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**Document type**

Conference Paper

**Source type**

Conference Proceedings

**ISSN**

0094243X

**ISBN**

978-073541971-1

**DOI**

10.1063/5.0000905

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Erdumlu, N.  
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## Extraction and characterization of nanocrystalline cellulose (NCC) from ramie fiber by sulphuric acid hydrolysis

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## Dye sensitized solar cell (DSSC) with immersion time variation of working electrode on the dye of C<sub>4</sub> plant chlorophyll of corn leaves (*Zea mays* L.)

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## Analysis and topology optimization structural design excavator bucket tooth using finite element method

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## Green building potential of existing dormitory building based on energy efficiency and conservation

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## Effect of water depth and water flow on the physics and mechanic properties of the underwater wet welded low carbon steel with post weld heat treatment

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Zainal Arifin; Syamsul Hadi; Hanung Nugroho Jati; Singgih Dwi Prasetyo; Suyitno

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## The influence of electrospinning flow rate parameter on ZnO nanofiber as photoanode of dye-sensitized solar cell

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## Assessment of tourism destination sustainability status using rap-tourism case of natural based tourism

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## Design and development of PC-based photovoltaic test and measurement device for photovoltaic quality inspection

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## Strategic planning in procurement of raw materials based on Kraljic's purchasing portofolio model

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## The economic benefits of the implementation of batik Indonesian National Standard (SNI) by ISO methodology - Economic benefit standard (EBS) approach

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## Slotted blade effect on Savonius wind rotor performance

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## Inventory control of machine spare part using periodic review method : A case study in PT Sari Warna Asli Textile

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## An application of anticipatory FMEA for preventing failures in humanitarian response operation

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## Soil moisture clustering using the k-means clustering method in the UNS's agricultural laboratory at Jumantono

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## Future and challenge of 3D printed bone external fixator: Statics stress simulations of polycarbonate Taylor spatial frame ring

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## Creating motifs using silver electrolyte gel in electroplating technique

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## People detection and tracking methods for intelligent surveillance system

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## Policy determination of inventory control of batik fabric using Q and P *lost sale* probabilistic model through montecarlo simulation approach as the system testing analysis

M. Iqbal Sabit; Agus Mansur; Faizuddin Firdaus

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Subuh Pramono; Budi Basuki Subagio; Eddy Triyono; Agus Ramelan; Chico Hermanu Brillianto Apribowo; Muhammad Hamka Ibrahim

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R. B. Seno Wulung; Midarto Dwi Wibowo

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I. Wayan Suletra; Yusuf Priyandari; Eko Liquidanu

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## Workplace design selection framework to increase productivity by using virtual reality

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## The urea release rate of bead gel based on kappa carrageenan, pectin, and glucomannan

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## Effect of inlet blade geometry on performance propeller turbine for pipe inline instalation

[Hasan Bisri](#); [D. D. D. Prija Tjahyana](#); [Dwi Aries Himawanto](#)

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## Experimental study of the effect of blade angle on pico tubular bulb turbine performance in horizontal flow

[Akhmad Nurdin](#); [Dwi Aries Himawanto](#); [Syamsul Hadi](#)

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## Selecting the synthetic leather and outsole supplier for shoe production in small medium enterprise

[Suhartini](#); [Hastawati Chrisna Suroso](#)

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## Modbus HMI bluetooth for outseal PLC

Djoko Untoro Suwarno

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## Development of simultaneous substrate mixer and cold atmospheric plasma treatment for mushroom cultivation

N. Redzuan; M. R. Rabbi; L. Agun; N. Ahmad; K. Zakaria; R. M. Sirat; R. M. Saad; R. Yasak

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## Performance comparison of VPPM visible light communication demodulator using analog to digital converter and analog comparator sampling

Muhammad Hamka Ibrahim; Miftahuddin Irfani; Annisa Hanifa; Subuh Pramono

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## Application of titanium doped g-C<sub>3</sub>N<sub>4</sub> for the degradation of toxic dyes in textiles wastewater

Anatta Wahyu Budiman; Bregas S. T. Sembodo; Ahmad Alviansyah; Irma B. S. Putri

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## Wind powered centrifugal reaction pump for very low head water lifting

Y. B. Lukiyanto; Budi Setyahandana; Rines

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## Placement multi flexible alternating current transmission system (FACTS) : Static var compensator (SVC) and static synchronous compensator (STATCOM) for improving voltage stability of 500 KV Java-Bali electrical power system

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## Defect analysis of shoes production processes using statistical process control and failure mode effect analysis method

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## Design and development of PC-based smart programmable power supply for battery charging system

[Muhammad Hamka Ibrahim](#); [Rizal Abdulrozaq Rosadi](#); [Agus Ramelan](#); [Chico Hermanu Brillianto Apribowo](#)

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## The design of automatic syringe shaker as the media supporting method of dissolved gas analysis (DGA) transformer oil

[Ratih Rachmatika](#); [Augustinus Sujono](#); [Chico Hermanu Brillianto Apribowo](#)

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## Developing green manufacturing indicators for the decorative paint industry: A case study of Indonesia

[Gun Nanda Tian Purnama](#); [Sawarni Hasibuan](#); [Zulfa Fitri Ikatrinasari](#)

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## Parallel simulation of pattern formation in a reaction-diffusion system of FitzHugh-Nagumo using GPU CUDA

[Alfredo Gormantara](#); [Pranowo](#)

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## Effect of environment on the defects of welded aluminum AA 1100

[Rafael Simanjuntak](#); [Nurul Muhayat](#); [Aditya Rio Prabowo](#); [Y. C. N. Saputro](#); [Triyono](#)

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## Sentiment analysis of Indonesian presidential election 2019 on the twitter with lexicon-based and support vector machine (SVM)

[Fredericus Dwi Nugraha Putra](#); [Pranowo](#); [Budiyanto Setyohadi](#)

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## Design close-loop control of BLDC motor speed using PID method in solar power with matlab/simulink

[Chico Hermanu Brillianto Apribowo](#); [Hari Maghfiroh](#); [Arifian Tri Laksita](#)

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## The line segmentation algorithm of Indonesian electronic identity card (e-KTP) for data digitization

[Yasmine Afifah](#); [Augustinus Sujono](#); [Chico Hermanu Brillianto Apribowo](#)

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## Big data & early alert (anomaly) detection in Paiton coal fired power plant

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## A novel blind chessboard support system (BCSS) featuring magnetorheological elastomer sensor

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## Comparative study of electric vehicles in urban area in Indonesia

[Muhammad Nizam](#)

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## Two and four blades windmill characteristics of traditional salt farmers from Demak Region

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## Routing and scheduling employee transportation using tabu search

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## Studies of geothermal silica as rubbers compounds reinforcing filler

[Muh. Wahyu Sya'bani](#); [Yuli Suwarno](#); [Mertza Fitra Agustian](#); [Indra Perdana](#); [Rochmadi](#)

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## Optimal energy control of DC-drive conveyor using LQR method

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## Active power and reactive power control using fuzzy-PID compensator for grid-connected inverter

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## Quality improvement of woods product using the quality function deployment (QFD) method at PT. X

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## Framework of low cost IOT system to monitor coal mining wastewater quality

[Abdi Suryadinata Telaga](#); [Radix Rascalía](#)

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## Plug-in hybrid electric vehicle mode selection strategy for full battery consumption and known road slope condition

[Muhammad Hamka Ibrahim](#); [Hari Maghfiroh](#); [Muhammad Nizam](#); [Chico Hermanu Brilianto Apribowo](#)

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## The influence of magnesium oxide and montmorillonite on the flame retardant and flexural strength of fiber glass-unsaturated polyester composites

[Sahid Bayu Setiajit](#); [Kuncoro Diharjo](#); [Wijang Wisnu Raharjo](#)

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## Investigation on multi-channel types of primary reformer catalyst using computational fluid dynamic (CFD)

[Ari Diana Susanti](#); [Yazid Bindar](#)

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## The need for national standard of x-band radar technology to detect rainfall and disaster mitigation

[Ajun Tri Setyoko](#); [Endi Hari Purwanto](#); [Reza Lukiawan](#); [Meilinda Ayundyahrini](#)

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## Rollover performance analysis of electric bus superstructure frame with alternative material using finite element method

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## An agent based simulation model for retail price promotion strategies

[Niniet Indah Arvitrida](#); [Adji Candra Kurniawan](#)

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## Macro ergonomics approach to analyze the quality of public bike-sharing transportation services

[Adithya Sudiarno](#); [Shofa Aulia Aldhama](#)

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## Feasibility of METSI UGM office as a workplace in natural lighting availability and its occupants' adaptive behavior

[Arif Kusumawanto](#); [Silfia Mona Aryani](#); [Mega Setyowati](#)

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## Battery management system design (BMS) for lithium ion batteries

Muhammad Nizam; Hari Maghfiroh; Rizal Abdulrozaq Rosadi; Kirana D. U. Kusumaputri

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## Integration of quality function deployment (QFD) and value engineering in improving the quality of product: A literature review

Aulia Ishak; Rosnani Ginting; Alfin Fauzi Malik

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## Product development and design with a combination of design for manufacturing or assembly and quality function deployment: A literature review

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## Construction design of multistage axial field BLDC motor

Fahrul; Rusdhianto Effendi Abdul Kadir; Mochammad Rameli

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## Camera distance effect for smart detection littering

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## Assessment of manufacturing readiness level in PT.ABC (case study: Technology on hospital bed products)

Fadli Syamsuddin; Yusuf Priyandari; Susanto Sudiro

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## The prototypes of automated guided vehicle based on bluebotics autonomous navigation technology

Hoedi Prasetyo; Laras Prasetyo Adhi

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## Characterization and bioactivity test of secondary metabolite isolated from ethyl acetic fraction of *Petrosia alfiani* sponge from Barrang Lompo Island

Rahmayanti; Ahyar Ahmad

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## Experimental investigation of blades number of savonius water turbine on performance characteristic

Dwiseno Wihadi; Stefan Mardikus

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## Design and aerodynamics analysis of rear wing formula student car using 3 dimension CFD (computational fluid dynamics)

M. A. Dharmawan; D. D. P. Tjahjana; B. Kristiawan; S. I. Pertiwi

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## Android-based parking violation reporting application

[Budi Yulianto](#); [Setiono](#)

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## Measure the readiness of university testing laboratory (case study : Universitas Sebelas Maret)

[Anita Arya Rosanti](#); [Roni Zakaria](#); [Fakhrina Fahma](#)

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## Strengthening strategy for developing internal laboratory readiness to be a testing laboratory (study case : Sebelas Maret University)

[Kristy Permatasari](#); [Fakhrina Fahma](#); [Roni Zakaria](#)

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## Predictive maintenance model for centrifugal pumps under improper maintenance conditions

[Nazmee Hashim](#); [Adnan Hassan](#); [Mohd Foad Abdul Hamid](#)

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## Numerical solution of Darcy-Brinkman-Forchheimer equation for forced-convective fluid flow through porous medium using DMLPG method

[Pranowo](#); [Agung Tri Wijayanta](#)

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## The dynamic of the incineration waste-to-energy power plant policy in Indonesia

[Agusniar Rizkia Luthfia](#); [Albertus Sentot Sudarwanto](#); [Eka Nada Shofa Alkhajar](#)

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## Current research on city logistics and possible adoption in developing countries

[Kuncoro Harto Widodo](#); [Yandra Rahadian Perdana](#); [Russell G. Thompson](#); [Hengki Purwoto](#); [Dwi Ardianta Kurniawan](#); [Joewono Soemardjito](#)

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## Synthesis of biodiesel from kapok (*Ceiba pentandra* L.) seed oil through ultrasound-enhanced transesterification reaction

[Ratna Dewi Kusumaningtyas](#); [Muhammad Yasir Adhi Utomo](#); [Pipit Risky Nurjanah](#); [Dwi Widjanarko](#)

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## A scheme to increase Indonesian national standard certification in the batik SMEs (case study at XYZ SME)

[Kurnia Tri Atmojo](#); [Fakhrina Fahma](#); [Wahyudi Sutopo](#)

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## Characteristics of successive droplets impacting hot aluminum surface around nucleate boiling regime

Arif Widyatama; Akmal Irfan Majid; Teguh Wibowo; Deendarlianto; Samsul Kamal

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## Analysis of the effect of magnesium addition on Al-Si alloy using stirr casting method on physical and mechanical properties

Teguh Triyono; Eko Surojo; Vicky Tri Utomo

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## Synthesis of green diesel through hydrodeoxygenation reaction of used cooking oil over NiMo/Al<sub>2</sub>O<sub>3</sub> catalyst

S. D. Sumbogo Murti; Fusia Mirda Yanti; Atti Sholihah; Asmi Rima Juwita; Joni Prasetyo; Meyly Ekawati Thebora; Edwin Pramana; Hens Saputra

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## A proposed policy of medication inventory system in pharmacy installation (case study in Semen Padang Hospital)

Asmuliardi Muluk; Jonrinaldi; Fadhita Maisa Asri

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## Reducing defect in furniture industry using a lean six sigma approach

Ermayana Megawati; Purnawan Adi Wicaksono; Denny Nurkertamanda

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## Municipal solid waste logistics management: A study on reverse logistics

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## Improvement of efficiency of dye-sensitized solar cells (DSSC) transparent by optimizing of anthocyanin dyes hybrid dyenamo yellow (DN-F01)

Nadiyah E.-H. Diyanahesa; A. Supriyanto; A. H. Ramelan

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## The influence of discharge current to temperature distribution of lithium ion cells

Sunarto Kaleg; Abdul Hapid; Miftahul Anwar; Feri Adriyanto; Hillga R. Radhita; Sukmaji I. Cahyono; Kuncoro Diharjo

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## The effect of adding armrest and seat assist on chair for elderly prayer performance (sitting to standing)

Nani Cahya Ningrum; Nurhayatu Nufut Alimin; Prima Adhi Kusuma; Lu'lu' Purwaningrum

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## Current-voltage monitoring of plasma arc discharge submerged in water for nanoparticles fabrication

Lia Anjarwati; Miftahul Anwar; Yan Mahardhika; Ramanda Fadhillah; Chico Hermanu Brillianto Atribowo; Teguh Endah Saraswati; Yuana Ayub

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## Mobile, fast response, and interactive measurement tool of psychological disorders under android based smartphone

[W. A. Syafei](#); [A. Ediaty](#); [D. V. S. Kaloeti](#); [J. Ariati](#); [M. A. Virzawan](#); [A. B. Prasetijo](#); [S. Pramono](#)

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## Analysis of chemical composition and microstructure in hexagonal bolt in aircraft Cessna Caravan 208B

[Indreswari Suroso](#); [Muhammad Nur Rizqi](#)

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## A novel low PAPR preamble for very high throughput WLAN IEEE 802.11ac 80MHz system

[Wahyul A. Syafei](#); [Achmad Hidayatno](#); [Ajub A. Zahra](#); [S. Pramono](#)

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## Design variables reactive power compensator using magnetic energy recovery switch (MERS) for induction motor

[Chico Hermanu Brillianto Apribowo](#); [Luthfy Mahkmudy](#); [Oktavian Listiyanto](#)

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## Experimental method for improving efficiency on photovoltaic cell with using floating installation method

[Chico Hermanu Brillianto Apribowo](#); [Abyan Habibie](#); [Zainal Arifin](#); [Feri Adriyanto](#)

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## Design and economic analysis of floating PV-wind turbine plant for renewable energy supply in Indonesia

[Chico Hermanu Brillianto Apribowo](#); [Muhammad Hamka Ibrahim](#); [Muhammad Ramadhan Bagus Purnomo](#)

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## Design and implementation of closed-loop controls for smart charging lithium ion battery UNS using switching technique boost converter

[Chico Hermanu Brillianto Apribowo](#); [Muhammad Akmal](#); [Miftahul Anwar](#)

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## Optimization of 4G LTE (long term evolution) network coverage area in sub urban

[Subuh Pramono](#); [Lia Alvionita](#); [Mustofa Danang Ariyanto](#); [Meiyanto Eko Sulisty](#)

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## Analysis and optimization of 4G long term evolution (LTE) network in urban area with carrier aggregation technique on 1800 MHz and 2100 MHz frequencies

[Subuh Pramono](#); [Mustofa Danang Ariyanto](#); [Lia Alvionita](#); [Meiyanto Eko Sulisty](#)

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## Design of a hydroponic monitoring system with deep flow technique (DFT)

[Subuh Pramono](#); [Arif Nuruddin](#); [Muhammad Hamka Ibrahim](#)

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## Movement flexibility of autistic children during individual therapy using ABA Lovaas table modification with foldable table top

[Dwi Candra Purnamasari](#); [Sintha Sari Martaningtyas](#); [Lulu Purwaningrum](#)

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## Maintenance strategy selection in a cement company: An integrated AHP-FAHP approach

[Masoud Rahiminezhad Galankashi](#); [Fatemeh Khorramrouz](#); [Mehran Esmaeilnezhad](#); [Farimah Mokhatab Rafiei](#); [Muhammad Hisjam](#)

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## Implementation of lean manufacturing in an electronic assembly company

[Celine Koh Xian Lin](#); [Syed Ahmad Helmi](#); [Muhammad Hisjam](#); [Ahad Ali](#)

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## Ergonomic improvement in a manufacturing company

[Tuan Ahmad Farhan Hakimi](#); [Syed Ahmad Helmi](#); [Muhammad Hisjam](#); [Ahad Ali](#)



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## Photodegradation of batik waste with graphitic carbon nitride using UV-BLB

[Bagas Cahyadi](#); [Leony Inatsan Pertiwi](#); [Queenta Perdanita Putri](#); [Anatta Wahyu Budiman](#)

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## An application of support vector machine to detect anomalies in time series data

[Yoga S. Satriawan](#); [Joko Slamet Saputro](#)

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## Internet reactor laboratory application design on android client devices

[Adi Abimanyu](#); [Damasus Riko Prijono](#); [Agus Arif](#); [Muhtadan](#)

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## Design and implementation of autonomous solar powered iot farm monitoring system using MQTT over cellular network

[Muhammad Hamka Ibrahim](#); [Chico Hermanu Brilianto Apribowo](#); [Fahmi Ismail](#); [Bima Damar Jati](#); [Sony Adyatama](#); [Attar Al Mufashal Rasyid](#); [Bima Tri Prasetya](#)

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## Design and implementation biogas production by anaerobic digestion for sustainable energy development: A case study residential in Indonesia

Chico Hermanu Brillianto Apribowo; Muhammad Hamka Ibrahim; Adhitya Pitara Sanjaya

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# A Data Envelopment Analysis Approach for Assessing the Efficiency of Sub-sectors of Creative Industry: A Case Study of Batik Enterprises from Semarang, Indonesia

Naniek Utami Handayani<sup>1,a)</sup>, Diana Puspita Sari<sup>1</sup>, M. Mujiya Ulkhaq<sup>1</sup>, Yusuf Widharto<sup>1</sup>, and Risa Candra Ayu Fitriani<sup>1</sup>

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**Abstract.** The creative industry (CI) is considered to promote human development while promoting the economic growth. It maintains and protects historical and cultural heritage, improve cultural capital, and foster communities as well as individual creativity. Although there is widespread classification of the CI, the Ministry of Tourism of Indonesia has classified CI into 16 sub-sectors, i.e., (1) advertising, (2) architecture, (3) interior design, (4) product design, (5) craft, (6) visual communication design, (7) fashion, (8) film, animation, and video (9) photography, (10) application and game developers, (11) music, (12) performing arts, (13) publishing, (14) fine arts (15) TV and radio (broadcasting), and (16) gastronomy/culinary. The creative industry is an industry that originates from the use of creativity, skills and individual talents to create prosperity and employment by generating and exploiting the individual's creative and creative power. Batik industry is one of Creative Industry in Indonesia which plays an important role in the economic development. However, the Batik are facing difficulties in many areas, especially in spending their scarce resources efficiently. A case study to assess the efficiency of the Batik enterprises has been conducted by applying the data envelopment analysis in Semarang, Indonesia. The results show that from ten assigned Batik enterprises, there are nine enterprises' that are considered efficient, while the rest are regarded as inefficient. This research is expected to give some advantages to the Batik enterprises' regarding how to use their limited resources in an efficient way.

## INTRODUCTION

Small and medium enterprises (SMEs) are broadly acknowledged to have a vital role in the economic development. Both developed and developing countries believe that they could bring huge economic benefits by contributing to the entrepreneurship, employment creation, as well as income generation [1-3]. Particularly in the developing countries, the SMEs are considered as important not only since they create the employment but also because they employ unskilled workers who are abundant in such countries [4]. The SMEs gave big contributions to the employment growth and gave steady decline in poverty rate. Beyond the dark year, the SMEs even contributed more to economic growth compared to big enterprises due to their dependency towards formal markets and credits [5]. In fact, the SMEs represent more than 99% of the total number of enterprises in Indonesia and employ more than 97% of the entire workforce [6-7]. In addition, the SME sector exported as of 16% of total non-oil exports, and accounted for 57.94% of total gross domestic product (GDP) at current prices [7].

The creative industries refer to a variety of economic activities related to knowledge and data generation or exploitation. It may also be referred to differently as the cultural sectors [8] or the creative economy [9]. Howkins' creative economy comprises advertising, architecture, art, crafts, design, fashion, film, music, performing arts, publishing, R&D, software, toys and games, TV and radio, and video games [9]. The definition of CI refers to industry which has its origin in individual creativity, skill and talent, and which has a potential for wealth and job creation through the generation and exploitation of intellectual property [10].

# Development of Neck Surface Electromyography Gaming Control Interface for Application in Tetraplegic patients' Entertainment

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**Abstract.** In the recent past, surface Electromyography (sEMG) signals has been effectively applied in control interfaces for robots, prosthetic hands, legs and other areas. Few works has focused on neck EMG control in spite of the neck being central to human movements and engagements. We propose a neck EMG model that estimates head movements and apply the signals to control a game developed in Unity 3D engine. The game involves randomly falling and accelerating objects. The user slides the games' player character (paddle) using neck EMG to intercept as many objects. EMG signal is rectified and FIR filtered and used to control the position of a sliding probe of the game in real-time. The paper utilizes an equation model and a Machine Learning model to translate the filtered signal to corresponding neck rotation. From the results, all the subjects reported accuracy of over 70% which confirm the applicability of the interface and ease of use in that there is little or no calibration needed. The control model using equation showed intuitive direction and speed control while the Machine Learning scheme offered more stable direction control but limited speed control of the sliding paddle. The control interface can be applied in multiple areas that involve neck activity e.g. in rehabilitation as well as gaming interface to enable entertainment for the disabled.

## INTRODUCTION

The activity of muscles is observed as bio-electric potentials in human beings which constitutes electromyogram (EMG) signal. Surface EMG (sEMG) is the signal acquired from the surface/belly of the muscle group under consideration, usually recorded using surface electrodes. EMG studies in literature can be broadly categorized in to two categories; classification and regression [1]. The former is concerned with accurate prediction of patterns and grouped activity in to a sensible single or multiple action. There is a wide application of this for example in hand or finger prosthetics where voluntary control of certain muscle should correspond to a fine motor action like pinching, pointing and others. The other category of EMG control is concerned with regression and or finding a relationship between continuous muscle activity in a task.

EMG integration into daily activities takes different forms and shapes ranging from gesture and posture recognitions [2], robotic control [3], [4], [5], wheelchair control [6], muscle rehabilitations [7] to list but a few. An application field which is similar to the proposed research is the use of EMG signals in gaming environment [8], [9], [10]. A paper [11], sought to investigate how myo-gaming, a term used to describe application of myoelectric signals to gaming, improves EMG control and whether there are any performance improvements over time. The authors

# Maintenance Strategy Selection in a Cement Company: An Integrated AHP-FAHP Approach

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**Abstract.** This study develops an integrated AHP-FAHP approach to select the best maintenance strategy for different equipment of a cement manufacturer located in Iran. Although the topic has been investigated in previous literature, it is less examined in cement manufacturers of developing countries. To fill this gap, this research has been conducted in three phases as follows. Firstly, the most important measures of maintenance strategy selection are developed and ranked using a questionnaire. Next, these measures are applied to choose the best maintenance strategy for different equipment of a case study using an Analytic Hierarchy Process (AHP). Finally, a Fuzzy AHP is developed to investigate the obtained results in an uncertain environment. The considered strategies include Corrective maintenance (CM), Reliability Centered Maintenance (RCM), Total Productive Maintenance (TPM), Preventive Maintenance (PM) and Predictive Maintenance (PDM). According to the obtained results, safety, cost, reliability and availability are the most important criteria of maintenance strategy selection. In addition, according to AHP, the PDM strategy is suggested for furnace, PM is suggested for electro filter machine and CM is suggested for crusher. These results are comparatively investigated by FAHP and some managerial insights are suggested.

## INTRODUCTION

Availability is an important factor which should be considered in today's competitive markets. In this regard, companies have acknowledged the importance of maintenance planning and its role to improve the equipment availability. With the advent of mass production, the usage time of manufacturing equipment has been significantly increased. However, any manufacturing machine needs a comprehensive maintenance planning approach. Although the concept of maintenance strategy selection and the similar topics have been vastly investigated in previous literature, few studies have been conducted in cement manufacturing companies especially in developing countries. Therefore, it is essential to determine the most important measures of maintenance strategy selection, identify the proper Multiple-Criteria Decision Making (MCDM) approach to rank the alternatives and finally consider the uncertainty of decision makers' judgments. In other words, while maintenance strategy selection is an important topic which should be more investigated, it is less examined with regard to the required measures, appropriate MCDM approaches and uncertain nature of the problem. This ignorance is somewhat due to the intrinsic complexities linked with identification of proper criteria, variability of the available MCDM techniques and finally the fuzzy nature of decision makers' judgments. However, this research propose an integrated AHP-FAHP

# Risk Estimation of Construction Activities of Buildings

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**Abstract.** Building construction work is one of the most dangerous activities among all industries. These works are often associated with different types of risks, which if not eliminated or minimized during design stages would cause fatal accidents and severe injuries during the construction stages. Risk elimination or reduction cannot be achieved without recognizing hazards and assessing risk through evaluation techniques. Risk may not be directly quantifiable, and the presence of confounding variables, ongoing interventions and uncertainty makes generalization of findings to the overall population a suspect. It is difficult to measure risk because it often assumes ordinal scales and data related to it is scarce. This paper presents a risk estimation technique that evaluates risk and produce data that can be used in response decisions to aid risk elimination or reduction in building construction processes. The technique to be presented in this paper will be based on experts' opinion and will depend on experts' knowledge and working experience in the construction industry. The study will conduct a risk assessment survey where experts will be asked to assign risk values to 25 construction activities of five structural elements (footing and foundation, column, wall, beam and roof). The objective is to estimate unit safety risk for each activity and determine the overall risk of the project. A questionnaire with all five components and their corresponding construction activities was used to evaluate risk severity levels and time of exposure for each activity. Data collected was analysed with SPSS descriptive statistics and one-way ANOVA. The findings show that construction field personnel perceive roof, beam and foundation as the most risky design elements to construct. Also excavation, shuttering and anchoring/welding are the most risky activities in the construction process. No significant differences were found between the perceptions of the three groups of construction field personnel (engineers, superintendents and HSEs) regarding risk perception.

## INTRODUCTION

Construction works are inherently risky and have potential hazards to people, assets, environment and reputation to companies. Based on incident and fatality rate, the sector is classified as one of the most dangerous industries for industrial workers. A large number of incidents of fatalities and permanent injuries to workers and damages to the industry occur every year. According to the global statistics of the International Labor Organization (ILO, 2018) [1], the accident rate in the construction industry was three times higher than that of other industries and the fatality rate of construction workers was five times that of all industries. Construction fatality rate in Malaysia rose from 7.26 deaths per 100,000 workers in 2014 to 14.57 in 2017, and recorded 118 fatalities in 2018 (DOSH, 2018) [2]. Occupational incidents are predictable and preventable with the process of hazard identification as well as risk assessment and control [3]. Therefore, in order to prevent or minimize occupational accidents, the top-most priority for the construction industry is evaluating and identifying hazards, assessing risks associated with such hazards and attempting to control them during design phases of projects. Risk assessment and quantification is an appropriate method of identifying risks associated with constructing structural elements and activities [4]. This can be achieved by the ability of field personnel to perceive risk and implement effective risk assessment and management practices [5], through their knowledge of construction design processes and safety. Formal identification of hazards and