in collaboration with the Institut Teknologi Sepuluh Nopember (ITS), Indonesia. The previous 8 conferences were held in Bali, Indonesia (2005), Thailand (2007), Malaysia (2009), Maldives (2011), New Delhi, India (2013), Bali, Indonesia (2014), Phuket, Thailand (2016), and Cranfield, UK (2018). “Emerging Technologies in Supply Chain: Opportunities and Challenges” is the theme for this year conference. As we all know, the development of new technologies has major impacts on operations and supply chain management. Technologies such as advanced robotics, drone, driverless trucks, cloud computing, 3D printing, Internet of Things (IoT), Blockchain, and many others have tremendously changing the way the products are manufactured, and the supply chains are managed, and the way we work.

This year we attracted over 180 submissions representing authors from almost 40 countries. Of these, 100 papers have been selected for presentations. This demonstrates a strong international network of the conference that has been maintained since 2005. The reviewers and the scientific committee also noted that many submissions are of high quality. A substantial number of them were recommended for journal publication with revisions. With a wide range of topics and authors coming from many different institutions, this conference will stimulate enriching discussions as well as productive networking environment.

We are also pleased to have two renowned keynote speakers. Professor Shuo-Yan Chou is the Director of the Center for Internet of Things Innovation and a distinguished professor at the Department of Industrial Management, National Taiwan University of Science and Technology (NTUST). Professor Chou will be presenting a topic on Smart Transformation Enabled by Digital Fusion and Industry 4.0, a highly relevance to the conference theme. The second one is Professor Kannan Govindan, who is the Head of the Center for Sustainable Supply Chain Engineering, University of Southern Denmark who will be presenting a topic on supply chain sustainability.

Finally, this conference will not be possible without the contribution of many parties, including the committee, the reviewers, the keynote speakers, the participants, and of course the host institutions and the sponsors. We would like to thank them all for their contribution.

Wishing you all a productive and enjoyable conference.

Conference Chairs,

Assoc. Professor Matthews Nkhoma, RMIT Vietnam

Professor Nyoman Pujawan - ITS, Indonesia

Asst. Professor Reza Akbari, RMIT Vietnam

Assoc. Professor Imam Baihaqi, ITS Indonesia

Professor Caroline Chan, RMIT Australia

About The OSCM Conference

The OSCM Conference was first held in Bali in December 2005, hosted by the Department of Industrial Engineering, Institut Teknologi Sepuluh Nopember (ITS), Indonesia. Subsequent OSCM conferences were successfully held in various locations: Bangkok (2007), Malaysia (2009), Maldives (2011), New Delhi (2013), Bali (2014), Phuket (2016), Cranfield (2018), and now in Ho Chi Minh (2019)

Keynote Speakers

Professor Shuo-Yan Chou



Professor Chou is the Director, Center for Internet of Things Innovation, and distinguished professor Department of Industrial Management, National Taiwan University of Science and Technology (NTUST). He has published over 60 SCI/SSCI journal papers; PI or Co-PI of more than 80 projects. His research interests are in Internet of Things Innovation, Industrial Internet of Things, Big Data Analytics, Artificial Intelligence, Smart City Applications, Blockchain Application, Intelligent Transportation Systems, Entrepreneurship, Decision Theory, Digital Manufacturing, Computational Geometry.

Professor Kannan Govindan



Professor Govindan is the Head of the Center for Sustainable Supply Chain Engineering, University of Southern Denmark. He has published over 350 peer-reviewed research articles in journals, conferences and books. His h-index is 66 and total citation 15482 (until 26 March 2019). His research areas, among others, are Sustainable Supply Chain Management, Sustainable Circular Economy, Corporate Social Responsibility, Sustainable Consumption and Production, Extended Producer Responsibility, Industry 4.0 with Sustainable Supply Chain focus.

Operations and Supply Chain Management: An International Journal.



In addition to organizing regular conferences, we also publish an international journal called **Operations and Supply Chain Management: An International Journal**, as the main outlet of the extended papers presented at OSCM conferences. The journal publishes high quality refereed articles in the field of operations and supply chain management. The journal is indexed in Scopus and Web of Science (Emerging Science Citation Index, by Clarivate Analytics).

We invite original contributions that present modelling, empirical, review, and conceptual works. For more information please visit the journal's website: <http://journal.oscm-forum.org/>

The Committee

General Chair : Mathews Nkhoma, RMIT University, Vietnam

General Co-Chair : Nyoman Pujawan, ITS, Indonesia

Program Chair:

- Imam Baihaqi, ITS, Indonesia
- Reza Akbari, RMIT University, Vietnam
- Caroline Chan, RMIT, Australia

Conference Administrator:

- Vu Hoang Thuy Tien, RMIT University, Vietnam
- Dana Karningsih, ITS, Indonesia
- Dewanti Anggrahini, ITS, Indonesia
- Gita Widi Bhawika, ITS, Indonesia

Arrangement Chair:

- Nguyen Thanh Thuy, RMIT University, Vietnam
- Robert McClelland, RMIT University, Vietnam
- Hiep Pham, RMIT University, Vietnam
- Quynh Nguyen, RMIT University, Vietnam
- Hung Nguyen, RMIT University, Vietnam
- Victor Gekara, RMIT University, Australia
- Prem Chhetri, RMIT University, Australia
- Booi Kam, RMIT University, Australia

International Committee:

- Kamrul Ahsan, RMIT University, Australia
- The Jin Ai, University of Atmajaya, Jogjakarta, Indonesia
- Thunyarat (Bam) Amornpetchkul, NIDA Business School, Thailand
- Watcharavee Chandraprakaikul, University of the Thai Chamber of Commerce, Thailand
- Imam Baihaqi, Sepuluh Nopember Institute of Technology (ITS), Indonesia
- Hing Kai Chan, The University of Nottingham Ningbo China
- Paul Childerhouse, Massey University, New Zealand
- Ajay Das, Baruch College, The City University of New York, USA
- Kanchan Das, East Carolina University, USA
- Rene De Koster, Erasmus University, The Netherlands
- Per Engelsest, Molde University College, Norway
- Javad Feizabadi, Malaysia Institute for Supply Chain Innovation, Malaysia
- Yudi Fernando, Universiti Malaysia Pahang, Malaysia
- Dimitris Folinax, Alexandrion Technological Educational Institute of Thessaloniki, Greece
- George Hadjinicola, University of Cyprus
- Per Hilletoft, Jönköping University, Sweden
- Petros Ieromonachou, University of Greenwich, UK
- Takashi Irohara, Sophia University, Japan
- Sakun Boon-Itt, Thammasat University, Thailand
- Vipul Jain, Victoria University of Wellington, New Zealand
- Sanjay Jharkharia, Indian Institute of Management Kozhikode, India
- Ferry Jie, Edith Cowan University, Australia
- Yasutaaka Kainuma, Tokyo Metropolitan University, Japan
- Kap Hwan Kim, Pusan National University, Korea
- Duangpun Kritchanhai, Mahidol University, Thailand
- Reza Lashkari, University of Windsor, Canada
- Kun Liao, Central Washington University, USA
- Ming K. Lim, Chongqing University, China
- Ioannis Manikas, University of Greenwich, UK
- Bimaraya Metri, Indian Institute of Management, Trichy, India
- Barbara Ocicka, SGH Warsaw School of Economics, Poland
- Shunichi Ohmori, Waseda University, Japan
- Rajesh Piplani, Nanyang Technological University, Singapore
- Daniel Prajogo, Monash University, Australia
- Ramayah, Universiti Sains Malaysia
- Violeta Roso, Chalmers University of Technology, Sweden
- Ruhul Amin Sarker, University of New South Wales, Australia
- Anders Segerstedt, Lule University of Technology, Sweden
- Togar Simatupang, Bandung Institute of Technology, Indonesia
- Mecit Can Emre Simsekler, Khalifa University, Abu Dhabi, UAE
- Himanshu Shee, Victoria University, Australia
- Harm-Jan Steenhuis, Hawaii Pacific University, USA
- Suprayogi, Bandung Institute of Technology, Indonesia
- Katsuhiko Takahashi, Hiroshima University, Japan
- Armagan Tarim, Hacettepe University, Turkey
- Benny Tjahjono, Coventry University, UK
- Blanka Tundys, University of Szczecin, Poland
- Jyri Vilko, Lappeenranta University of Technology, Finland
- Kun-Jeng Wang, National Taiwan University of Science and Technology, Taiwan
- Hui Ming Wee, Chung Yuan Christian University, Taiwan
- Gede Agus Widyadana, Petra Christian University, Indonesia
- Joel Wisner, University of Nevada, Las Vegas, USA
- Hartanto Wong, Aarhus University, Denmark
- Sha'ri Mohd Yusof, Universiti Teknologi Malaysia
- Yahaya Yusuf, University of Central Lancashire, UK
- Suhaiza Zailani, University of Malaya, Malaysia

Contents

KEYNOTE ABSTRACTS.....	1
INDUSTRY 4.0 AND ITS IMPACT ON SUSTAINABLE SUPPLY CHAIN MANAGEMENT	1
<i>Kannan Govindan</i>	
SMART TRANSFORMATION ENABLED BY DIGITAL FUSION AND INDUSTRY 4.0	1
<i>Shuo-Yan Chou</i>	
A COMPOSITE COST-TIME TRADE-OFF MODEL FOR MULTI-STOREY PROJECT FAST TRACKING 2	
<i>Paul Amaechi Ozor, Charles Mbohwa</i>	
A DATA MINING APPROACH TO OPTIMISE LARGE-SCALE OPTIMISATION PROBLEM	2
<i>Truong Van Nguyen, Li Zhou, Petros Ieromonachou</i>	
A DETERIORATING INVENTORY MODEL WITH LIMITED VEHICLE CAPACITY, STOCK DEPENDENT DEMAND AND UNAVAILABILITY SUPPLY	3
<i>I Gede Agus Widyadana, Nyoman Sutapa</i>	
A FRAMEWORK FOR ORGANIZATIONAL CHANGE: PURPOSE	3
<i>Dag Naslund, Andreas Norrman</i>	
A MULTI-OBJECTIVE TRANSPORTATION PROBLEM UNDER QUANTITY DEPENDENT COST STRUCTURE AND CREDIT PERIOD POLICY IN TRIANGULAR-INTUITIONISTIC FUZZY ENVIRONMENT.....	4
<i>Raj Kumar Bera, Shyamal Kumar Mondal</i>	
A STUDY ON LOGISTICS RISK ASSESSMENT: THE CASE OF CONTAINER SHIPPING IN EGYPT	4
<i>Sara Elzarka</i>	
ACCOUNTING FOR SUSTAINABILITY IN SUPPLY CHAIN VISIBILITY ASSESSMENT.....	5
<i>Apeji Uje Daniel, Funlade T. Sunmola, Petros Khoudian</i>	
AN APPROACH TO DEPLOYMENT READINESS REVIEW IN MANUFACTURING	6
<i>Alireza Javahernia, Funlade Sunmola</i>	
AN EMPLOYMENT-FOCUSED CURRICULUM FRAMEWORK TO CLOSE SKILLS GAPS AMONG SUPPLY CHAIN PROFESSIONALS.....	6
<i>Caroline Chan, I Nyoman Pujawan, Mahendra Rianto</i>	
AN INVESTIGATION OF RELATIONSHIP AMONG STORE ATTRIBUTES, CUSTOMER SATISFACTION, REPURCHASE INTENTION AND ADVOCACY: CASE OF JEWELLERY STORES IN INDIA.....	7
<i>Yash Daultani, Kshitij Goyal, Saurabh Pratap</i>	
ANALYSIS OF MANUFACTURING DATA USING QUALITY ANALYSIS PLATFORM.....	8
<i>Shwan An, Yongju Cho</i>	
APPLYING A SUSTAINABLE INDUSTRY 4.0 IN SOUTHEAST ASIAN AGRI-FOOD INDUSTRY, A LITERATURE STUDY TO THEIR CHALLENGES AND OPPORTUNITIES	8
<i>Denny Satria Ika, Hui-Min Wee, Laurence</i>	
APPLYING FUZZY ANALYTICAL HIERARCHY PROCESS TO RESHORING DECISIONS WITH COMPLEXITY AND UNCERTAINTY	9
<i>Movin Sequeira, Per Hilletoft</i>	

ASPECTS OF DIGITALIZING THE SUPPLY CHAIN SOURCING PROCESS: A CASE STUDY FROM THE NORWEGIAN INDUSTRY	9
<i>Johannes Cornelis De Man, Emrah Arica</i>	
ASSESSING SUPPLY CHAIN MATURITY FOR RETAIL PHARMACY CHAIN.....	10
<i>Sara Elzarka</i>	
AUTOMATIC GENERATION OF FUZZY INFERENCE RULES IN A RESHORING DECISION CONTEXT	10
<i>Anders Adlemo, Per Hilletoft</i>	
BIO-PLASTIC PACKAGING AND PRODUCT CO-INNOVATION: CRITICAL ISSUES IN B2B COLLABORATION.....	11
<i>Liliani, Benny Tjahjono</i>	
BIVARIATE CONTROL CHART FOR QUALITY CONTROL ANALYSIS IN BREAD PRODUCTION PROCESS, INDONESIA.....	11
<i>Silvia Sagita Arumsari, Luh Putu Eka Yani, Tika Endah Lestari</i>	
BLOCKCHAIN FOR IMPROVEMENT OF EMERGENCY RESPONSE IN HUMANITARIAN LOGISTICS INDONESIA	12
<i>Paulina Kus Ariningsih, Gregorios Yogas Sundara</i>	
BUSINESS AND SUPPLY CHAIN STRATEGY OF FLYING ABOVE THE DESSERT: A CASE STUDY OF EMIRATES AIRLINES.....	12
<i>Niyazudeen Kamarudeen, Balan Sundarakani</i>	
CARRIAGE CHOICE SIMULATION MODEL IN RAILWAY TRANSPORTATION FOR CEMENT DISTRIBUTION SYSTEMS	
<i>Winda Narulidea, Oki Anita Candra Dewi</i>	
CASHEW NUTS IN VIETNAM: FROM THE FARM TO THE INTERNATIONAL MARKETPLACE	13
<i>John Walsh, Nguyen Quang Trung</i>	
CIRCULAR ECONOMY ADOPTION IN THE AQUAFEED INDUSTRY	14
<i>Niken Kusuma Wardani, Benny Tjahjono</i>	
CLOUD COMPUTING AND IOT APPLICATION: CURRENT STATUSES AND PROSPECT FOR INDUSTRIAL DEVELOPMENT	14
<i>Onu Peter, Charles Mbohwa</i>	
CO-PRODUCTION OF VALUE BETWEEN FUNCTIONS FOR SUPPLY CHAIN PERFORMANCE.....	15
<i>Umer Mukhtar, Tashfeen Azhar</i>	
COMPLEXITY IN HANDLING ORDERS OF SPARE PARTS	15
<i>Per Engelseth, Brian E. White</i>	
CONNECTING SUPPLY CHAIN MANAGEMENT STRATEGIES, AGILITY AND PERFORMANCE IN SOUTH AFRICAN SMES.....	16
<i>Welby-Vandrys Loury-Okoumba, Chengedzai Mafini, Joyendu Bhadury</i>	
CUSTOMER INFORMATION USAGE: IMPROVING SUPPLY CHAIN PERFORMANCE AND ADVANCING LOGISTICS SERVICES IN CONSTRUCTION PROJECTS	16
<i>Jenny Bäckstrand, Anna Fredriksson, Árni Halldórsson & Ida Gremyr</i>	
CUSTOMER SATISFACTION AND REVERSE LOGISTICS IN E-COMMERCE: THE CASE OF KLANG VALLEY.....	17
<i>Emy Ezura A. Jalil</i>	

DESIGN RECOMMENDATIONS FOR THE FEASIBILITY OF AUTOMOTIVE PARTS REMANUFACTURING: A CASE STUDY IN INDONESIA	18
<i>Didik Wahjudi, Benny Tjahjono, Shu San Gan, Yopi Yusuf Tanoto, Stefanus Hans</i>	
DESIGNING INTEGRATED RISK CATALOG FOR ENTERPRISE RISK MANAGEMENT OFFICE OF CEMENT INDUSTRY (A CASE STUDY)	18
<i>Dewanti Anggrahini, Gita Widi Bhawika, I Gusti Ayu Putri Priyanka</i>	
DETERMINATION OF SUPPLY CHAIN LOCATION SEAWEED INDUSTRY WITH DYNAMIC PROGRAMMING	19
<i>A. Harits Nu'man, L. Nurwandi, Yani. Khrishnamurti, Muhardi</i>	
DETERMINING THE IMPORTANT FACTORS OF PORT DIGITALIZATION: THE EMPIRICAL CASES OF INDONESIAN PORTS.....	20
<i>Raja Oloan Saut Gurning</i>	
DEVELOPING BUSINESS MODEL OF PHYSICAL THERAPY TRICYCLE BY INTEGRATING LEAN CANVAS AND VALUE ENGINEERING	20
<i>Putu Dana Karningsih, Dyah Santhi Dewi, Wilson Pasaribu, I Made London Batan</i>	
DEVELOPING NETWORK PROJECT SCHEDULING FOR ASSEMBLY OPERATIONS IN THE AIRCRAFT MANUFACTURING COMPANY USING ACTIVITY ON NODE (AON).....	21
<i>Dewanti Anggrahini, Nani Kurniati, Muhammad AbdanSyakura</i>	
DEVELOPING PERFORMANCE MEASUREMENT SYSTEM IN FOOD INDUSTRY: A LITERATURE REVIEW	22
<i>Soksamnang Kong, Jirapan Liangrokapt</i>	
DIGITAL MUDA -THE NEW FORM OF WASTE BY INDUSTRY 4.0.	22
<i>Jamila Alieva, Robin Von Haartman</i>	
DISTRIBUTION CHALLENGES OF HEALTH COMMODITIES	23
<i>Andrew-Vans Bray, Samuel Ofosu Awuah</i>	
DISTRIBUTION PROCESS DESIGN TO IMPROVE SUSTAINABILITY MANUFACTURING EFFICIENCY	24
<i>Purnawan Adi Wicaksono, Heru Prastawa, Sri Hartini, M. Syarifudin Zain</i>	
DRIVERS AND BARRIERS FOR INLAND WATERWAY TRANSPORTATION–LESSONS LEARNT	24
<i>Violeta Roso, Ceren Altuntas Vural, Anna Abrahamsson, Matilda Engström, Sara Rogerson And Vendela Santén</i>	
EFFECT OF RECYCLING IN AN IMPERFECT PRODUCTION SYSTEM WITH ACCEPTANCE QUALITY LEVEL DEPENDENT DEVELOPMENT COST	25
<i>Shyamal Kumar Mondal</i>	
EMERGING TECHNOLOGIES IN SUPPLY CHAIN: MATURITY MODEL AND ASSESSMENT INSTRUMENT	26
<i>Immarita Dinar Fajriyani, I Nyoman Pujawan</i>	
ENHANCING MANUFACTURING FLEXIBILITY FOR FINANCIAL PERFORMANCE: THE MEDIATING ROLE OF CULTURAL COMPATIBILITY	26
<i>Hung Nguyen, Norma Harrison, Dothang Truong, George Onofrei</i>	
ENHANCING SUPPLY CHAIN CAPABILITIES IN AN ETOCONTEXT THROUGH "LEAN AND LEARN"	27
<i>Jenny Bäckstrand, Daryl John Powell</i>	

ENHANCING SUPPLY CHAIN PERFORMANCE BY SUSTAINABLE SUPPLIER SELECTION AND ORDER SPLITTING STRATEGIES	27
<i>Vipul Jain</i>	
EVALUATING THE IMPACT OF SAFETY CULTURE DIMENSIONS ON PATIENT SAFETY USING MACHINE LEARNING.....	28
<i>M. C. Emre Simsekler, M. Alalami, Samir Ellahham, Al Ozonoff</i>	
EVALUATION OF ADOPTING E-PROCUREMENT AND ITS IMPACT ON PERFORMANCE IN APPAREL SUPPLY CHAIN.....	28
<i>M.U.G. Jayawardhena, Pradeepa Jayaratne</i>	
EVALUATION OF THE GREEN SUPPLY CHAIN MANAGEMENT FOR ORGANIC PRODUCTS - THEORETICAL AND EMPIRICAL APPROACH.....	29
<i>Blanka Tundys, Tomasz Wiśniewski</i>	
EXPLORING MACHINE LEARNING APPLICATIONS IN SUPPLY CHAIN MANAGEMENT	30
<i>Luh Putu Eka Yani, I Made Alan Priyatna, Ammar Aamer</i>	
EXPLORING THE IMPACT OF INNOVATIVENESS OF HOSPITALITY SERVICE OPERATION ON CUSTOMER SATISFACTION.....	31
<i>Ngan T. Truong, Duy Dang-Pham, Robert McClelland, Mathews Nkhoma</i>	
EXPLORING THE KEY FACTOR CATEGORIES FOR THE DIGITAL SUPPLY CHAIN	32
<i>Chelinka Rafiesta Sahara, Jemica Damar Elyanto Paluluh, Ammar Mohamed Aamer</i>	
FACTORS AFFECTING IOT ADOPTION IN FOOD SUPPLY CHAIN MANAGEMENT	32
<i>Ifadhila Affia, Luh Putu Eka Yani, Ammar Aamer</i>	
FACTORS OF KAIZEN TRANSFERABILITY IN NON-JAPANESE CULTURES.....	33
<i>Silvia Sagita Arumsari, Yusril Maulana Rachim, Ammar Mohamed Aamer</i>	
FASHION PRODUCT DEMAND PREDICTION BASED ON ARTIFICIAL NEURAL NETWORK CONSIDERING PRODUCT VARIANCE	34
<i>Andi Cakravastia, Karina Apriana</i>	
FEASIBILITY OF ANALYTICAL HIERARCHY PROCESS AS A TOOL FOR RESHORING DECISIONS	34
<i>Movin Sequeira, Per Hilletofh</i>	
FORWARD AND REVERSE SUPPLY CHAIN NETWORK DESIGN FOR NEW AND REFURBISHED PRODUCTS IN E-COMMERCE LOGISTICS.....	35
<i>Yash Daultani, Naoufel Cheikhrouhou, Saurabh Pratap, Dharendra Prajapati</i>	
FUZZY LOGIC IN A RESHORING DECISION-MAKING CONTEXT.....	36
<i>Per Hilletofh, Movin Sequeira</i>	
GREEN PRODUCTION INVENTORY MODEL WITH CAP AND TRADE POLICY FOR GREENHOUSE GAS EMISSION.....	36
<i>Amalesh Kumar Manna, Asoke Kumar Bhunia</i>	
GREEN SUPPLY CHAIN MANAGEMENT: A RESEARCH AGENDA	37
<i>Alina Shamsuddin, Eta Wahab, Wan Nurul Karimah Wan Ahmad, Nor Hazana Abdullah</i>	
GREEN SUPPLY CHAIN MANAGEMENT MEASUREMENT IN DEFENSE COMPANY IN INDONESIA	37
<i>Afferdhy Ariffien, Irayanti Adriant, Regita Ayu Pratiwi</i>	
HOW ECONOMIC INTEREST IMPACT ON SCM PERFORMANCE?	38
<i>Seock-Jin Hong</i>	

HYBRID SIMULATION AND INTEGER LINEAR PROGRAMMING MODEL FOR INTERMODAL DISTRIBUTION: A CASE STUDY OF FERTILIZER COMPANY IN INDONESIA.....	38
<i>Dody Hartanto, Rahmat H. Saleh</i>	
IMPACT OF ERP USAGE ON OPERATIONAL PERFORMANCE OF SRI LANKAN MANUFACTURING COMPANIES.....	39
<i>Jayarathna B.C.P, Herath H.M.T.S, Kumudumali M.A.</i>	
IMPACT OF GLOBAL AGRI-FOOD COMMODITY FLOWS ON FOOD AND FEED SAFETY	40
<i>Milena Zupanec, Anneluise Mader, Robert Pieper, Helmut Schafft</i>	
IMPLEMENTATION TRAFFIC CONTROL ALGORITHM FOR MULTI-AGV SYSTEM.....	40
<i>Pasan Dharmasiri, Ilya Kavalchuk, Mohammadreza Akbari</i>	
IMPROVEMENT OF INFORMATION FLOW FOR RAIL FREIGHT TRANSPORTATION	41
<i>Nattakit Yuduang, Jirapan Liangrokapart</i>	
INFUSION OF DRY PORTS IN MALAYSIAN CONTAINER SEAPORT SYSTEM: A PREPARATION TOWARDS UNPREDICTABILITY IN GLOCALISATION-CENTRIC TRADE SYSTEM.....	41
<i>Jagan Jeevan, Monizaihasra Mohamed, Violeta Roso</i>	
INTRODUCING TRAMP AND LINER SHIPPING MODEL TO PRODUCTION PLANNING	42
<i>Qian Huang, Shunichi Ohmori, Kazuho Yoshimoto</i>	
INVOLVING SUPPLIERS IN A LEAN TRAINING PROGRAM.....	43
<i>Peter Manfredsson, Per Hilletofth, Ewout Reitsma</i>	
JOINT PROMOTIONS AND INVENTORY DECISIONS.....	43
<i>George Hadjinicola, Andreas Soteriou</i>	
KNOWLEDGE TRANSFER FOR THE NEXT GENERATION OF LOGISTICS EXPERTS	44
<i>Sandra Eitler, Reinhold Schodl</i>	
LAST MILE DELIVERY AS A COMPETITIVE LOGISTICS SERVICE IN VIETNAM – A CASE OF DHL E-COMMERCE VIETNAM.....	44
<i>Hiep Cong Pham, Dat Nguyen, Chau Doan, Quyen Thai, Ngoc Nguyen</i>	
LEADERSHIP AND PERFORMANCE: THE CASE OF AUSTRALIAN SMES IN THE SERVICES SECTOR	45
<i>Sara Kasraie, John Burgess</i>	
LINER SHIPPING NETWORK DESIGN IN INDONESIA “SEA-TOLL” AGENDA: TANJUNG PERAK CORRIDOR	46
<i>Muchammad Arya Zamal, Rommert Dekker</i>	
LOCAL DISTRIBUTION OF ORGANIC FOOD: A REVIEW AND RESEARCH AGENDA	47
<i>Yinef Pardillo Baez, Movin Sequeira, Per Hilletofth</i>	
LOCKER FACILITY ALOCATION FOR DELIVERY OF GOODS IN THE E-COMMERCE BUSINESS ...	48
<i>Oki Anita Candra Dewi, Siti Nurminarsih, Maulin Masyito Putri, Muhammad Faisal Ibrahim, Winda Narulidea</i>	
LOGISTIC PARTNERSHIP IN THE FOOD SUPPLY CHAINS MANAGEMENT IN THE CONTEXT OF INTERNATIONAL EXPANSION.....	49
<i>Blanka Tundys, Marta Starostka-Patyk, Katarzyna Grondys, Paula Bajdor, Joanna Nowakowska-Grunt</i>	
LOGISTICS SETUPS IN A THIRD-GENERATION PORT	50
<i>Yulia PANOVA, Per Hilletofth</i>	

MANAGEMENT AND DESIGN OF ROBOTIC SORTING SYSTEMS.....	50
<i>René De Koster, Bipan Zou, Yeming Gong</i>	
MANAGEMENT OF CYBER SECURITY THREATS IN THE FACTORIES OF THE FUTURE SUPPLY CHAINS.....	51
<i>Jukka Hemilä, Markku Mikkola, Jarno Salonen</i>	
MODELING OF THE AREA OF TRANSPORTATION MOVEMENT NETWORK POTENTIAL FLOOD FOR DISASTER MITIGATION CASE STUDY: BANDUNG RAYA AREA	52
<i>Darwin, B.Kombaitan, Heru Purboyo Hidayat P, Gatot Yudoko</i>	
MULTI OBJECTIVE RELIEF DISTRIBUTION SYSTEM MODEL FOR VOLCANO DISASTER VICTIMS	52
<i>Amelia Santoso, Dina N. Prayogo, Joniarto Parung, Calvin Soputra</i>	
NEW APPROACH TO ESTIMATE CUSTOMER SATISFACTION LEVEL	53
<i>Mokh Suef</i>	
NEW FUTURE FOR SUSTAINABILITY AND INDUSTRIAL DEVELOPMENT: SUCCESS IN BLOCKCHAIN, INTERNET OF PRODUCTION, AND CLOUD COMPUTING TECHNOLOGY.....	53
<i>Onu Peter, Charles Mbohwa</i>	
NEGOTIATING THE MULTI-NATIONAL SUSTAINABLE FOOD SUPPLY CHAIN: A CONCEPTUAL ROADMAP	78
<i>John Wilkerson, Yuehe Cui, Yixin Jin, Yiqin Lin</i>	
PERFORMANCE EVALUATION OF PROFESSIONAL SERVICES SUPPLY NETWORK: A MULTI-CRITERIA DECISION-MAKING APPROACH.....	54
<i>Omkarprasad S.Vaidya</i>	
PERFORMING SUPPLY CHAIN DESIGN ACTIVITIES DURING PRODUCT DEVELOPMENT PROJECTS: A SYSTEMATIC LITERATURE REVIEW.....	55
<i>Ewout Reitsma, Per Hilletoft, Eva Johansson</i>	
PROPOSED DESIGN OF INTELLIGENT INSPECTION SYSTEM FOR QUALITY CONTROL PROCESS	55
<i>Yudha Prasetyawan, Alfia Khairani Simanjuntak, Azimatul Khusniah</i>	
PURCHASING AS A LEVER OF INNOVATIONS IN ERA OF DIGITAL TRANSFORMATION	56
<i>Barbara Ocicka</i>	
REDUCING OCCURRENCE OF TRANSFORMER FAILURE FROM 0.75% TO 0.35% USING TOOLS OF LEAN SIX SIGMA.....	57
<i>Shrinivas Repak, Mukund Madhav Tripathi</i>	
RELIABLE QUALITY MANAGEMENT IN ROAD FREIGHT OPERATIONS.....	58
<i>Paul A. Ozor, Charles Mbohwa</i>	
RESCUE AND RELIEF OPERATION AFTER A DEVASTATING FIRE ACCIDENT: A HUMANITARIAN LOGISTICS-BASED MODELING APPROACH	58
<i>Kanchan Das, R. S. Lashkari, Azizur R. Khan</i>	
RESEARCH ON COMPLEMENTARITY BUSINESS MODEL OF FRESH E-RETAILER DRIVEN BY CONSUMERS' DEMAND: A CASE STUDY BASED ON THE COOPERATION BETWEEN YIGUO AND XIACHUFANG	59
<i>Zhang Xumei, Jiang Xiaoling, Deng Zhenhua, Wu Shengnan</i>	
RICE EXPORT VOLUME FORECASTING IN VIET NAM USING ARTIFICIAL NEURAL NETWORK..	60
<i>Dung Thi My Tran, Truc-Hung Ngo, Tham Thi Tran, Ton Hien Duc Truong, Vinh Thai</i>	

RISK ANALYSIS IN SUPPLY CHAIN AT SMALL MEDIUM ENTERPRISE FOR CLAM AND SEAWEED (KERULA) CRACKERS PRODUCTS	60
<i>Eko Nurmianto, Dwi Endah Kusriani, Arino Anzip</i>	
RISK ASSESSMENT BASED ON BUSINESS CONTINUITY MANAGEMENT OF HARBOR TUG SHIPPING OPERATIONS	61
<i>Eko Hariyadi Budiyanto, Raja Oloan Saut Gurning, Trika Pitana, Ingdiranta Zefanya Br Sebayang</i>	
RISK GOVERNANCE FOR PROTECTING CRITICAL INFRASTRUCTURE SUPPLY CHAINS: TOWARDS A CONCEPTUAL MULTI-LEVEL FRAMEWORK.....	62
<i>Victoria Ahlqvist, Andreas Norrman, Marianne Jahre</i>	
RISK POOLING AND STOCK ALLOCATION UNDER COST AND DEMAND UNCERTAINTY	62
<i>RefikGullu</i>	
SIMULATION MODELING FOR AUTOMATED PHARMACY DISPENSING SYSTEM: A CASE STUDY IN HOSPITAL	63
<i>Premrudee Soontranan, Duangpun Kritchanhai</i>	
STUDY OF VESSEL OPERATION IN INDONESIA “SEA – TOLL” AGENDA	63
<i>Muchammad Arya Zamal, Senator Nur Bahagia</i>	
SUPPLY CHAIN COORDINATION UNDER VENDOR MANAGED INVENTORY SYSTEM CONSIDERING CARBON EMISSION FOR IMPERFECT QUALITY DETERIORATING ITEMS	64
<i>Agustina Viani Trinanda Adi Nugroho, Hui Ming, Wee</i>	
SUPPLY CHAIN RISK MANAGEMENT OF FISHERY PRODUCTS IN SURABAYA TRADITIONAL MARKET	65
<i>Ignatia Martha Hendrati, Achmad Room Fitriant, Indrawati Yuhertiana</i>	
SUPPLY-PROCESSING-DISTRIBUTION MODELSFOR HOSPITAL SUPPLY CHAIN –A CASE STUDY OF HOSPITAL SUPPLY CHAIN IN THAILAND.....	65
<i>Daranee Senarak, Duangpun Kritchanhai</i>	
SUSTAINABLE DEVELOPMENT IN AN IMPERFECT PRODUCTION SYSTEM BY CONTROLLING GREENHOUSE GAS EMISSION	66
<i>Madhusudan Dolai, Amalesh Kumar Manna, Shyamal Kumar Mondal</i>	
SYSTEM DYNAMIC MODELING FOR CARGO NON-KS DELIVERY REVENUE IMPROVEMENT IN CGD DRY-PORT	66
<i>Asep Ridwan, Muhammad Iman Santoso, Ratna Ekawati, Reno Prasetyo</i>	
THE CHALLENGES OF EMERGING TECHNOLOGIES: THE EXPERIENCE OF PROCUREMENT PROFESSIONALS	67
<i>Loo Saw Khuan</i>	
THE CONTAINER SHIPPING FLEET PLANNING PROBLEM UNDER TRADE DISPARITIES OF NATIONAL LOGISTICS SYSTEM IN INDONESIA	68
<i>Siti Nurminarsih, Maulin Masyito Putri, Karina Virgiananda Sirsya</i>	
THE DEVELOPMENT OF ONLINE PLATFORM FOR HUMANITARIAN LOGISTICS	69
<i>Raden Didiet Rachmat Hidayat, Sandriana Marina, Lira Agusinta, Aswanti Setyawati, Reza Fauzi Jayasakti, Aisyah Rahmawati</i>	
THE EFFECT OF PRICING STRATEGIES ON RETAILERS: AN AGENT-BASED MODELING APPROACH.....	70
<i>Niniet I. Arvitrida, Adji Candra, Nurhadi Siswanto, Lila Yuwana</i>	

THE HALAL SUPPLY CHAINS MAPPING IN INDONESIAN TRADITIONAL MARKET AS EFFORT IN CREATING FOOD SECURITY ENVIRONMENT: AN INITIAL CONCEPT	70
<i>Ah. Ali Arifin</i>	
THE IMPACT OF CULTURE OF QUALITY (COQ) ON THE ORGANIZATIONAL PERFORMANCE.....	71
<i>Yu Han, Vikas Kumar, Ngân Tuyết Truong, Nhu Y Ngoc Hoang</i>	
THE IMPACT OF SUPPLIER INVOLVEMENT ON SUPPLY CHAIN RISKS AND RESILIENCE	71
<i>Grażyna Wieteska</i>	
THE IMPLEMENTATION OF LOGISTICS INFORMATION TECHNOLOGY IN MITIGATING SMES LOGISTICS CHALLENGES IN VANDERBIJLPARK.....	72
<i>O. Omoruyi</i>	
THE USE OF C4ISR IN SMART CITY FOR DISASTER MITIGATION IN ASYMMETRICAL WARFARE PERSPECTIVE.....	72
<i>Luh Putu Ika Primayanti, Febyorita Amelia</i>	
TOWARDS SUSTAINABILITY IN SOURCING: A HYBRID MCDM APPROACH	73
<i>Ahmed Mohammed</i>	
UNDERSTANDING THE INFLUENCE BETWEEN BLOCKCHAIN TECHNOLOGY AND TRUST IN SUPPLY CHAIN MANAGEMENT: A LITERATURE REVIEW	73
<i>Abbas Batwa, Andreas Norrman</i>	
VEHICLE ROUTING MODEL FOR MILK RUN DELIVERY OF FRESH PRODUCE: THE CASE OF A 3PL SERVICE PROVIDER CATERING SUPERMARKETS	74
<i>Hashini Kodippili, Nishal A. Samarasekera</i>	
WAREHOUSE OPERATION OPTIMIZATION THROUGH ON-SITE OBSERVATION AND SIMULATION	75
<i>Hiep Cong Pham, Dat Nguyen</i>	
WASTE ELIMINATION ACTION EVALUATION USING MANUFACTURING SYSTEM VALUE ANALYSIS.....	76
<i>Yudha Prasetyawan, Maudy Ramadhani Putri, Siti Qomariyah</i>	
WHAT ARE THE MOST PROMISING INNOVATIONS IN LOGISTICS?	76
<i>Reinhold Schodl, Sandra Eitler</i>	
WHY YOUR PRODUCT VARIETY MANAGEMENT STRATEGY MAY FAIL: BARRIERS IN THE REDUCTION OF THE PRODUCT VARIETY.....	77
<i>Loris Battistello, Alexandria Trattner, Lars Hvam</i>	

MULTI-OBJECTIVE RELIEF DISTRIBUTION SYSTEM MODEL FOR VOLCANO DISASTER VICTIMS

Amelia Santoso, Dina N. Prayogo, Joniarto Parung & Calvin Soputra
Industrial Engineering Study Program, University of Surabaya,
Surabaya 60293 Indonesia, E-mail: amelia@staff.ubaya.ac.id

ABSTRACT

Because of its location in the ring of fire, Indonesia has around 30% of all volcanoes in the world. After the volcano erupted, the area around the volcano was damaged and many people lost their houses, jobs, and possibilities to live in there. Before the volcano erupts, people who live around the volcano must be evacuated as soon as possible to one of the available shelters. In the shelters, drinking water, food, and medicine are needed by victims who were evacuated to survive aftermath of a disaster. To distribute reliefs to all shelters effectively, we developed a multi-objective relief distribution model. This distribution system model aims to determine the allocation of various types of relief items to several shelters with a minimum total cost and balanced service level between locations. This multi-objective relief distribution model considered multi-item, multi-period, multi-vehicle, and multi-trip by using a pre-emptive goal programming approach. This optimization model was applied to the numerical example based on Semeru Mount as the highest active volcanoes in Indonesia, which is located in Lumajang, East Java.

Keywords: relief distribution model, multi-objective optimization, pre-emptive goal programming

1. INTRODUCTION

Indonesia is an archipelago, located in the Pacific Ring of Fire and also in the meeting of four tectonic plates, i.e., the Asian continental plate, the Australian continental plate, the Indian Ocean plate, and the Pacific Ocean plate (CFE-DM, 2018). Because of its location, Indonesia geographically is a vulnerable country facing natural disasters (Van Rossum and Krukkert, 2010). Natural disasters, such as earthquakes, volcanic eruptions, and tornados, are catastrophic events caused by nature and cannot be controlled by men (Shaluf, 2007). In Indonesia, volcanic eruptions frequently occurred because Indonesia has around 30% of all volcanoes in the world. According to the Indonesian National Board for Disaster Management (BNPB), during the last 5 years, Indonesia has 78 volcanic eruptions; thus, this paper focuses on the impacts of volcano eruptions.

Natural disasters have caused damage and destruction of property, infrastructure, and assets; people lost their jobs and the possibilities to live (Sahay et al., 2016). To reduce or minimize the impact of natural disasters, a disaster management planning is needed. According to Perez-Gallarce (2017), the disaster management cycle contains four phases, namely, mitigation, preparedness, response, and recovery as shown in Figure 1. Habib (2016) categorized mitigation and preparedness into pre-disaster phases, whereas response and recovery phases are categorized into post-disaster phases. Mitigation phase is the first phase of disaster management that includes the activity steps to reduce vulnerability to disaster impacts, either economy or human (Camacho-Vallejo, 2015). Preparedness phase refers to design activities or procedures to minimize the disaster impacts to people and property. Response phase is a phase of aftermath disaster that

includes all activities or operations to save lives and prevent further damage, whereas the recovery or reconstruction phase is a phase of aftermath disaster that includes rehabilitation activities (Altay and Green 2006).

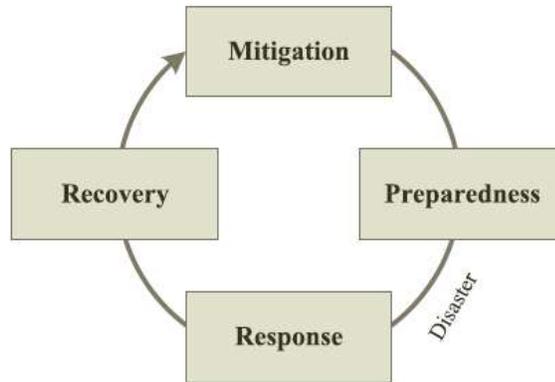


Figure 1. Four phases of the Disaster Management Cycle (Perez-Gallarce, 2017)

This paper focuses on the response phase of the disaster management cycle, a phase aftermath a volcanic eruption. Cozzolino (2012) divided the response phase into two sub-phases, namely, immediate response and restore, as shown in Figure 2. The immediate response sub-phase deals with how to rescue people, whereas the restore sub-phase deals with how to supply relief goods (medical attention, food, water, and shelter) to the refugees. Shaluf (2007) states that the worst consequence of volcanic eruption is when people have to be moved (evacuated) to shelters. Therefore, this paper deals on how to supply or distribute the relief goods to refugees in every shelter, especially to those who were affected by volcanic eruptions.

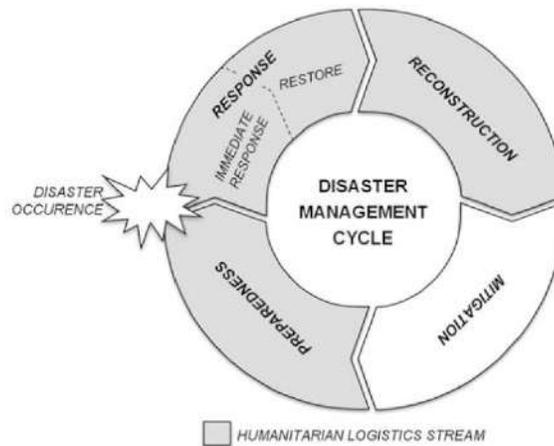


Figure 2. Response sub-phases in Disaster Management Cycle (Cozzolino, 2012)

Each shelter needs various relief (multi-item) and regional and provincial agencies (BNPD) have to distribute multi-relief to multi-shelter using multi-vehicle. Each vehicle can have multi-trip per period to supply a similar or a different shelter. Therefore, this paper proposed a model of distributing multi-reliefs to multi-shelters using multi-vehicle, in which each vehicle can have many trips in a period. The proposed relief distribution system model has multi-objectives. The objectives are, first, to minimize the total cost of relief distribution and, second, to balance the

service level of each shelter. Pre-emptive method is used to solve the multi-objective relief distribution system model. The pre-emptive methods solve the proposed model by completing each objective function in sequence (Winston, 2004).

2. RESEARCH FRAMEWORK

The research objectives can be achieved through systematic and structured steps. We started by defining the problem of distributing relief goods to each shelter. After the second step, which was to review literature, we began to develop the proposed model, which is a multi-objective distribution system model by considering multi-item, multi-vehicle, and multi-trip for each vehicle and multi-shelter. The next step was to create a scenario that consists of some actual data obtained in the field and some data assumptions. After completing the model using a pre-emptive approach and analyzing it, finally, conclusions and suggestions were done.

3. MODEL DEVELOPMENT

In the aftermath of a disaster, the basic needs of refugees must be met so the government through the BNPD distributes relief goods to each shelter where the refugees live. The proposed multi-objective distribution system model developed based on Lin et al. (2011) consists of two echelons, namely, the regional and provincial agency (BNPD) and multi-shelters. Regional and provincial agency (BNPD) is a government agency tasked to distribute the relief goods to multi-shelters. In each shelter, a lot of items are needed to be fulfilled during a certain period, and a corresponding penalty cost is imposed when the demand cannot be fulfilled within that period.

In the proposed distribution system model, one BNPD distributes relief items to many shelters. BNPD has multi-homogeneous vehicles to transfer multi-relief to shelters. In one period, vehicles can have many trips to the same or different shelter during a period as long as they have available time to transfer relief. At the same time (in one trip), a vehicle can only send multi-relief goods to one shelter, but the shelter can be visited by more than one vehicle that sends all requests for shelter in the same period. Each vehicle has weight and volume capacity restrictions. Certain relief demand at certain shelters in a period can be fulfilled by multiple vehicles and multiple trips using the same vehicle or not. This proposed model determined the number of reliefs that are distributed to a certain shelter using a certain vehicle in a certain trip at a certain period in order to minimize the total cost to meet the demand for relief goods and to minimize the gap in service level between shelters.

3.1. Mathematic Notation

Several mathematical notations that are used in this proposed multi-objective relief distribution system model can be classified become indexes, parameters, and decision variables as follows:

Index

i	=	Type of relief
j	=	Shelter location
l	=	Vehicle
t	=	Period
k	=	trip

Parameter

- ξ_j = Transportation time to shelter location j
 C_{jl} = Transportation cost to location j using vehicle l
 H = Total of available work time per period
 W = Maximum load weight capacity of vehicle l
 V = Maximum load volume capacity of vehicle l
 M = A large number
 D_{ijt} = Demand of relief i at location j in period t
 FP_i = Penalty cost of relief i if there is remaining unsatisfied demand
 a_i = Unit weight of relief i
 b_i = Unit volume of relief i

Decision Variable

- X_{ijltk} = Amount of relief i delivered to shelter location j using vehicle l in period t trip k
 w_{ijt} = Unsatisfied demand for relief item i at shelter location j in period t
 S = Maximum difference of service level between two shelter locations
 s_j = Service level of shelter location j
 Y_{jltk} = Equal to 1 when relief are delivered to shelter location j using vehicle l at period t trip k , and 0 otherwise

3.2. Mathematic Formulation

This proposed aid distribution model has two objective functions. The first objective function (equation 1) is to minimize the total cost to meet the demand for relief goods, consisting of penalty cost and transportation cost. The penalty cost is the cost incurred because there is a demand for relief items that cannot be met. The second objective function (equation 2) is to minimize the gap of service level between shelters. This objective function aims to balance service level among shelters. Both objective functions are formulated as follows:

$$\min \sum_i \left(\left(\sum_j \sum_t D_{ijt} - \sum_j \sum_l \sum_t \sum_k X_{ijltk} \right) FP_i \right) + \sum_j \sum_l \sum_t \sum_k C_{jl} Y_{jltk} \tag{1}$$

$$\min. S \tag{2}$$

This proposed model has several constraints as follows:

$$s_p - s_q = S^+ - S^- \quad \forall p, q \in J, p \neq q \tag{3}$$

$$s_j = \frac{\sum_i \sum_l \sum_t \sum_k X_{ijltk}}{\sum_i \sum_t D_{ijt}} \quad \forall j \tag{4}$$

$$\sum_l \sum_k (X_{ijltk} + w_{ijt}) = D_{ijt} \quad \forall i, j, t \tag{5}$$

$$X_{ijltk} \leq M Y_{jltk} \quad \forall i, j, l, t, k \tag{6}$$

$$\sum_j \sum_k \xi_j Y_{jltk} \leq H \quad \forall l, t \tag{7}$$

$$\sum_i \sum_j a_i(X_{ijltk}) \leq W \quad \forall l, t, k \quad (8)$$

$$\sum_i \sum_j b_i(X_{ijltk}) \leq V \quad \forall l, t, k \quad (9)$$

$$\sum_j Y_{jltk} \leq 1 \quad \forall l, t, k \quad (10)$$

$$Y_{ltk} = \sum_j Y_{jltk} \quad \forall l, t, k \quad (11)$$

$$Y_{ltk} \geq Y_{jlt(k+1)} \quad \forall l, t, k; k < \bar{k} \quad (12)$$

$$S^+, S^- \geq 0 \quad (13)$$

$$S^+, S^- \leq S \quad (14)$$

$$w_{ijt} \geq 0 \quad \forall i, j, t \quad (15)$$

$$X_{ijltk} \geq 0 \quad \forall i, j, l, t, k \quad (16)$$

$$Y_{jltk} \in \{0,1\} \quad \forall j, l, t, k \quad (17)$$

Equations (3) and (4) are used to determine the gap in service levels to meet the needs of all relief items at the shelter. The level of service for fulfilling all relief items at the shelter is calculated from the ratio between the total demand for all relief goods that are fulfilled at the shelter and the total demand for all relief goods at the shelter. Equation (5) ensures that the total demand for each item of relief goods in a period is fulfilled within that period. Equation (6) guarantees that the relief goods are delivered using the assigned vehicle, whereas equation (7) ensures that in each period, each vehicle can be used only in the available working hours in that period. Equations (8) and (9) limit the total weight and total volume of loading of relief goods to not exceed the capacity of the vehicle. Equations (10) and (11) ensure that each vehicle on the same trip only sends relief goods to one shelter, whereas equation (12) guarantee that all trips of each vehicle are done in sequence order. Equations (13) and (14) guarantee that the values of the gap are absolute. Equations (15) and (16) guarantee non-negative decision variables, whereas equation (17) ensures binary decision variables.

4. RESULTS & DISCUSSION

The proposed multi-objective distribution system model is implemented using Mount Semeru data. Mount Semeru is one of the most active volcanoes in East Java, Indonesia, exactly located in Lumajang city. The height of Mount Semeru is 3,676 m above sea level, making it the highest mount in East Java. In the aftermath of a disaster, relief goods are distributed to the victims. Distributed relief goods have to be suitable for their needs. Mount Semeru data can be obtained from BPBD Lumajang. All data are collected as shown in Table 1. - Table 4.

Table 1. Shelter Location and Number of Refugee

Location	Capacity (person)	Number of Refugee (person)	Breastfeeding mothers (person)	Toddler (kid)
GOR Wira Bakti & Lapangan	20,000	18,413	3,995	1,149

Location	Capacity (person)	Number of Refugee (person)	Breastfeeding mothers (person)	Toddler (kid)
Stadion Semeru	30,000	29,642	5,640	1,209
Barak/Aula Yonif 527	7,500	6,826	700	-
Asrama Nakertrans	1,000	808	428	272
Kantor Diklat	1,000	809	429	273
Total	59,500	56,498	11,192	2,903

Table 2. Amount of Relief Sent For Each Location Each Period

Relief goods	Dimension	Location of shelter				
		GOR Wira Bakti & Lapangan	Stadion Semeru	Barak/Aula Yonif 527	Asrama Nakertrans	Kantor Diklat
Mineral water 600 ml	box	2,878	4,739	1,423	90	90
Prepared food	box	864	1,422	342	27	27
Medicine	box	185	297	68	8	8
Toddler food	pack	575	605	-	136	137
Sanitary napkins	pack	160	226	28	18	18

Table 3. Weight, Volume and Penalty Cost of Each Relief

Relief good 1	Weight (kg) 2	Volume (m ³) 3	Penalty cost (Rp) 4
Mineral water 600 ml	15	0.0239	1,500,000,-
Prepared food	3	0.0217	1,500,000,-
Medicine	5	0.006	1,500,000,-
Toddler food	0.12	0.0008	1,500,000,-
Sanitary napkins	1.5	0.0078	1,500,000,-

Table 4. Parameters

Parameter 1	Amount 2
Number of vehicle	3 units
Weight capacity of vehicle	5,895 kg
Volume capacity of vehicle	13 m ³
Travel time to each shelter location	0,5 hour
Loading and unloading time of relief	1 hour
Number of trips	6 trips
Operation time	10 hours
Planning periods	7 days

Using a pre-emptive approach, relief goods sent to the shelter location can be shown in Table 5 and the unfulfilled demand can be shown in Table 6.

Table 5. Number of Relief Goods Sent

Relief	Shelter Location	Period						
		1	2	3	4	5	6	7
Mineral water 600 ml	GOR Wira Bakti & Lapangan	1709.9 3	1709.9 3	1709.9 3	1709.9 3	1273.36	2102.9 3	1709.93
	Stadion	3126.1	2340.1	3126.1	2910.7	3126.16	2565.4	3126.16

Relief	Shelter Location	Period						
		1	2	3	4	5	6	7
	Semeru	6	6	6	4		8	
	Barak/Aula Yonif 527	692.13	1423	108.13	692.13	1423	692.13	672.15
	Asrama Nakertrans	0	90	90	0	0	57.071	90
	Kantor Diklat	90	90	0	90	90	0	90
Prepared food	GOR Wira Bakti & Lapangan	864	864	864	864	864	864	864
	Stadion Semeru	1422	1422	1422	1422	1422	1422	1422
	Barak/Aula Yonif 527	342	342	342	342	342	342	342
	Asrama Nakertrans	27	27	27	27	0	27	27
	Kantor Diklat	27	27	0	27	27	27	27
Medicine	GOR Wira Bakti & Lapangan	185	185	185	185	185	185	185
	Stadion Semeru	297	297	297	297	297	297	297
	Barak/Aula Yonif 527	68	68	68	68	68	68	68
	Asrama Nakertrans	8	8	8	8	0	8	8
	Kantor Diklat	0	8	0	0	0	8	0
Toddler food	GOR Wira Bakti & Lapangan	575	575	575	575	575	575	575
	Stadion Semeru	605	605	605	605	605	605	605
	Barak/Aula Yonif 527	0	0	0	0	0	0	0
	Asrama Nakertrans	136	136	136	136	0	136	136
	Kantor Diklat	137	99,303 61	0	137	137	137	137
Sanitary napkins	GOR Wira Bakti & Lapangan	160	160	160	160	160	160	160
	Stadion Semeru	226	226	226	226	226	226	226
	Barak/Aula Yonif 527	28	28	28	28	28	28	28
	Asrama Nakertrans	18	18	18	18	0	18	18
	Kantor Diklat	0	0	0	18	0	18	18

Table 6. Unfulfilled Demand

Relief	Shelter Location	Period						
		1	2	3	4	5	6	7
Mineral water 600 ml	GOR Wira Bakti & Lapangan	1168.0 67	1168.0 67	1168.0 67	1168.0 67	1604.6 45	775.06 67	1168.0 67
	Stadion Semeru	1612.8 4	2398.8 4	1612.8 4	1828.2 6	1612.8 4	2173.5 15	1612.8 4
	Barak/Aula Yonif 527	730.86	0	337.87	730.87	0	730.87	750.85
	Asrama Nakertrans	90	0	0	90	90	32.93	0
	Kantor Diklat	0	0	90	0	0	90	0
Prepared food	GOR Wira Bakti & Lapangan	0	0	0	0	0	0	0
	Stadion Semeru	0	0	0	0	0	0	0
	Barak/Aula Yonif 527	0	0	0	0	0	0	0
	Asrama Nakertrans	0	0	0	0	27	0	0
	Kantor Diklat	0	0	27	0	0	0	0
Medicine	GOR Wira Bakti & Lapangan	0	0	0	0	0	0	0
	Stadion Semeru	0	0	0	0	0	0	0
	Barak/Aula Yonif 527	0	0	0	0	0	0	0
	Asrama Nakertrans	0	0	0	0	8	0	0
	Kantor Diklat	8	0	8	8	8	0	8
Toddler food	GOR Wira Bakti & Lapangan	0	0	0	0	0	0	0
	Stadion Semeru	0	0	0	0	0	0	0
	Barak/Aula Yonif 527	0	0	0	0	0	0	0
	Asrama Nakertrans	0	0	0	0	136	0	0
	Kantor Diklat	0	37.69	137	0	0	0	0
Sanitary napkins	GOR Wira Bakti & Lapangan	0	0	0	0	0	0	0
	Stadion Semeru	0	0	0	0	0	0	0
	Barak/Aula Yonif 527	0	0	0	0	0	0	0
	Asrama	0	0	0	0	18	0	0

Relief	Shelter Location	Period						
		1	2	3	4	5	6	7
	Nakertrans							
	Kantor Diklat	18	18	18	0	18	0	0

Table 7 shows the level of service for each number of shelters 0.74811. This value recognizes the percentage of fulfillment of 74,811% of the total shelter demand. In addition, the percentage of fulfillment of each demand is the same, and this means that each shelter is served equally. The results of model gave the first objective function, the total cost amount Rp.38,009,100 and the second objective function is no gap of service level between all shelter locations.

Table 7. Service Level of each Shelter

Shelter Location	Service Level
GOR Wira Bakti & Lapangan	0,74811
Stadion Semeru	0,74811
Barak/Aula Yonif 527	0,74811
Asrama Nakertrans	0,74811
Kantor Diklat	0,74811

5. CONCLUSION

During the restore sub-phase, BNPD distributes multi-reliefs to multi-shelters using multi-vehicles which each vehicle has multi-trips. The proposed relief distribution model gave result with minimal cost as well as balanced service level. The future research should develop metaheuristic algorithm in order to solve the proposed model faster.

6. ACKNOWLEDGEMENT

This research is part of Disaster research funded by the Directorate General of Higher Education. We grateful thanks for their support in this research funding.

7. REFERENCES

- Altay, N. and Green, W. G. (2006).⁵ OR/MS research in disaster operations management. *European Journal Operation Research*. Vol. 175 (1), 475-493
- Habib, M.S., Lee, Y.H. and Memon, M.S. (2016).⁵ Mathematical models in humanitarian supply chain management: a systematic literature review. *Mathematical Problems in Engineering* Vol. 2016, Article ID 3212095, <http://dx.doi.org/10.1155/2016/3212095>
- Camacho-Vallejo, J.F., Gonzalez-Rodriguez, E. and Almaguer, F.J. (2015).⁵ A bi-level optimization model for aid distribution after the occurrence of a disaster. *Journal of Cleaner Production* Vol. 105, 134-145
- CFE-DM (The Center for Excellence in Disaster Management and Humanitarian Assistance) (2018), Indonesia disaster management reference book. <https://www.cfe-dmha.org>
- Cozzolino, A. (2012), *Humanitarian logistics: cross-sector cooperation in disaster relief management*. Springer, New York.
- Lin, Y.H., Batta, R., Rogerson, P. A., Blatt, A., & Flanigan, M. (2011).² A logistics model for emergency supply of critical items in the aftermath of a disaster. *Socio-Economic Planning Sciences* 45(4), 132-145.
- Sahay, B.S., Menon, V.C., and Gupta, S. (2016).⁵ Humanitarian logistics and disaster management: the role of different stakeholders, in Sahay, B.S., Gupta, S., and Menon, V.C. (ed), *Managing Humanitarian Logistics*, Springer, India.

- | Shaluf, I.M. (2007).⁵ An overview on disasters. *Disaster Prevention and Management: An International Journal*, Vol. 16 (5), 687-703
- | Perez-Galarce, F., Canales, L.J., Vergara, C. and Candia-Vejar, A. (2017).⁵ An optimization model for the location of disaster refuges. *Socio-Economic Planning Sciences* Vol. 59, 56-66
- | Van Rossum, J. and Krukkert, R. (2010).⁵ Disaster management in Indonesia : logistical coordination and cooperation to create effective relief operations. *Jurnal Teknik Industri* Vol. 12(1), 25-32
- | Winston, W.L. (2004).⁵ *Operations research applications and algorithms*, 4th Edition. Thomson Learning, Inc., Canada.