Proceedings of 7th International Conference on Industrial, Mechanical, Electrical and Chemical Engineering 2021 (ICIMECE 2021)

Editors • Mujtahid Kaavessina, Anatta Wahyu Budiman, Muhammad Hamka Ibrahim, Muhammad Hisjam, Aditya Rio Prabowo, Endah Retno Dyartanti and Subuh Pramono

icimece ⌬ 2021

Issues

PRELIMINARY

Preface: International Conference on Industrial, Mechanical, Electrical and Chemical Engineering 2021 (ICIMECE 2021)

View article   🗎 PDF

INVITED PAPER

Emerging post-lithium batteries: Opportunities in Indonesia

Muhammad Hilmy Alfaruqi

Abstract ▾   View article   🗎 PDF

CONTRIBUTED ORAL PAPER

Modeling of a pellet biomass furnace of 200 kW

Tito Gusti Nurrohim; Suyitno; Rizqi Abdul Rahman; Heru Sutanto; Mohamad Muqoffa

Abstract ▾   View article   🗎 PDF

Lithium-ion cylinder battery power cooling: A review

Zeluyvenca Avista; Ubaidillah; Indri Yaningsih; Aditya Rio Prabowo

Abstract ▾   View article   🗎 PDF

Automation and monitoring system of drying parameters in cabinet dryer using Arduino (temperature and humidity)

Ari Rahayuningtyas; Diang Sagita; Novita Dwi Susanti

Abstract ▾   View article   🗎 PDF

Preliminary experiment of *Saccharomyces cerevisiae* immobilization using method of in situ flocculation

Aswandi Asmadi; Mujtahid Kaavessina; Margono

Abstract ▾   View article   🗎 PDF

Effect of injection molding processing parameters on tensile properties of recycled polypropylene based composites reinforced with bamboo fibers

Govinda; Indah Widiastuti

Abstract ▾   View article   🗎 PDF

Effect of bamboo fiber alkalization treatment on water sorption characteristics and mechanical properties of recycled polypropylene-bamboo composites

Mohammad Khoirul Huda; Indah Widiastuti

Abstract ▾   View article   🗎 PDF

Review: Recent developments in the design and application of magnetorheological fluids in the medical field

Agus Lutanto; Ubaidillah; Aditya Rio Prabowo; Fitrian Imaduddin; Dimas Adiputra

Abstract ▾   View article   🗎 PDF

Preliminary design for manufacturing and assembling bread dough mixer machine

Catur Harsito; Anugrah Akbar; Ari Prasetyo; Teguh Triyono; Budi Santoso

Abstract ▾   View article   🗎 PDF

The effect of health warning labels on intention to repurchase cigarettes in Surakarta city using structural equation model method

Bagus Muchlis Putra; Lobes Herdiman; Susy Sumartini; Taufiq Rochman

Abstract ⌄ | View article | 🔃 PDF

Access point configuration on Internet of Things with bootstrap WiFi networking Raspberry Pi

Yustina Tritularsih; Hoedi Prasetyo; Fenty Pandansari

Abstract ⌄ | View article | 🔃 PDF

Regional innovation driving factors model (Cianjur Regency)

Anita Ilmaniati; Isma Masrofah

Abstract ⌄ | View article | 🔃 PDF

Integration AHP and MOORA for sustainable supplier selection during the COVID-19 pandemic era: A case study

Muhammad Faisal Ibrahim; Tara Laurensia; Dana Marsetiya Utama

Abstract ⌄ | View article | 🔃 PDF

The effect of quenching agents at T6 heat treatment on hardness Al6061-sea sand composite

Hafidh Rawi Mufti; Hammar Ilham Akbar; Eko Surojo; Wibowo; Teguh Triyono; Sukmaji Indro Cahyono; Nurul Muhayat; Triyono

Abstract ⌄ | View article | 🔃 PDF

Assistive technology on the SS1-V1 weapon stock to support shooting stability for DEPOHAR 50 - TNI AU

Langgeng Andy Setiawan; Susy Susmartini; Lobes Herdiman

Abstract ⌄ | View article | 🔃 PDF

Li-ion batteries as energy storage for solar power plant

Muhammad Nur Ikhsanudin; Maudy Pratiwi Novia Matovanni; Rizky Ibnufaatih Arvianto; Sunu Herwi Pranolo; Agus Purwanto; Joko Waluyo

Abstract ⌄ | View article | 🔃 PDF

Comparison of the production of dimethyl ether (DME) from lignite coal and biomass as energy sources to substitute LPG: A case study in Indonesia

Rizky Ibnufaatih Arvianto; Muhammad Nur Ikhsanudin; Maudy Pratiwi Novia Matovanni; Anatta Wahyu Budiman; Sunu Herwi Pranolo; Joko Waluyo

Abstract ⌄ | View article | 🔃 PDF

The thermophysical properties, configurations and applications of nanofluids on solar PV/T system: A review

Nuha Khairunnisa; Zainal Arifin; Budi Kristiawan; Mohd Afzanizam Mohd Rosli

Abstract ⌄ | View article | 🔃 PDF

The gravitational water vortex turbine: A review and application development

Rieky Handoko; Syamsul Hadi; D. Danardono Dwi P.T.; Ari Prasetyo

Abstract ⌄ | View article | 🔃 PDF

Selection of materials for the prosthetic liner using coconut water composite as a substitute for EVA

Arung Sasmaya Bahari; R. Hari Setyanto; Lobes Herdiman

Abstract ⌄ | View article | 🔃 PDF

Characteristic of the UAV structural design and platform in military-use environment: State and development

Annas Isman Saputro; Aditya Rio Prabowo; D. Danardono Dwi Prija Tjahjana; Ristiyanto Adiputra; Hari Nubli

Abstract ⌄ | View article | 🔃 PDF

Multicriteria optimization of 3D printed flow restrictor using Taguchi method and PCR-TOPSIS for dimensional accuracy and printing duration

Virsha Alviasha; Joko Triyono; Eko Pujianto

Abstract ⌄   View article   📄 PDF

Manufacturing green hybrid new material made from bagasse, rice husk ash and reinforced glutinous glue as noise absorption

Lobes Herdiman; R. Hari Setyanto; Susy Susmartini; Taufiq Rohman

Abstract ⌄   View article   📄 PDF

Power efficiency analysis by using UBEC for prosthetic hand ⌂

Agung Dwicahyo; Lobes Herdiman; Susy Susmartini

Abstract ⌄   View article   📄 PDF

Implementation of lean six sigma reducing E-DOWNTIME waste proposed improvement of flooring board production at PT. LBB

Rut Yolanda Karfisa Br Lumbanraja; Fakhrina Fahm; Eko Pujiyanto

Abstract ⌄   View article   📄 PDF

Formulating strategic purchasing strategy: A case study

Hery Suliantoro; Drajat A. Dilaga; M. Mujiya Ulkhaq

Abstract ⌄   View article   📄 PDF

Implementation of fluid-structure interaction (FSI) in marine design: Calculation review on hull structures

Rizky Adhi Febrianto; Syamsul Hadi; Raymundus Lulus L. G. Hidayat; Dong Myung Bae; Bo Cao; Aditya Rio Prabowo

Abstract ⌄   View article   📄 PDF

Synthesis of superabsorbent (hydrogel) based on banana peel cellulose-acrylamide-carrageenan with microwave grafting method

Sperisa Distantina; Ivan Satritama; Verania Arneta Putri; Ghea Safiraventa Anggreini

Abstract ⌄   View article   📄 PDF

Rice husks and bagasse as composite materials characterized by heat resistance

Larasati Sekar Palupi; Susy Susmartini; R Hari Setyanto

Abstract ⌄   View article   📄 PDF

Development of ceramic jewellery industry in the form of necklaces with Indonesian batik motifs

T. Yuniarto; P. W. Anggoro; B. Bawono; P. K. Fergiawan; A. P. Bayuseno; J. Jamari

Abstract ⌄   View article   📄 PDF

Failure analysis: Hardness and stress study of failed IC engine rocker arms

Aprianur Fajri; Nurul Muhayat; Aditya Rio Prabowo; Fitrian Imaduddin; D. Danardono Dwi Prija T.; Ari Prasetyo; Yemi Kuswardi; Jung Min Sohn; Dharu Feby Smaradhana

Abstract ⌄   View article   📄 PDF

A critical review on structural testing and assessment of lightweight sandwich structure for ship structure application

Tuswan Tuswan; Abdi Ismail; Achmad Zubaydi; Bambang Piscesa; Nadya Paramita Langening Sukma Sukma

Abstract ⌄   View article   📄 PDF

Assessment of debonding failures in the sandwich plate of stern ramp door of ferry Ro-Ro using k-nearest neighbor algorithm

Safri Adam; Tuswan Tuswan; Abdi Ismail; Achmad Zubaydi; Bambang Piscesa; Aditya Rio Prabowo

Abstract ⌄   View article   ⬚ PDF

Conceptual design and performance evaluation of COVID-19 vessel for public health service in Indonesia's remote Island

Tuswan Tuswan; Saefulloh Misbahudin; Adi Widianto; Mahendra Guna Satriananta; Rayhan Satria Dwinata; Abdi Ismail; Muhammad Luqman Hakim; Good Rindo; Aditya Rio Prabowo; Teguh Putranto

Abstract ⌄   View article   ⬚ PDF

Design of work aids on temporary storage stations based on Karakuri Kaizen principles (case study: Industri Tahu Sari Murni)

Ricky Aziz Febrianto; Eko Liquiddanu; Rahmaniyah Dwi Astuti

Abstract ⌄   View article   ⬚ PDF

Warehouse design under class-based storage policy based on entry-item-quantity analysis: A case study

Sekarsari Utami Wijaya; Rahayu Johanna; , Muhammad Faisal Ibrahim

Abstract ⌄   View article   ⬚ PDF

Microwave-assisted in synthesis of cassava bagasse-acrylamide-carrageenan bead gel

Sperisa Distantina; Widya Nur Ramadhani; Dimas Rizqi Damarjati Listyono; Nurul Hidayatun

Abstract ⌄   View article   ⬚ PDF

Study of middle interceptor implementation on patrol boat

Samuel; Aji Setiawan; Eko Sasmito Hadi; Muhammad Iqbal; Parlindungan Manik

Abstract ⌄   View article   ⬚ PDF

Simulation computational fluid dynamics: The effect of adding rear wing airfoil Eppler 423 Gurney flap on speed and pressure distribution value

D. D. P. Tjahjana; B. Kristiawan; Suyitno; W. E. Juwana; R. A. Rachmanto; C. H. Brilianto; S. D. Prasetyo; A. F. Muhammad; Z. Arifin

Abstract ⌄   View article   ⬚ PDF

New operating mode of magnetorheological fluids (MRFs) simulation studies with finite element methods for magnetics (FEMM)

Purwadi Joko Widodo; Eko Prasetya Budiana; Ubaidillah; Fitrian Imaduddin

Abstract ⌄   View article   ⬚ PDF

CFD-based analysis of an accidental jet-fire release on LNG bunkering vessel

Haris Nubli; Jung Min Sohn

Abstract ⌄   View article   ⬚ PDF

IoT based early warning system of landslide and flood disasters

Hanifah Yulia; Subuh Pramono; Sutrisno; B. D. Jati

Abstract ⌄   View article   ⬚ PDF

Wind energy in Tanzania: Turbines classification and territory status review

Enock Michael; Dominicus Danardono Dwi Prija Tjahajana; Aditya Rio Prabowo; Ristiyanto Adiputra

Abstract ⌄   View article   ⬚ PDF

Performance comparison of position and swing angle control system on a gantry crane

Anis Tri Hayati; Fitrian Imaduddin; Ubaidillah; Budi Santoso; R. Lullus Lambang G.H.

Abstract ⌄   View article   ⬚ PDF

Identification of design requirements for noodles untangling and cutting machines on non-wheat noodle production line: A QFD approach

Novrinaldi; A. Haryanto; U. Hanifah; M. A. Karim; S. A. Putra; E. K. Pramono; A. Sitorus; N. K. I. Mayasti

Abstract ∨ · · · View article · · · PDF

Measuring user experience of a decision support system for operating room scheduling using the user experience questionnaire

Pasca Purwoko; Yusuf Priyandari; Cucuk Nur Rosyidi

Abstract ∨ · · · View article · · · PDF

Mathematical modeling of fluidized bed drying kinetics of unhulled rice in a swirling fluidized bed dryer with bed ratio 1.25

Novrinaldi; S. A. Putra; A. Sitorus

Abstract ∨ · · · View article · · · PDF

The effect of adding heatsink cooling with concentrator on increasing photovoltaic performance

Z. Arifin; M. L. Baharuddin; W. E. Juwana; Suyitno; D. D. D. P. Tjahjana; M. Muqoffa; S. D. Prasetyo

Abstract ∨ · · · View article · · · PDF

Effect of addition of emulsifier Tween 20 on microencapsulation rice bran oil using natural polymers kappa-carrageenan and chitosan

Fadilah; Ari Diana Susanti; Sperisa Distantina; Viona Rohmah Armia Gita Kusuma; Gemilang Ramadhan Syahputraningrat

Abstract ∨ · · · View article · · · PDF

Low-density parity-check codes (LDPC) 5G -new radio (NR) performance using modified min-sum decoding algorithm

Eni Wardihani; Syrico A. Setyawan; Muhammad Mukhlisin

Abstract ∨ · · · View article · · · PDF

Analysis of gear fault based on acoustic signal and least square support vector machine

Didik Djoko Susilo; Achmad Widodo; Toni Prahasto; Muhammad Nizam

Abstract ∨ · · · View article · · · PDF

Natural weathering on recycled polypropylene-bamboo fiber composites

Arianti Ramadhani; Indah Widiastuti

Abstract ∨ · · · View article · · · PDF

Low cost three-phase electrical power quality analyzer system using PC-based USB DAQ

Latif Nur Fauzi; Muhammad Hamka Ibrahim; Muhammad Nizam

Abstract ∨ · · · View article · · · PDF

The optimization of polytetrafluoroethylene (PTFE) cutting parameters for minimizing energy consumption in CNC turning of using Taguchi method

Suwondo Adi Saputro; Cucuk Nur Rosyidi; Eko Pujiyanto

Abstract ∨ · · · View article · · · PDF

The effect of volume, ball diameter, and milling time through the ball mill process of corncob

Rusdi Nur; Ahmad Nurul Muttaqin; Baso Nasrullah; Dermawan

Abstract ∨ · · · View article · · · PDF

Design and analysis of ozone monitoring system produced by plasma corona discharge for disinfectant

Ivan Robi Septian; Miftahul Anwar; M. Maulana Yusuf; Riski Rama Kusuma; Teguh Endah Saraswati; Meiyanto Eko Sulistyo; Feri Adriyanto; Fandi Surya Adinata

Abstract ∨   View article   ⬇ PDF

Detection of product container defect using automatic visual inspection: System design and performance evaluation

Muhammad Hamka Ibrahim; Hari Maghfiroh; Agus Ramelan; Subuh Pramono; Cucuk Nur Rosyidi

Abstract ∨   View article   ⬇ PDF

Economic dispatch optimization using Lagrange multipliers as merit order strategy for thermal power plant in Java and Sumatra

Henry Pariaman; Gita Maya Luciana; Muhammad Hisjam

Abstract ∨   View article   ⬇ PDF

Dynamic analysis of different fenestration design in artificial hip joint using finite element analysis

Ikhsan; Triyono J.; A. R. Prabowo; Jung Min Sohn

Abstract ∨   View article   ⬇ PDF

Experimental study of an EAHE combined with a solar collector and a solar panel

S. H. S. Surbakti; T. B. Sitorus; J. S. Purba; W. O. D. Hutabarat; G. J. Yudha

Abstract ∨   View article   ⬇ PDF

Study on EAHE system combined with several components in the Medan city

J. S. Purba; T. B. Sitorus; S. H. S. Surbakti; W. O. D. Hutabarat; G. J. Yudha

Abstract ∨   View article   ⬇ PDF

The performance of an earth-air heat exchanger by using a solar chimney

G. J. Saragi; T. B. Sitorus; W. O. D. Hutabarat; S. H. S. Surbakti; J. S. Purba

Abstract ∨   View article   ⬇ PDF

Workload analysis of non-wheat noodle production with standard time approach (case study: Youngster SME, Subang West Java, Indonesia)

N. K. I. Mayasti; A. Haryanto; U. Hanifah; R. Kumalasari; M. A. Karim; Novrinaldi; S. A. Putra; E. K. Pramono; A. Sitorus

Abstract ∨   View article   ⬇ PDF

Demographic and behaviour clustering on chicken meat's seller using K-means method

Harwati; A. M. S. Asih; B. M. Sopha

Abstract ∨   View article   ⬇ PDF

Residual ultimate strength formulations of submarine pressure hull subjected to collisions of attendant vessels or floating objects

Quang Thang Do

Abstract ∨   View article   ⬇ PDF

Integration of yeast cells flocculation with continuous ethanol fermentation using laboratory scale of integrated aerobic anaerobic baffled reactor

Leader Firstandika; Margono; Mujtahid Kaavessina

Abstract ∨   View article   ⬇ PDF

Rattan as an alternative material for elementary school furniture to support active learning

Ratriana Aminy; Prima Adhi Kusuma; Cucuk Nur Rasyidi; Lulu Purwaningrum

Abstract ∨   View article   ⬇ PDF

Numerical approach of TiO$_2$ and CNT nanofluids flowing in circular, rectangular, and triangular tubes

Bayu Sutanto; Budi Kristiawan; Indri Yaningsih; Agung Tri Wijayanta; Takahiko Miyazaki

Abstract ∨   View article   🗎 PDF

Pilot scale production of digested cow manure bio-pellet for alternative fuel

Paryanto; Joko Waluyo; Anwar Saputro; Margono; Sunu Herwi Pranolo; Ari Diana Susanti; Bregas S. T. Sembodo; Prabang Setyono

Abstract ∨   View article   🗎 PDF

Parameter optimization of FDM type 3D printing against dimensional accuracy with recycled filament plastic LDPE (low density polyethylene)

Tri Hannanto Saputra; Adhi Setya Hutama; Ana Ningsih; Herda Agus Pamasaria

Abstract ∨   View article   🗎 PDF

The effect of furniture type and working position when drawing with laptop on musculoskeletal pain among students and the desk design strategy

Dian Moneta; Lu'lu' Purwaningrum

Abstract ∨   View article   🗎 PDF

Recent progress on geometrical and stress concentration characterization of welded joints ∂

Moritz Braun

Abstract ∨   View article   🗎 PDF

Simulation of a two-dimensional ice crushing processes with the Mohr-Coulomb nodal split model

Hauke Herrnring; Moritz Braun

Abstract ∨   View article   🗎 PDF

A cooperative manufacturer-retailer inventory model with carbon tax regulation, imperfect production, and rework

Wakhid Ahmad Jauhari; I. Nyoman Pujawan; Mokh Suef

Abstract ∨   View article   🗎 PDF

Iron-loaded activated carbon as a tar cracking/reforming catalyst in the production of clean producer gas from oil palm biomass

Syed Shatir A. Syed-Hassan; Nur Hanina Malek; Rusmi Alias

Abstract ∨   View article   🗎 PDF

Designing an e-commerce success factor model based on inputs from practitioners and entrepreneurs to evaluate the e-commerce website (a case study: Magetan leather crafts SMEs)

Arga Seta Asmara Sakti; Eko Liquiddanu

Abstract ∨   View article   🗎 PDF

An operational model design of leather bag consumer needs to increase the sales of leather bag products (a case study of Magetan leather industry)

Her Tafga Arfanindita; Eko Liquiddanu

Abstract ∨   View article   🗎 PDF

Resistant starch type-3 (RS-3) production from cassava starch with high rotational speed of rotor-stator mixer

Sumarno; Prida Novarita Trisanti; Bramantyo Airlangga; Abissantun Priyambodo; Aditya Rachman Ganimeda

Abstract ∨   View article   🗎 PDF

Biodelignification of sengon wood using trametes versicolor

Prida Novarita Trisanti; Ferdi Saepulah; Filo Sofia Kamila Mukmin; Sumarno Sumarno

Abstract ⌄ | View article | 🗋 PDF

The influence of mixing on electrocoagulation performance during soy sauce wastewater treatment

F. A. Nugroho; P. T. P Aryanti; A. A. Dania; F. F. Sari

Abstract ⌄ | View article | 🗋 PDF

Multi-response optimization in injection molding process of PLA bone screw using Taguchi method and response surface methodology

Rizca Tri Wulandari; Joko Triyono; Eko Pujiyanto

Abstract ⌄ | View article | 🗋 PDF

Warehouse design under class-based storage policy based on entry-item-quantity analysis: A case study

Sekarsari Utami Wijaya ✉; Rahayu Johanna; , Muhammad Faisal Ibrahim

Check for updates

View Online   Export Citation   CrossMark

Articles You May Be Interested In

Data warehousing in the business intelligence

AIP Conference Proceedings (September 2022)

Real-time data integration in smart warehouse as a contemporary approach

AIP Conference Proceedings (April 2023)

Warehouse layout design with class-based storage approach to minimize material transfer distance

AIP Conference Proceedings (February 2023)

Warehouse Design under Class-Based Storage Policy Based on Entry-Item-Quantity Analysis: A Case Study

Sekarsari Utami Wijaya[a], Rahayu Johanna[b] , Muhammad Faisal Ibrahim[c]

Department of Logistics Engineering, Universitas Internasional Semen Indonesia, Gresik, Indonesia

[a] Corresponding author: sekarsari.wijaya@uisi.ac.id
[b] rahayu.johanna17@student.uisi.ac.id
[c] muhammad.ibrahim@uisi.ac.id

Abstract. In an effort to minimize the impact of unpredictable demand, the company will make an inventory policy. The warehouse as a place for storing goods before being distributed to consumers has an essential role in ensuring supply sustainability in the supply chain system. Many problems occur in the warehouse which causes a decrease in warehouse performance which has an impact on the company's operations. One of the things that play an essential role in increasing the efficiency of warehouse operations is the warehouse layout design. Class-based storage policies are used to regulate the procedures for storing goods into 3 classifications. Classification is obtained based on Pareto's law by considering the level of storage and retrieval activity. Entry-Item-Quantity (EIQ) analysis is an analysis that involves three main factors of logistics distribution, namely, E (Order Entry), I (Item), and Q (Quantity) which is applied to further analyze frequently ordered products, so that it can support the layout warehouse. UD. XYZ is a distributor that sells many kinds of materials for roofs. This study considers determining the number of racks needed by Entry Item Quantity-Class Based Storage analysis. Furthermore, this study will compare the warehouse layout based on IK, IQ, EN, and EQ. It aims to obtain the best improvement in the warehouse layout that has the smallest expected distance. Based on the analysis that has been done, the warehouse shall provide 14 type 1 racks and 13 type 2 racks. The smallest expected distance, the best warehouse layout design. IQ analysis results in the best warehouse layout design.

Keywords: Class-Based Storage analysis, EIQ analysis, EQ analysis, warehouse.

INTRODUCTION

In practice, every trade tends to have a whole uncertainty about demand. It has encouraged the traders to make policies about the inventory system. Its aims to anticipated unpredictable demand. The policy about inventory systems prompts traders to provide a facility that will be used for a warehouse for storing goods. A warehouse is a facility used as a temporary storage place for goods before being distributed to end consumers. These goods can be raw materials, work in process, and or finished goods. Warehouses play an important role in maintaining the suitability of supply to demand in the supply chain system [1]. Some of the problems that often occur in warehouses include difficulty in moving goods, accumulation of goods, long searching for goods, and lack of capacity. Moving goods that spend a lot of time causing high costs in material handling. Delays occur due to the length of time it takes to search for items. In addition, the pile of goods that are too high makes it difficult to withdraw goods. Warehouse layout is one of the things that affect the efficiency and effectiveness of the warehouse. The appropriate warehouse layout design will play a role in increasing operating efficiency [2].

Class-based storage policies are usually used to regulate goods storage procedures that divide goods into three classes, namely classes A, B, and C [3]. Its classifications are based on the law of Pareto by considering storage and retrieval (S/R) activity rate. This method produces a layout design for the storage area of all kinds of goods based on

their class. Racks are designed to increase storage capacity, the displacement of workers, and retrieval system goods. It is also designed to minimize the distance traveled workers as possible.

Entry-Item-Quantity (EIQ) analysis is applied to further analyze frequently ordered products, so that it can support the distribution center layout. According to [4], EIQ is an analysis involving three main logistics distribution factors namely, E (Order Entry), I (Item), and Q (Quantity). This analysis proposes the improvement of warehouse layout design based on IK (items by order number) is the order frequency of product items purchased by the seller. IQ (Item Quantity) is the number of each kind of goods ordered and purchased by the seller. EN (Entry Quantity) is the number of items purchased by the customer. EQ (Entry Quantity) is the order quantity of customer [5]. EIQ can determine the amount of the rack used in the improved layout of the warehouse by Class-Based Storage.

Previous research about Class-Based Storage with Entry Item Quantity Analysis was conducted by [6]. The differences between previous research and this research is the design of racks. On previous research, a type 1 rack was designed consisting of 2 the level. First level was to utilize pallet wheeled furnished with a brace or lock the wheels and second level used steel as material for making store shelves. Whereas, this experimental design a rack type 1 designed consisting of 2 levels. All of levels use steel materials for making store shelves. Another research that used Class-Based Storage with Entry Item Quantity Analysis is[4]. This difference between two research studies is characteristic goods. According to research by [4], characteristic goods were cigarettes that are distributed to local distributors. Whereas, characteristic goods of this paper is materials for roofs. So, the novelty of this article is about the design of rancks and characteristics of goods.

UD. XZY is a distributor that sells many kinds of materials for roofs. The materials are consist of roofs, tin roof, asbestos roof, roof ridge cap, galvalume roof, and spandex roof. Several problems that were already described had also occurred in this distributor. This study considers determining the number of racks needed by Entry-Item Quantity-Class Based Storage analysis. Furthermore, this study will compare the warehouse layout based on IK, IQ, EN, and EQ. It aims to obtain the best improvement in the warehouse layout that has the smallest expected distance for UD. XYZ.

METHODS

In general, there are five steps to determine the number of racks and the best layout of the warehouse. First, classify goods using the Class-Based Storage method based on IK, IQ, EN, and EQ. The threshold for determining the ABC split is close to 20%, 30%, and 50% of the cumulative percentage of goods ordered. Calculation of the Class-Based Storage as follows: sort the data IK/IQ/EN/EQ from largest to smallest, calculate the cumulative frequency of data IK/IQ/EN/EQ, calculate the percentage of cumulative frequency, and classify the type of goods into A, B, or C class based on threshold determined before. Second, design shelving storage racks. Design storage racks are depended on the heavy and dimensions of goods, the high and wide of the level. Third, calculate the number of racks as storage. Racks are used to store the equipment in the warehouse. This study uses two types of racks, namely, type 1 racks and type 2 racks.

Figure 1 shown the type 1 racks; the rack is used to store roof and roof ridge cap. Type 2 racks are used to store tin roof, asbestos roof, galvalume roof, and spandex roof, shown in Figure 2. To determine how many racks are needed, it can be obtained by calculating the average of recorded stock of goods each day. Then, divide the average of the recorded stock each day by rack capacity.
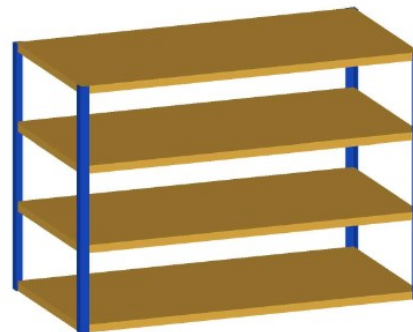

FIGURE 1. Type 1 Racks

FIGURE 2. Type 2 Racks

Fourth, design warehouse layout by racking systems. Design layout warehouse is adapted to reflect the shelf space defined in the previous step. Last, calculate the expected distance. According to [7], expected distance is the distance that is expected from storage to entry points and freight out of goods. The expected distance for the entire picking path can be calculated by first finding the probability of entering a node and multiplying it by the probability of each arc going out of the node and the distance along the arc [7]. Distance calculation uses Euclidean Distance. The formula is as follow:

$$d_{ij} = \sqrt{\left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2} \tag{1}$$

where
x_i = x coordinate of the i-th center of facility
x_j = x coordinate of the j-th center of facility
y_i = y coordinate of the i-th center of facility
y_j = y coordinate of the j-th center of facility
d_{ij} = distance between the i-th and j-th center of facility
The best warehouse layout design between IK, IQ, EN, and EQ has a minimum expected distance value.

RESULTS AND DISCUSSION

The total size of UD. XYZ warehouse about 260 m^2. Its length is about 20 m^2 and its width about 13 m^2. Only 110 m^2 of total warehouse size is used to store the materials. The existing warehouse layout design shown in Figure 3 does not consider the distance between the aisle in every location of materials.
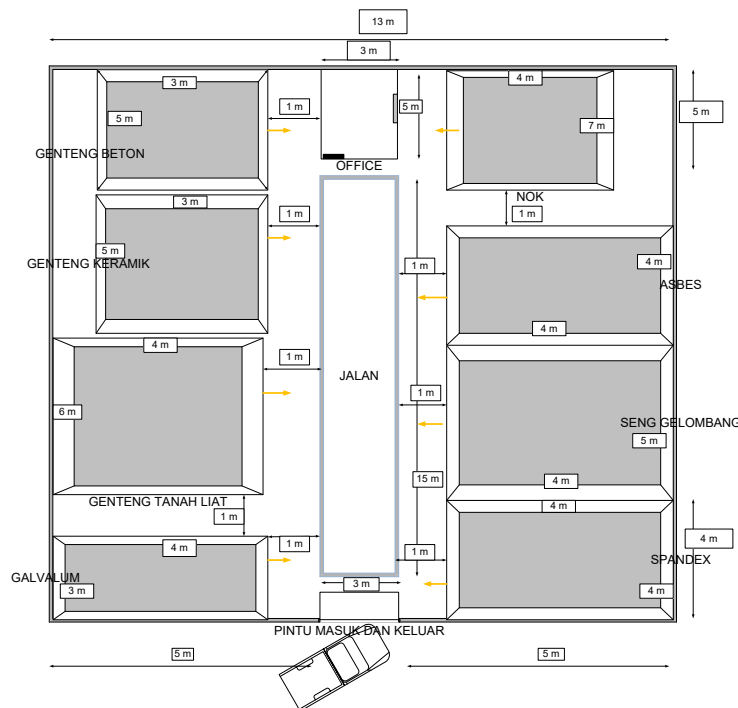

FIGURE 3. The Existing Warehouse Layout UD. XYZ

The IK, IQ, EN, EQ, and stock of materials data are collected. Data is collected for six months (November 2020 until April 2021). The four alternative EIQ (IK, IQ, EN, EQ) data is used to classify the Class-Based Storage method. Table 1 shows the result of EIQ data processing approached Class-Based Storage method. The number of materials ordered in class A is the smallest because the proportion of class A about 1% - 20% of accumulated percentage. The highest number of material ordered is in class C because the proportion of class C about the smallest 50% - 100% of accumulated percentage. Class A materials shall be stored in racks near from access door, class B materials shall be stored in racks between class A and class C, and class C materials shall be stored in the common racks due to weak flexibility. This result is suitable as study conducted by [5], the storage position for goods provided for small retailers

shall be arraged in accordance with the result of the ABC classification. Class A products (1% - 20% of accumulated item percentage) shall be stored in the automatic stereoscopic shelves owing to high values and strong flexibility, class C products (20% - 50% of accumulated item percentage) shall be stored in the common shelves due to weak flexibility, and class B products (50% - 100% of accumulated item percentage) shall be jointly stored in the automatic stereoscopic shelves with class A product.

TABLE 1. The Result of Classification EIQ Calculated by Class Based Stroge Method

Classi-fication	IK		IQ		EN		EQ	
	Quantity	Category	Quantity	Category	Quantity	Category	Quantity	Category
A-class	109	7	244.500	6	95	7	102.057	6
B-class	166	12	417.600	13	142	12	158.573	12
C-class	288	30	645.871	30	228	30	272.241	31
Total	**554**	**48**	**1.307.971**	**49**	**465**	**49**	**532.871**	**49**

The materials in the warehouse will be stored in racks based on the Class-Based Storage method. The stock of materials is used to determine the number of racks. According to the IK and EN calculation, the warehouse shall provide 14 type 1 racks and 16 type 2 racks. The area is needed about 49,88 m^2. Meanwhile according to the IQ and EQ calculation, the warehouse shall provide 14 type 1 racks and 13 type 2 racks. The area is needed about 45,46 m^2. the total area of UD. XYZ about 260 m^2 (**Table 2**). The area owned UD. XYZ can provide the area required.

TABLE 2. The Number of Racks and Spaces Needed

| Type of Rack	Materials	The Number of Levels	The Height between Levels (m)	Capacity (unit)	The Number of Racks	The Dimensions (m^2)	The Space Needed (m^2)
			IK and EN Analysis				
Type 1	Roof and roof ridge cap	2	1	450	14	1x1=1	14
Type 2	Tin roof, asbestos roof, galvalume roof, and spandex roof	3	0,5	100	16	2,2 x 1,1= 2,42	38,72
	Total				**30**		**49,88**
			IQ and EQ Analysis				
Type 1	Roof and roof ridge cap	2	1	450	14	1x1=1	14
Type 2	Tin roof, asbestos roof, galvalume roof, and spandex roof	3	0,5	100	13	2,2x1,1=2,42	31,46
	Total				**30**		**45,46**

According to EIQ analysis, four warehouse layout designs are proposed based on IK, IQ, EN, and IQ. The racks are laid under the quantities required. The materials are also stored in accordance with the result of EIQ-Class-Based Storage analysis (**Fig. 4**).

The in and out materials data are used for performing calculations on the probability expected distance. Expected distances are calculated by multiplicating the probability of the materials movement from rack to access door and the total distance of the materials movement from rack to access door. Expected distance conducted adapted to the layout of already made from the analysis entry items quantity. So, there is four value of expected distance (**Table 3**). The in and out total distances are same because there is only one access door to in and out the materials. The highest expected distance, the worst warehouse layout design. EN analysis result the worst warehouse layout design because the total
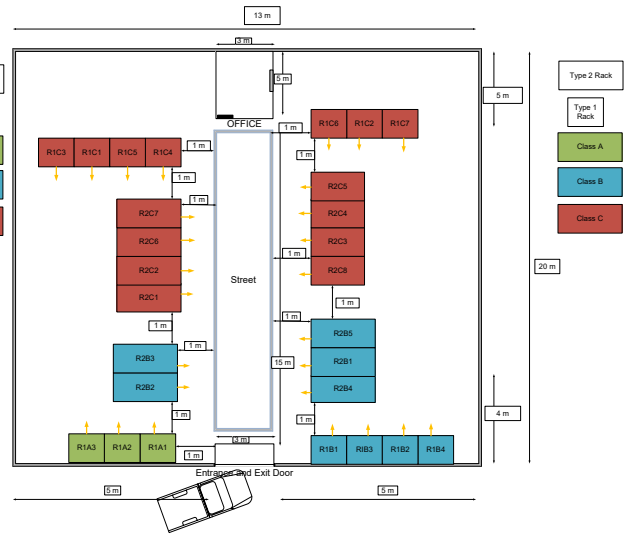
expected distance is about 138,32. The smallest expected distance, the best warehouse layout design. EQ analysis results in the best warehouse layout design. The nearest expected distance can affect the time for material handling. The material handling in IQ's layout design is more effective than others ad also it can affect the costs. It's cost will be more efficient than others. So that, the warehouse layout design proposed to UD. XYZ is the IQ analysis warehouse layout design.
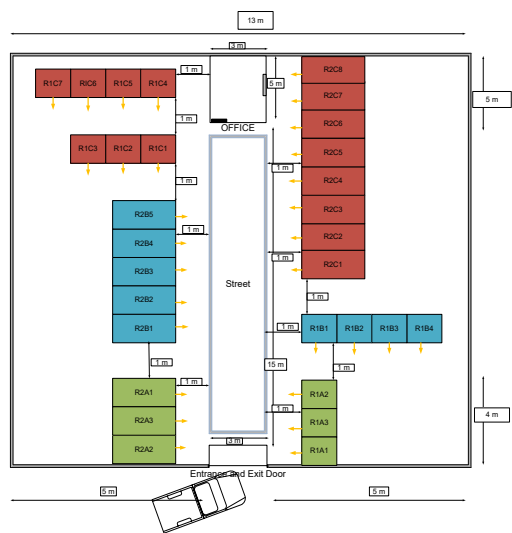
TABLE 3. The Expected Distance

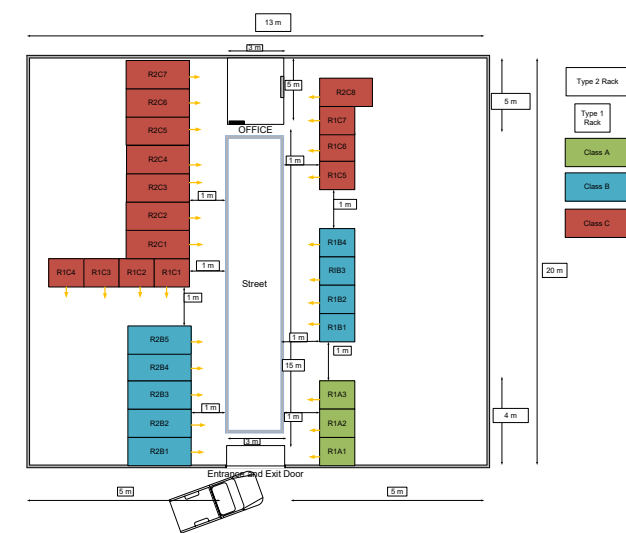| EIQ Analysis	The In Distance (in meter)	The Out Distance (in meter)	Total Expected Distance (in meter)
Existing	196,01	196,01	196,01
IK	174,96	174,96	174,96
IQ	138,32	138,32	138,32
EN	175,84	175,84	175,84
EQ	143,92	143,92	143,92
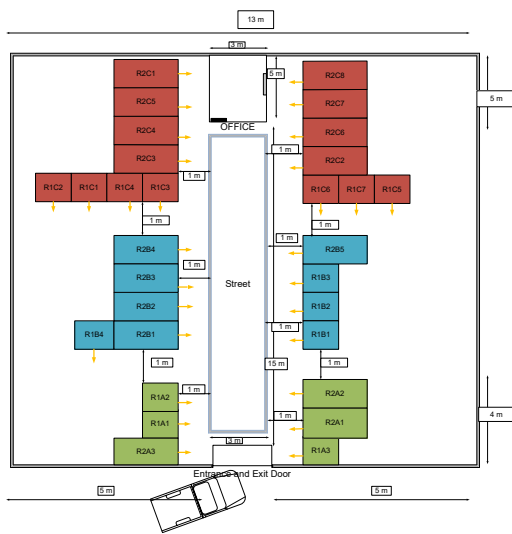
IK Analysis

IQ Analysis

EN Analysis

EQ Analysis

FIGURE 4. The Warehouse Layout Design

CONCLUSIONS

Warehouse storage is an essential step in the logistics process, which directly reflects the status of the material before and in circulation and serves as the basis for the company in evaluating the materials' production and sales. Based on the analysis that has been done, the warehouse shall provide 14 type 1 racks and 13 type 2 racks. The smallest expected distance, the best warehouse layout design. IQ analysis results in the best warehouse layout design. So that, the warehouse layout design proposed to UD. XYZ is the IQ analysis warehouse layout design.

The weakness of this research is the racks only have two levels on type 1 racks and three levels on type 2 racks. Recommendations for the further research are examining what happens if the type 1 racks can be broken up into three or more partitions and the type 2 racks broken up into four or more partitions with the stonger material of racks to improve the distance estimate and increase the capacity of warehouse. Finally, the next research also try to build a simulation model to gain more insights and validate the expected distance calculations.

ACKNOWLEDGMENTS

REFERENCES

[1]   R. B. M. De Koster, A. L. Johnson, and D. Roy, "Warehouse design and management," ed: Taylor & Francis, 2017.

[2]   F. Yener and H. R. Yazgan, "Optimal warehouse design: Literature review and case study application," *Computers & Industrial Engineering,* vol. 129, pp. 1-13, 2019/03/01/ 2019.

[3]   M. Schenone, G. Mangano, S. Grimaldi, A. C. J. P. Cagliano, and M. Research, "An approach for computing AS/R systems travel times in a class-based storage configuration," vol. 8, no. 1, pp. 273-290, 2020.

[4]   Y. Zhao, Y. Shi, and H. Karimi, "Entry-Item-Quantity-ABC Analysis-Based Multitype Cigarette Fast Sorting System," *Mathematical Problems in Engineering,* vol. 2012, 11/21 2012.

[5]   C.-K. Kao, G.-X. Xu, X.-E. Fang, and M.-C. Zheng, "Case Study of building Storage Strategy in the Logistics Distribution Center—Logistics Company A as an Example," *European Journal of Engineering Research and Science,* vol. 3, p. 40, 04/24 2018.

[6]   N. Setiawan, F. Setiawan, Y. Herawati, "Usulan Perbaikan Tata Letak Gudang Barang Jadi PT X Menggunakan Class-Based Storage Berdasarkan Analisis Entry Item Quantity (EIQ)", 2018.

[7]   U. Venkatadri and S. Kubasad, "Estimating Travel Distances and Optimizing Product Placement for Dedicated Warehouses with Manual Picking," 2012.

CERTIFICATE

This is to certify that

Warehouse Design under Class-Based Storage Policy Based on Entry-Item-Quantity Analysis: A Case Study

has been presented by

Sekarsari Utami Wijaya, Rahayu Johanna, Muhammad Faisal Ibrahim

In **The 7th International Conference on Industrial, Mechanical, Electrical and Chemical Engineering (ICIMECE 2021)**

Surakarta, Indonesia on October 5th ,2021

Chairman

Mujtahid Kaavessina, Ph.D.