



CONFERENCE PROGRAMS AND ABSTRACT

**The 3rd FIRST 2019 INTERNATIONAL CONFERENCE
FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY
OCTOBER 09-10, 2019
*Palembang, Province of South Sumatera
Indonesia***

Organized by :



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PREFACE

The 3rd FIRST 2019 (Forum in Research, Science, and Technology) International Conference was initiated and organized by State Polytechnic of Sriwijaya in collaboration with Management and Science, University (MSU), Malaysia and National Chin-Yi University of Technology, Taiwan. The theme of the conference was “Integration of Advanced Technology to Enhance Social Welfare”. The 3rd FIRST 2019 International Conference facilitated the participants from all over the world to meet face to face to open chances in establishing connection and collaboration among them. It was not only for the researchers in academics, but also in industries and governments. This conference became an effective media to link the researchers from many parts of the world conference, for exchanging, sharing, following up and discussing the results of the latest research, industry’s needs, and government regulatory policies. The 3rd FIRST 2019 International Conference became worthwhile platform for researchers to present their finding in the areas on multidisciplinary of Engineering and Science (Track 1), Computer Science and ICT (Track 2), and Social Science (Track 3). It has also provided an opportunity for the professionals and researchers to learn and share about the latest development and research in those 3 tracks.

The 3rd FIRST 2019 International Conference attracted so many authors not only from Indonesia but also from other countries, such as Japan, Taiwan, and Malaysia. There were 180 papers were accepted in the 3rd FIRST 2019 International Conference, including 89 papers for Track 1 (Engineering and Science), 46 papers for Track 2 (Computer Science and ICT), and 45 papers for Track 3 (Social Science). In The 3rd FIRST 2019 International Conference, there were 4 keynote speakers and 2 invited speakers. As the keynote speakers, there were Prof. Yasushi Kiyoki, Ph. D from KEIO University, Japan, Prof. Nurul Taufiqu Rochman, M. Eng, Ph. D, From LIPI, Indonesia, Prof. Tjiptohadi Sawarjuwono, M. Ec., Ph. D., Ak, from Universitas Airlangga, Indonesia, and Prof. Win-Jet Luo, from National Chin-Yi University of Technology, Taiwan. As the invited speakers, there were Dr. R. Wisnu Nurcahyo, DVM from Universitas Gadjah Mada, Indonesia, and Assoc. Prof. Dr. Intan Zaurah binti Mat Darus from Universiti Teknologi, Malaysia. The 3rd FIRST 2019 International Conference committee would like to say thank you very much for all the participants and their respected institutions that have supported for the success of the 3rd FIRST 2019 International Conference, and also for all of the guess and sponsors of the 3rd FIRST 2019 International Conference.

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Authors

Affandi, Muhammad Irfan
Marketing Efficiency of Organic Rice in Lampung Province

Afrizawati
The Effect of Organization Climate on Performance with Job Satisfaction as an Intervening Variable

Akbar, Muhamad
E-Government Policy, Leadership Commitment, Apparatus Resources Development, and Their Implications on Public Service Performance

Aladin
Industrial Clusterization to Improve the Competitiveness of Small and Medium Industries in the City of Palembang

Alhadi, Esya
Impact of Customer Orientation and Quality of Service on Trust and Customer Loyalty

Alhamdari, Lailita
Analysis Method Economic Value Added of Cosmetics Companies Listed on Indonesia Stock Exchange

Amalia, Rizki Fitri
Political Connection, Profitability, and Capital Intensity Against Tax Avoidance in Coal Companies on the Indonesia Stock Exchange

Amran, Ali
Relationship Between GPA, Length of Study, and Competency with the Length of Time to Get a Job

- Amri, Darul
Determinant of Development Strategies and Leadership Styles on Organizational Commitment and Their Implications for MSMEs Performance in Palembang
- Andriani, Titi
Impact of Customer Orientation and Quality of Service on Trust and Customer Loyalty
- Anshari, Muhammad
Human Resource Role and Online Strategy
- Aprianti, Siska
The Effect of Capital Readiness and E-Commerce Utilization on the Competitiveness of Micro, Small, and Medium Enterprises Woven, Palembang
- Ardiani, Susi
The Effect of Hospital Image and Service Quality on Customer Loyalty Through Customer Satisfaction
- Arifin, Kiagus Zainal
Determinants of Village Financial Management Accountability
- Armaini, Rosy
The Impact of Village Fund Program Implementation Toward Society Welfare in Indonesia
- Aryani, Yuli Antina
Industrial Clusterization to Improve the Competitiveness of Small and Medium Industries in the City of Palembang
- Badri, Markoni
The Environmental Compliance Management of Palm Oil Plantation in Ogan Komering Ilir Regency, Sumatera Selatan, Indonesia
- Bustan, Jusmawi
Analysis Method Economic Value Added of Cosmetics Companies Listed on Indonesia Stock Exchange
- Bustan, Jusmawi
The Effect of Culinary Knowledge and Culinary Experience on Local Culinary Attractiveness
- Carlos, RS
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Choiruddin
Determinants of Village Financial Management Accountability
- Darfin, Deri
The Public Service Quality of Library Service at the Library Unit Polytechnic State of Sriwijaya
- Darlies, Meiyi
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Darmaliana
The Development of Teaching Material Speaking 2 Based on Communicative Approach
- Desiani, Anita
Relationship Between GPA, Length of Study, and Competency with the Length of Time to Get a Job

- Dewata, Evada
Industrial Clusterization to Improve the Competitiveness of Small and Medium Industries in the City of Palembang
- Divianto
The Effect of Organization Climate on Performance with Job Satisfaction as an Intervening Variable
- Djumrianti, Desloehal
Online Transportation Technology and Women's Driver Communication Skills
- Dwitayanti, Yevi
The Impact of Village Fund Program Implementation Toward Society Welfare in Indonesia
- Effendi, Ridwan
The Public Service Quality of Library Service at the Library Unit Polytechnic State of Sriwijaya
- Elisa
Evaluation of Sales Price Within Calculation Cost of Good Production SMEs Pempek Ilir Barat I and Bukit Kecil District, Palembang
- Ermatita
The Clustering of Paddy Fields Using Machine Learning Algorithms in the Province of South Sumatera
- Erwin, Muhamad
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Evawati, Nian Masna
Language Experience Approach in Teaching Reading Comprehension to the Engineering Students
- Fadila, Dewi
Impact of Learning, Socialization, and Financial Lifestyle of Students' Intention to Invest in Capital Market
- Faridah
The Effect of Taxpayer Awareness and Tax Sanctions on Compliance in Paying Land and Building Taxes
- Firdaus, Yusnizal
The Environmental Compliance Management of Palm Oil Plantation in Ogan Komering Ilir Regency, Sumatera Selatan, Indonesia
- Fithri, Eka Jumarni
Determinants of the Quality Regional Financial Statement
- Frimansyah
Determinant of Development Strategies and Leadership Styles on Organizational Commitment and Their Implications for MSMEs Performance in Palembang
- Gustiani, Sri
The Effectiveness of Blended Learning Approach on Essay Writing Subject
- Hamid, Abd.
The Effect of Culinary Knowledge and Culinary Experience on Local Culinary Attractiveness
- Handayani, Sri
Marketing Efficiency of Organic Rice in Lampung Province
- Handayani, Sri
Comparison Analysis of Added Value of Organic Rice and Inorganic Rice

- Hanifati
Online Transportation Technology and Women's Driver Communication Skills
- Hardiyansyah, Hardiyansyah
E-Government Policy, Leadership Commitment, Apparatus Resources Development, and Their Implications on Public Service Performance
- Hartati, Sukmini
Dimension of Village Expenditure in Development Sector
- Hartaty, Sri
Determinants of the Quality Regional Financial Statement
- Herawati, Yusleli
Evaluation of Sales Price Within Calculation Cost of Good Production SMEs Pempek Ilir Barat I and Bukit Kecil District, Palembang
- Herman
The Effect of Directed Reading—Thinking Activity on Students' Critical Thinking Abilities
- Husori, Al
The Environmental Compliance Management of Palm Oil Plantation in Ogan Komering Ilir Regency, Sumatera Selatan, Indonesia
- Indriasari, Desi
Determinants of Village Financial Management Accountability
- Irmeilyana
Relationship Between GPA, Length of Study, and Competency with the Length of Time to Get a Job
- Jauhari, Hadi
Human Resource Role and Online Strategy
- Koesharijadi, Koesharijadi
E-Government Policy, Leadership Commitment, Apparatus Resources Development, and Their Implications on Public Service Performance
- Koryati
Language Experience Approach in Teaching Reading Comprehension to the Engineering Students
- Kusmartini, Sri Endah
The Development of Teaching Material Speaking 2 Based on Communicative Approach
- Lisnini
Model of Empowerment as Strategies for Women SMEs Entrepreneurs Competitiveness in Palembang
- Lupikawaty, Marieska
Analysis Method Economic Value Added of Cosmetics Companies Listed on Indonesia Stock Exchange
- Lupikawaty, Marieska
Evaluation of Sales Price Within Calculation Cost of Good Production SMEs Pempek Ilir Barat I and Bukit Kecil District, Palembang
- Mahendrati, Hermina Agustina
Individual Readiness for Change and Affective Commitment to Change: The Mediation Effect of Technology Readiness on Public Sector
- Mandiangan, Pridson
Online Transportation Technology and Women's Driver Communication Skills

- Mangundjaya, Wustari
Testing the Role of Charismatic Leadership, Psychological Climate, and Organizational Citizenship Behavior on Resilience
- Mangundjaya, Wustari L.
Leader–Member Exchange and Affective Commitment to Change: Mediating Role of Change Self-Efficacy
- Mangundjaya, Wustari
Testing the Impact of Organizational Justice on Affective Commitment to Change with Work Engagement as Mediator
- Mangundjaya, Wustari
Individual Readiness for Change and Affective Commitment to Change: The Mediation Effect of Technology Readiness on Public Sector
- Mangundjaya, Wustari L.
Testing Mediation of Psychological Empowerment, Work Engagement to Affective Commitment to Change
- Maretha, Fetty
Model of Empowerment as Strategies for Women SMEs Entrepreneurs Competitiveness in Palembang
- Maria
The Impact of Village Fund Program Implementation Toward Society Welfare in Indonesia
- Mariskha, Z
Impact of Learning, Socialization, and Financial Lifestyle of Students' Intention to Invest in Capital Market
- Martini, Rita
Dimension of Village Expenditure in Development Sector
- Marwa, Taufiq
Exploring Linkage Among Experiential Value, Image of Destination, and Intention to Revisit in Nature Tourism
- Masnila, Nelly
The Effect of Taxpayer Awareness and Tax Sanctions on Compliance in Paying Land and Building Taxes
- Maulana, Riska
Impact of Learning, Socialization, and Financial Lifestyle of Students' Intention to Invest in Capital Market
- Miskiyah, Neneng
Human Resource Role and Online Strategy
- Mubarok, Muhammad Husni
The Effect of Taxpayer Awareness and Tax Sanctions on Compliance in Paying Land and Building Taxes
- Nadjmuddin, Muhammad
The Effect of Directed Reading—Thinking Activity on Students' Critical Thinking Abilities
- Natoen, Ardiyan
The Influence of Commitment on State Civil Apparatus in the Governor Office of South Sumatera
- Nirmagustina, Dwi Eva
Comparison Analysis of Added Value of Organic Rice and Inorganic Rice

- Nurhasanah
The Impact of Village Fund Program Implementation Toward Society Welfare in Indonesia
- Oktarian, Rido Prawira
Relationship Between GPA, Length of Study, and Competency with the Length of Time to Get a Job
- Oktarida, Anggeraini
Determinants of the Quality Regional Financial Statement
- Paisal
The Effect of Organization Climate on Performance with Job Satisfaction as an Intervening Variable
- Pangestu, Bramntyo Muhamad
The Effect of Capital Readiness and E-Commerce Utilization on the Competitiveness of Micro, Small, and Medium Enterprises Woven, Palembang
- Pebrianti, Yulia
Model of Empowerment as Strategies for Women SMEs Entrepreneurs Competitiveness in Palembang
- Periansya
The Influence of Commitment on State Civil Apparatus in the Governor Office of South Sumatera
- Purwati
Evaluation of Sales Price Within Calculation Cost of Good Production SMEs Pempek Ilir Barat I and Bukit Kecil District, Palembang
- Puspitasari, Dwi Andriani
Leader–Member Exchange and Affective Commitment to Change: Mediating Role of Change Self-Efficacy
- Rahma, Munaja
Students' Perception of English Blended-Learning in State Polytechnic of Sriwijaya
- Riama, Lambok Vera
Determinants of the Quality Regional Financial Statement
- Ridho, Sari Lestari Zainal
Human Resource Role and Online Strategy
- Ridhwan, Moehammad
Students' Perception of English Blended-Learning in State Polytechnic of Sriwijaya
- Rini
Model of Empowerment as Strategies for Women SMEs Entrepreneurs Competitiveness in Palembang
- Risa
The Development of Teaching Material Speaking 2 Based on Communicative Approach
- Risnawati
The Development of Teaching Material Speaking 2 Based on Communicative Approach
- Robinson
The Public Service Quality of Library Service at the Library Unit Polytechnic State of Sriwijaya

- Rusnadi, Irawan
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Sandrayati
The Effect of Hospital Image and Service Quality on Customer Loyalty Through Customer Satisfaction
- Sanmorino, Ahmad
The Clustering of Paddy Fields Using Machine Learning Algorithms in the Province of South Sumatera
- Sari, Evi Agustina
The Effectiveness of Blended Learning Approach on Essay Writing Subject
- Sari, Yuliana
Industrial Clusterization to Improve the Competitiveness of Small and Medium Industries in the City of Palembang
- Sari, Kartika Rachma
Determinants of Village Financial Management Accountability
- Sarikadarwati
The Effect of Hospital Image and Service Quality on Customer Loyalty Through Customer Satisfaction
- Sastrawinata, Hendra
Impact of Learning, Socialization, and Financial Lifestyle of Students' Intention to Invest in Capital Market
- Satriawan, Indra
The Influence of Commitment on State Civil Apparatus in the Governor Office of South Sumatera
- Seprianto, Dicky
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Setiawan, Heri
The Effect of Culinary Knowledge and Culinary Experience on Local Culinary Attractiveness
- Setiawan, Heri
Exploring Linkage Among Experiential Value, Image of Destination, and Intention to Revisit in Nature Tourism
- Shihab, Muchsin Sagaf
Exploring Linkage Among Experiential Value, Image of Destination, and Intention to Revisit in Nature Tourism
- Simanjuntak, Tiur
The Effectiveness of Blended Learning Approach on Essay Writing Subject
- Sopian, A.R
The Influence of Commitment on State Civil Apparatus in the Governor Office of South Sumatera
- Sulaiman
The Effect of Capital Readiness and E-Commerce Utilization on the Competitiveness of Micro, Small, and Medium Enterprises Woven, Palembang
- Sunani
The Effect of Directed Reading—Thinking Activity on Students' Critical Thinking Abilities

- Suryati
The Clustering of Paddy Fields Using Machine Learning Algorithms in the Province of South Sumatera
- Susilo
Testing Mediation of Psychological Empowerment, Work Engagement to Affective Commitment to Change
- Thoyib, M.
Determinant of Development Strategies and Leadership Styles on Organizational Commitment and Their Implications for MSMEs Performance in Palembang
- Tompunu, Alan Novi
Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park
- Ummasyroh
The Effect of Culinary Knowledge and Culinary Experience on Local Culinary Attractiveness
- Wahab, Zakaria
Exploring Linkage Among Experiential Value, Image of Destination, and Intention to Revisit in Nature Tourism
- Wahyudi, Riza
Determinant of Development Strategies and Leadership Styles on Organizational Commitment and Their Implications for MSMEs Performance in Palembang
- Widyastuti, Endah
Dimension of Village Expenditure in Development Sector
- Windarti, Gst Ayu Oka
Impact of Customer Orientation and Quality of Service on Trust and Customer Loyalty
- Yahya
The Effect of Organization Climate on Performance with Job Satisfaction as an Intervening Variable
- Yeny, Eli
The Effect of Directed Reading—Thinking Activity on Students' Critical Thinking Abilities
- Yulina, Bainil
The Effect of Capital Readiness and E-Commerce Utilization on the Competitiveness of Micro, Small, and Medium Enterprises Woven, Palembang
- Yulsiati, Henny
The Effect of Hospital Image and Service Quality on Customer Loyalty Through Customer Satisfaction
- Yurnalis
Testing the Impact of Organizational Justice on Affective Commitment to Change with Work Engagement as Mediator
- Yusri
The Effectiveness of Blended Learning Approach on Essay Writing Subject
- Yusuf, M.
The Environmental Compliance Management of Palm Oil Plantation in Ogan Komering Ilir Regency, Sumatera Selatan, Indonesia
- Zahara, Elvia
Impact of Customer Orientation and Quality of Service on Trust and Customer Loyalty

Zakaria

Students' Perception of English Blended-Learning in State Polytechnic of Sriwijaya

Zamheri, Ahmad

Criminal Law Policy on the Crime of Abuse to the Orang Rimba in the Bukit Duabelas National Park

Zulkarnaini

The Public Service Quality of Library Service at the Library Unit Polytechnic State of Sriwijaya

Zulkifli

Language Experience Approach in Teaching Reading Comprehension to the Engineering Students

Zulkifli, Zulkifli

Dimension of Village Expenditure in Development Sector



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TABLE OF CONTENTS

TRACK 1.....	1
ELECTRICAL ENGINEERING.....	1
A GLOBAL KNOWLEDGE SHARING AND SEMANTIC COMPUTING SYSTEM WITH 5-DIMENSIONAL WORLD-MAPFOR NATURAL AND SOCIAL ENVIRONMENT-ANALYSIS AND VISUALIZATION	1
5G Channel Model for 28 GHZ Frequency in Palembang	2
B Alfaresi , Z Nawawi , R F Malik, K Anwar.....	2
Wireless Sensor Network Data Communication and Information System to Regulate Water Volume and Turbine Rotation	3
Suzan Zefi ¹⁾ , Eka Susanti ²⁾ , R.A Halimahtussa'diyah ³⁾ , Sholihin ⁴⁾	3
Tomato Harvesting Arm Robot Manipulator; a Pilot Project.....	4
Yurni Oktarina ¹ ,Tresna Dewi ¹ , Pola Risma ¹ , and Muhammad Nawawi ¹	4
Performance Evaluation Solar Charge Controller on Solar Power System Home-Based SPV Amorphous 80 Watt-Peak.....	5
Armin Sofijan ¹ , Zainuddin Nawawi ² , Bhakti Yudho Suprpto ³ , Riman Sipahutar ⁴ , Irwin Bizzy ⁵	5
The Implementation of YateBTS Based GSM Using Raspberry PI.....	6
Sopian Soim ¹⁾ , Suroso ²⁾ , Ade Silvia Handayani ³⁾ , Ahmad Taqwa ⁴⁾ , Nur Shadrina ⁵⁾	6
Optimization of Own Electricity Usage with Electricity Supply from Solar Cells at Darajat Geothermal Power Plant.....	7
Brendy Chandra Supian Atmodjo ¹ and Rinaldy Dalimi ¹	7
Ultrasonic Sensor Application as a Performance Enhancement of Robot Two Wheels.....	8
Yeni Irdyanti ⁽¹⁾ , Rd. Kusumanto ⁽²⁾ , Masayu Anisah ⁽³⁾ , Niksen Alfarizal ⁽⁴⁾ , Zarmariesyah Erman ⁽⁵⁾ ...	8
Operation 3 Phase Induction Motor 1 KW Star Delta System Using HP (Smart Phone).....	9
Nofiansah ¹ , M. Noer ² , Nurhaida ³ , M. Hafidz Aulia ⁴	9
PLC Omron CJ1M CPU-21 Control Modification for Drill Oil Hole Machine in an Automotive Company	10



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Lin Prasetyani 1, Bayu Ramadhan1 , Tresna Dewi2 , William Sarfat1	10
Characteristics of Battery Use in Electric Car.....	11
Yessi Marniati*, Andri Suyadi, Herman Yani, Sutan Marsus**	11
Learning Module of Analog Electronics Practice	12
Sabilal Rasyad, Evelina, Amperawan, Dewi Permata Sari, Nyayu Latifah Husni.....	12
DIFFERENT METRIC DISTANCES ON THE K-MEANS METHOD IN BUILDING A CANS WASTE CLASSIFICATION SYSTEM USING THE CMYK COLOR MODEL	13
Implementation of Facial Feature Extraction Using Viola-Jones Method for Mobile Robot System ...	14
Ahmad Zarkasi ^{1,2} , Siti Nurmaini, Deris Setiawan, Ahmad Kuswandi, Sri Desy Siswanti.....	14
Effect of Load on BLCD Motor.....	15
Rumiasih, Carlos R. Sitompul, Anton Firmansyah, Indah Susanti	15
Implementation of DSK TMS320C6416T Module in Designed of Sound Detection	16
D A Pratama, N L Husni, E Prihatini, S Muslimin	16
Automatic Cooling of a PV System to Overcome Overheated PV Surface in Palembang.....	17
Ahmad Taqwa ^{1,2} , Tresna Dewi ^{1,2} , RD. Kusumanto ^{1,2} , Carlos R Sitompul ^{1,2} , Rusdianasari ¹	17
Analysis of Performance Test and Consumption of BLDC 350 W Motor Power to Mechanical Vibration with Variation of Speed and Load Variation	18
Hairul, Markori, Indrawasih dan Sudirman Yahya	18
The Influence of Change of an Angle of Illuminance on Solar Power Generating Capacity 30 Watts in Laboratory of Electrical Engineering Polytechnic of Sriwijaya.....	19
Zainuddin Idris, M. Yunus, Siswandi, Bambang Guntoro.....	19
The Effect of Drying Airflow Rate on H ₂ O MASS Evaporated for Banana Chips Drying Using Photovoltaic Solar Panel	20
Yohandri Bow ¹ , Adi Syakdani ² , Muhammad Taufik ² , Rusdianasari ³	20
Development and Feasibility Analysis of Floating Solar Panel Application in Palembang, South Sumatra.....	21
Benny Junianto ¹ , Tresna Dewi ² , Carlos Sitompul ²	21
Effects of Grid Frequency Drop on The Dynamic Performance of Full Converter Wind Turbine Generator.....	22
A. M. Shiddiq Yunus ¹ ,Makmur Saini ² , Sri Suwasti ¹ , dan Purwito Purwito ³	22



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
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Modified Design for Water Metering System.....	23
Nyayu Latifah Husni ¹ , Dampito ² , Abdurrahman ³ , Evelina ⁴ , ade Silvia Handayani ⁵ , Sabibal Rasyad ⁶ , Adella Rialita ⁷¹⁻⁷ Electrical Department, Politeknik Negeri Sriwijaya	23
Implementation of Fuzzy Logic Type-2 On Mobile Robot Navigation System.....	24
Ade Silvia Handayani, Jefri Alkausar, Sarjana Sarjana, Nyayu Latifah Husni, Siti Nurmaini, Irsyadi Yani.....	24
INTELLIGENT CONTROLLER FOR FLEXIBLE ROBOT ARM	25
The Analysis of Wear on Artificial HIP Joint with Dimple on Femoral Surface	26
Hasan Basri ^{1,*} , A. Syahrom ^{2,3} , Amir Putra Md Saad ² , A. T. Prakoso ¹ , D. Wicaksono ¹ , M. I. Amarullah ¹ , Tri Satya Ramadhoni ¹	26
Optimal Design of Plasticizing Screw Using Artificial Intelligent Approach.....	27
Fatahul Arifin ^{1, 2(*)} , Min-Wen Wang ¹ , Jhen-Wei Kuo ³ , Tzong-Horng Dzw ⁴	27
Mechanical Degradation Model of Porous FE Scaffold: Simulation Approach.....	28
Akbar Teguh Prakoso ¹ , Ardiyansyah Syahrom ^{2,3} , Amir Putra Md Saad ^{2,3} , Abdul Hadi Abdul Wahab ⁴ , M. A. Sulong ^{2,3} , Achmad Rendiko Ichsan ¹ , Apreka Diansyah ¹ , Risky Utama Putra ¹ , Muhammad Imam Ammarullah ¹ , Hasan Basri ^{1*}	28
Scoopy Blade for Low Current River Waterwheel Supporting The Energy Needs in The Rural Areas of Indonesia.....	29
Darmawi ¹ , Riman Sipahutar ² , Irwin Bizzy ³	29
SELT Design as a source of renewable electricity using the Flywheel Generator and Photodiode Sensor	30
Indra Maulana, Dicky Seprianto, Yossy Yudhianto, Muhammad Najib, Muhamad Azwar.....	30
Analysis of Upgrading Process Of South Sumatera Low Rank Coal	31
Riman Sipahutar ¹ , Diah Kusuma Pratiwi ¹ , Darmawi Bayin ¹ , Irwin Bizzy ¹ , Baiti Hidayati ^{1,2}	31
The Effect of Parameters on The Process of Making Objects With Rapid Prototyping Digital Light Processing Technology on The Bending Stress	32
Romli ¹ , D Seprianto ¹ , DP Putra ¹ , M Rasid ¹ and A. Zamheri ¹	32
The Effect of Rectangular Parallel Key Manufacturing Process Parameters Made With Stereolithography DLP 3D Printer Technology against Impact Strength.....	33
D Seprianto ¹ , R Sugiantoro ¹ , Siproni ¹ , Yahya ¹ and M Erwin ²	33
Simulation of the Effect of Cutting Angle in Lathe Process on Distribution of Cutting Temperature ..	34



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Sriwijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
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Ismail T ¹ , Amrifan SM ² , Irsyadi Y ³ , Riman S ⁴ , Rahmad H ⁵	34
Conduction Heat Rate Analysis of Tool in Titanium Turning Process	35
Ismail T ¹ , Amrifan S M ² , Riman S ³ , Irsyadi Y ⁴ , Sandro O ⁵ , Fatiandari A ⁶	35
Cooling Channel Design for a Built-In Spindle of a Machine Tool.....	36
Kun-Ying Li ^{1,2} , Win-Jet Luo ^{2*} , Shih-Jie Wei ¹ , and Yan-sin Liao ¹	36
Design of Automatic Control Systems at Loader Output of Snap Gauge Machine in Manufacturing Industry	37
Syahril Ardi ¹ and Rahardian Faizal Zuhdi ²	37
The Influence of Change of an Angle of Illuminance on Solar Power Generating Capacity 30 Watts in Laboratory of Electrical Engineering Polytechnic of Sriwijaya.....	38
Zainuddin Idris, M. Yunus, Siswandi, Bambang Guntoro.....	38
The Effect of Drying Airflow Rate on H ₂ O MASS Evaporated for Banana Chips Drying Using Photovoltaic Solar Panel	39
Yohandri Bow ¹ , Adi Syakdani ² , Muhammad Taufik ² , Rusdianasari ³	39
Development and Feasibility Analysis of Floating Solar Panel Application in Palembang, South Sumatra.....	40
Benny Junianto ¹ , Tresna Dewi ² , Carlos Sitompul ²	40
Effects of Grid Frequency Drop on The Dynamic Performance of Full Converter Wind Turbine Generator.....	41
A. M. Shiddiq Yunus ¹ , Makmur Saini ² , Sri Suwasti ¹ , dan Purwito Purwito ³	41
Modified Design for Water Metering System.....	42
Nyayu Latifah Husni ¹ , Dampito ² , Abdurrahman ³ , Evelina ⁴ , ade Silvia Handayani ⁵ , Sabilal Rasyad ⁶ , Adella Rialita ^{7,1-7} Electrical Department, Politeknik Negeri Sriwijaya	42
Implementation of Fuzzy Logic Type-2 On Mobile Robot Navigation System.....	43
Ade Silvia Handayani, Jefri Alkausar, Sarjana Sarjana, Nyayu Latifah Husni, Siti Nurmaini, Irsyadi Yani.....	43
The Analysis of Wear on Artificial HIP Joint with Dimple on Femoral Surface	44
Hasan Basri ^{1*} , A. Syahrom ^{2,3} , Amir Putra Md Saad ² , A. T. Prakoso ¹ , D. Wicaksono ¹ , M. I. Amarullah ¹ , Tri Satya Ramadhoni ¹	44
Mechanical Degradation Model of Porous FE Scaffold: Simulation Approach.....	46



The 3rd FIRST 2019
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Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Akbar Teguh Prakoso ¹ , Ardiyansyah Syahrom ^{2,3} , Amir Putra Md Saad ^{2,3} , Abdul Hadi Abdul Wahab ⁴ , M. A. Sulong ^{2,3} , Achmad Rendiko Ichsan ¹ , Apreka Diansyah ¹ , Risky Utama Putra ¹ , Muhammad Imam Ammarullah ¹ , Hasan Basri ^{1*}	46
Scoopy Blade for Low Current River Waterwheel Supporting The Energy Needs in The Rural Areas of Indonesia.....	47
Darmawi ¹ , Riman Sipahutar ² , Irwin Bizzy ³	47
SELT Design as a source of renewable electricity using the Flywheel Generator and Photodiode Sensor	48
Indra Maulana, Dicky Seprianto, Yossy Yudhianto, Muhammad Najib, Muhamad Azwar.....	48
Analysis of Upgrading Process Of South Sumatera Low Rank Coal	49
Riman Sipahutar ¹ , Diah Kusuma Pratiwi ¹ , Darmawi Bayin ¹ , Irwin Bizzy ¹ , Baiti Hidayati ²	49
The Effect of Parameters on The Process of Making Objects With Rapid Digital Prototyping Light Processing Technology on The Bending Stress	50
Romli ¹ , D Seprianto ¹ , DP Putra ¹ , and M Rasid ¹	50
The Effect of Rectangular Parallel Key Manufacturing Process Parameters Made With Stereolithography DLP 3D Printer Technology against Impact Strength.....	51
D Seprianto ¹ , R Sugiantoro ¹ , Siproni ¹ , Yahya ¹ and M Erwin ²	51
Simulation of the Effect of Cutting Angle in Lathe Process on Distribution of Cutting Temperature ..	52
Ismail T ¹ , Amrifan SM ² , Irsyadi Y ³ , Riman S ⁴ , Rahmad H ⁵	52
Conduction Heat Rate Analysis of Tool in Titanium Turning Process	53
Ismail T ¹ , Amrifan S M ² , Riman S ³ , Irsyadi Y ⁴ , Sandro O ⁵ , Fatiandari A ⁶	53
Cooling Channel Design for a Built-In Spindle of a Machine Tool.....	54
Kun-Ying Li ^{1,2} , Win-Jet Luo ^{2*} , Shih-Jie Wei ¹ , and Yan-sin Liao ¹	54
Design Control Systems of Marking Machine and Total Length Check Damper Assembly Based on Programmable Logic Controller.....	55
Syahril Ardi ¹ and Juliantito Ardianto ²	55
Experimental Vibration Study in Milling Thin-Walled TI6AL4V Under MQL Using Coconut Oil As Cutting Fluid.....	56
M Yanis ^{1*} , A S Mohruni ¹ , S Sharif ² , I Yani ¹ , M Zahir ¹	56
Determination Overlap Ratio on Savonius Twisted Water Turbine Using Numeca Software.....	57
Dr. Carolus Bintoro ¹ , Vicky Wuwung MT ¹ , Fathurrohman Nurdin ²	57



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(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
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Optimization Electricity Supply for Thousand Island Jakarta Province by Using Hybrid Photovoltaic-Wind Turbine-Diesel Generator-Crude Palm Oil (CPO) Power Plant-Battery System	58
Dharma Manurung ¹ and Rinaldy Dalimi ¹	58
Study on Using Casting Simulation Software for Design and Analysis Gate and Riser in Small Foundry Industries	59
Irawan Malik ¹ , A S Almadora ² and M Ali ³	59
Application of Vacuum Valve Technology as AFR Settings in 3500 Watt Operated by Methane Gas .	60
Tri Widagdo ¹ , Ella Sundari, Eka Satria martomi ¹	60
Innovation Utilization of Nitridation Method in Improving Hardness and Corrosion Resistance of Blacksmiths Crafts	61
Muhammad Rasid, S.T., MT. ¹	61
Performance Analysis of a Sludge Drying	62
Win-Jet Luo ¹ Nai-Feng Wu ² Cheng-Yan Lin ² Deri Suhaeji ²	62
Study on Ventilation Performance in Operating Room with Variation Ventilation Design	63
Yan-Lin Wu, Yu-Lieh Wu, Azka Hasya Hanifan	63
D Santoso ¹ , Z Abidin ¹ , J Yanto ²	64
Analysis Model for Orifice Flow Meter Correction Factor in Measuring in-Pipe Natural Gas Flow based on Numerical Simulation	65
Bunyamin ¹ , Kaprawi ¹ , Dewi Puspitasari ¹ , Sugianto ² , Nyayu Latifah Husni ³	65
The Analysis of Biogas Fermentation Time from Cow Manure on Biodigester Fixed Dome Batch Systems	66
Sajaruddin ¹ , Leila Kalsum ¹ , Zainuddin Muchtar ²	66
The Effect of Surface Modification on Heat Transfer of Heat Exchanger	67
Hong-Yi Lin, Yu-Lieh Wu, Kai-Siang Yang, Chih-Yung Tseng	67
Prototype of Biodiesel Processors Using Waste Oil (Study of The Effect of The Number of CAO Catalyst (Blood Shell Shells) and Reaction Time of The Biodiesel Rendemen)	68
Ida Febriana ^{1,2} , Anerasari M1, KA Ridwan ¹ , Taufik Jauhari ¹	68
Production of Ethyl Ester with The Influence of Electrode Type, Reaction Time And Electric Voltage from Waste Cooking Oil	69
Rosdiana Moeksin [*]), Farida Ali, Susila Arita	69



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Biscuit Product Development Using Moringa Oleifera Flour as an Additional Source of Nutrition	70
Hilwatullisan ^{1(a)} , M. Zaman ¹ , A.Husaini ¹ and Siti Chodijah ¹	70
The Physical Characteristics of Cracked Plastic Waste	71
Selpiana ¹ , Prahady Susmanto ¹ , Lia Cundari ¹ , Dedek Oktari ² , Omar Ibrahim ²	71
The Analysis of The Use Calcium Oxide from Waste Cockle Shells (<i>Anadara Granosa</i>) and Sodium Hydroxide Catalyst on Prototype Biodiesel Processors Using Waste Cooking Oil Reviewed on Yield of Biodiesel.....	72
Sahrul Effendy, Tahdid, Lety Trisnaliani, Sandy A Putra, dan Alifah R Hefyani.....	72
Effect of Temperature and Starter Concentration on The Fermentation Process in Making MOCAF .	73
Muhammad Yerizam ¹ , Suri Andayana ¹ and Utari Oktavia ¹	73
Adsorption of Synthetic DYE by Betel Nuts Activated Carbon in a Fixed-Bed Column, Experiments And Prediction of Breakthrough Curves.....	74
L Cundari*, M N Fakhri, M Z Rizki	74
Effect of Catalysts on The Quality of Biodiesel from Waste Cooking Oil by Induction Heating	75
Rusdianasari ¹ , Aida Syarif ¹ , Muhammad Yerizam ² , M. Syahirman Yusi ³ , Leila Kalsum ¹ , Yohandri Bow ²	75
Characterization of Red Beetroot Soft Jelly Candy with Guava Extract and Gel Colloid Added.....	76
Meilianti* ¹ , Marta Aznury ¹ , Yuniar ¹ , Sofia ¹ , Ismy Farhan ¹ , Lidia Agustina ¹	76
Flow Rate Effect and NAOH Concentration to CO ₂ Reduction in Biogas Products Using Absorber	77
Lety Trisnaliani ¹ , Dina Eka Pranata ² , Fatria ³ , Tahdid ⁴ , KA Ridwan ⁵ , M. Nurizzman Alfarizi ⁶ , Mangihut Pandapotan Lumbantoruan ⁷	77
Prototype of Tray Dryer Unit for Silica Gel Drying Based on Bagasse	78
Selastia Yulianti ^{1(a)} , Fadarina ¹ , Mustain Zamhari ¹ , and Ibnu Hajar ¹	78
Modification of Starch from Yam Taro with Hydrolysis Acid as The Adhesive	79
Yuniar ^{1,2} , Martha Aznury ¹ , Sofiah ¹ , Meilianti ¹	79
The Performance of Riverse Osmosis (RO) Membrane in Producing Pure Water.....	80
Robert Junaidi ¹ , Abu Hasan ² , dan Muhammad Yerizam ³ , Indah Purnamasarii ⁴	80
Concentrations of Dissolved Oxygen in Drinking Water	81
Erwana Dewi ^{1(a)} , Aisyah Suci N ¹ and Elina M ¹	81
Growth Kinetics of <i>Saccharomyces Cerevisiae</i> and Tape Yeast on the Cassava Pulp Fermentation	82



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Beni Hidayat, Udin Hasanudin, Muhamad Muslihudin, Syamsu Akmal, Siti Nurdjanah, Neti Yuliana	82
Distillation of Patchouli Oil Using Firewood and Liquefied Petroleum Gas as Fuel: Effects of Yield, Quality and Cost Analyses.....	83
Mahlinda and M. Dani Supardan	83
Evaluation of Main Parameter Process of Anaerobic Digestion of Cow Dung in Fixed Dome Biogester on Methane Gas Quality	84
Leila Kalsum, Abu Hasan, Rusdianasari, A.Husaini Yohandri Bow	84
Re-Design Pyrolysis Reactor Prototype for The Conversion of Plastic Waste into Liquid Fuel.....	85
Arizal Aswan, IrawanRusnadi, Fatria, Zurohaina, Rima Daniar	85
Value Added Analysis of Beef Floss with Fillers of Papaya Fruits And Banana Blossom's.....	86
Sri handayani, Chandra utami wirawati, Saroni saroni, Dwi eva nirmagustina.....	86
Marketing Efficiency of Organic Rice in Lampung Province	87
Sri Handayani, Dwi Eva Nirmagustina, Muhammad Irfan Affandi.....	87
Simple design of pyrolysis tool for making liquid smoke from shells and rubber seeds as a food preservative	88
Farida Ali, ¹ Roval Al Fiqri ²	88
Industrial Mapping in Java-Kalimantan-Nusa Tenggara Corridor	89
M A Berawi ¹ , P Miraj ^{2,3} , H Sidqi ² , G R Gaffara ^{2,4} and Gunawan ²	89
Revenue Analysis of Port-City Conceptual Design	90
M A Berawi ¹ , P Miraj ^{2,3} , E R Islamiah ² , and Gunawan ²	90
The Utilization of Plastics Waste in Flexible Pavement Hot Rolled Sheet and Asphalt Concrete Wearing Course With Marshall Immersion and Cantabro Test.....	91
Adhitya B B ¹ , Pataras M ² , and Kadarsa E ³	91
Characteristics Comparison of Refinery Asphalt, Rubberized Asphalt, and Buton Asphalt in Stone Matrix Asphalt Pavement with Marshall and Cantabro Method.....	92
Kurnia A Y ¹ , Dewi R ² , Permata D Y ³ , and Pataras M ⁴	92
The Effect of Polycarboxylate Addition towards The Workability and High Strength Concrete	93
Sumiati ¹ , Mahmuda ² , Andi Herius ³ dan Agus Subrianto ⁴	93



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Stabilization of Peat Soils Using Petrasoil with Cement Viewed from CBR Value and Free Compressive Strength Value of Soils	94
Ibrahim, S.T.,M.T. ¹ , Andi Herius, S.T.,M.T. ² , Julian Fikri, S.S.T., M.Sc. ³ , M. Shaid Ramadhinata ⁴ , Maryani ⁵	94
The Utilization of Crushed Clay Brick as Coarse Aggregate on Eco-Green Lightweight Foamed Concrete.....	95
Sumiati ¹ , Mahmuda ² , Sukarman ³ , Siswa Indra ⁴ , and Darma prabudi ⁵	95
Performance analysis of Patal - Pusri Intersections after underpass operated	96
Arfan Hasan ¹ , Indrayani ¹ , Ridho Adrian ¹ , Dwiki Syamanda ¹ , Darma Budi ¹ , and Akhmad Mirza ¹ .	96
Utilization of Coconut Shells as a Replacement of Some Coral Stone in Concrete Making	97
Raja Marpaung, Kosim, Zainuddin, Darma Prabudi	97
Public Transportation Service Bus Rapid Transit (BRT) Trans Musi Sustainable in Palembang City.....	98
A. Latif, Yusri, Moch.Absor, A. Fuad Z.	98
Transportation Needed of Bus Rapid Transit (BRT) Corridor in Palembang	99
Herlinawati, Puryanto, Sudarmadji, Sazili.....	99
Effect of Groundwater Table on Slope Stability and Design of Retaining Wall	100
R Ahmad ^{1*} , A B Mardhanie ¹ , P Suroso ¹ , T E Sutarto ¹ and R Alfajri ²	100
Falisa ^{1*} , Hendri Chandra ^{2*} , Harnani ^{3*}	108
^{1,3} Teknik Geologi, Universitas Sriwijaya, Indralaya.....	108
² Teknik Mesin, Universitas Sriwijaya, Indralaya	108
* <i>Corresponding author</i> : falisa@unsri.ac.id.....	108
Information System of Small And Medium Business in Palembang City	112
Hetty Meileni, Cindy Indah Pratiwi, Ienda Meiriska, and Desi Apriyanty	112
Inventory of Goods Data Processing Using The Economic Order Quantity (EOQ) Method	113
Hetty Meileni, Diky Juniansyah Putra, Desi Apriyanti, Indra Satriadi, Sony Oktapriandi	113
Internet of Thing for the Command Robot Command System.....	114
Emilia Hesti ¹ , Sholihin ² , Adewasti ³ , Sarjana ⁴	114
The Effect Of Addition Of High Density Poly Ethylene (Hdpe) As Binder On Hebel Light Brick (Celcon)	115



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Sriwijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



The Effect Of Addition Of High Density Poly Ethylene (Hdpe) As Binder On Hebel Light Brick (Celcon)	116
Implementation of Fingerprint Control in Majors Electrical Engineering Using Arduino.....	117
Ibnu Ziad ¹⁾ , Ali Nudin ²⁾ , Jon Endri ³⁾ , Ciksadan ⁴⁾	117
Biodiesel Production From Bintaro (Cerbera Manghas L) Seeds With Potassium Hydroxide As Catalyst	118
The Copper Fiber On Compressive Strength And Elastic Modulus On Concrete Fc'25	119
Information System Feature Development Of Telecommunications Engineering Study Program To Support The New Accreditation And The New Curriculum System.....	120
Grip Tool Cnc Mill 3a To Get 12 Sides Of The Elbow On Results Induction Electrical Furnance Casting	121
Implementation Of Parking Portal Door Security System Using Rfid And Password Based On Microcontrollers In Sriwijaya State Polytechnic	122
Technique Automatic For Detection And Segmentation Of Optic Disc Area In Retinal Image	125
Erwin ¹ , B Cania ² , I K Larasati ³	125
New Techniques For Segmentation And Extraction Retinal Blood Vessels.....	126
Erwin, A Rohman, L A Nurjanah, Yurika, D Sinta, Q Al'afwa	126
Optimization of City Bus Routes in Surabaya Using Memetic Algorithm as a Solution to Solve Orienteering Problem	127
Fauzi Rakhmad Firdausi, Arif Djunaidy, Ahmad Muklason	127
A Form of Preprocessing For Social Media Data Extraction	128
Dodo Zaenal Abidin, Siti Nurmaini, Reza Firsandaya Malik, Jasmir Jasmir	128
Factors Affecting Knowledge Sharing Capability of Doctors in Palembang.....	129
Nining Ariati, Dana Indra Sensuse, Putu Wuri Handayani	129
Serious Game Supply Chain Management Agribusiness as a Production Planning using Cournot Model.....	130
Saiful Bukhori	130
Smart Cup for Visual Impaired People Based on Arduino	132
Aryanti Aryanti ¹² , Lin Wei-cong ¹ , Lin chih-yi ¹ , Billy Brian Henriquez ⁴ , Ikhtison Mekongga ³ , Aaron Raymond See ^{1*}	132
Challenges of Teaching in Massive Open Online Course	133



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



M A Ahmad ¹ , A R C Hussin, H M Dahlan ¹ , J Mahmood	133
Analysis of Service Oriented Architecture and Enterprise Architecture Alignment for Loan Financing System.....	134
Ahmad Nurul Fajar	134
Analysis of Service Oriented Architecture and Enterprise Architecture Alignment for Loan Financing System.....	135
Ahmad Nurul Fajar	135
Analysis of Server Virtualization Service Performance Using Citrix Xenserver”	136
Surahmat, Alfred Tenggono	136
The Pattern of The Marketing Ground Coffee Beans Using Decision Support System	137
Suparto Darudiato, Eliando Eliando	137
The Pattern of The Marketing Ground Coffee Beans Using Decision Support System	138
Suparto Darudiato, Eliando Eliando.....	138
The Utilization of Ontology in Association Rule.....	139
Dewi Wardani, Achmad Khusyaini	139
The Evaluation of Semantic Mapping	140
Dewi Wardani ¹	140
Measurement of User Satisfaction Level on Implementation of SISKEUDES Application	141
¹ Mardiana and ² Eka Hartati	141
Garbage Collector Robot (GACOBOT) Design for Dry Waste Distribution.....	142
Aditya P. P. Prasetyo, Rendyansyah, Sri Desy Siswanti, Siti Nurmaini, Abdurahman.....	142
Use of Haversine Formula in Finding Distance Between Temporary Shelter and Waste End Processing Sites.....	143
Rezania Agramanisti Azdy, Febriyanti Darnis.....	143
Geographic Information Systems Search Test Location For Admission Of New Students In Sriwijaya State Polytechnic Using Location Based Service (LBS) Method.....	144
Book Catalog Information System in The Reading Room (Library) Web-Based at Informatics Management Department in State Polytechnic of Sriwijaya.....	145
Henny Madora ¹ , Yusniarti ² , Ida Wahyunigrum ³ , Muhammad Noval ⁴	145
Pull-down Fitness Technique Analysis using Motion Capture	146



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Sriwijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



R Passarella, A S Nugroho, and F N Arsyad	146
Analysis of EDFAT Methods in Photography Techniques	147
Meiyi Darlies, Ema Laila, Ali Firdaus, Muhamad Erwin.....	147
Predicting Cost Recovery Rate of Ischemic Stroke Patients: A Potential Application of Big Data Analysis in Hospital	148
^{1*} Heru Fahlevi, ² Teuku Roli Ilhamsyah Putra and ³ Rina Suryani Oktari.....	148
Development Analysis For Numbers And Colors Learning Media	149
Yesi Sriyeni and Maria Veronica.....	149
Animation Design as an Educational Media of Adolescents’ Social Behavior Deviation” has been accepted with major revision	150
Heki Aprianto and Alan Saputro	150
Designing Mobile Based User Interface for Promotion of Lakeur Craft Art Application at Balaputra Dewa State Museum.....	151
Syahrul, Pertiwi	151
Prototype of RFID –Based Parking Slot Availability Detection System	152
Lindawati ¹ , I Salamah ¹ , Asriyadi ¹ , M Fadhli ¹	152
Mobile Robot Motion Control Based on Static Hand Gesture.....	153
DS Sri , FP Rian , Z Ahmad	153
Object-Based Design and Modeling Batik Nusantara Catalog Wibatara.com	154
Adelin Adelin, Febria Sri Handayani.....	154
Genetic Algorithm Based Feature Selection With Ensemble Methods For Student Academic Performance Prediction	155
Al Farissi, Halina Mohamed Dahlan, Samsuryadi.....	155
Information System Strategy Planning In The Private Universities Of South Sumatera.....	156
Engine Replacement Scheduling Optimization Using Data Mining	158
Farizal1 and Albert Joelian	158
User Experience Analysis on Class I LPKA Palembang Filial E-School	159
D. Tri Octafian, Febrianty, Hendra Hadiwijaya	159
Information System of Student’s Final Report And Final Assignment At State Polytechnic of Sriwijaya with Android Based.....	160



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Sriwijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Rika Sadariawati, A. Ari Gunawan, Meivi Kusnandar.....	160
Design of Semester Exam Scheduling at The State Polytechnic of Sriwijaya Application	161
Nita Novita, M. Aris Ganiardi, Indri Ariyanti, Delta Khairunnisa.....	161
Augmented Reality in the Registration Flow for Entrance Examination at State Polytechnic of Sriwijaya Based on Android	162
Rike Sucihati,Ahmad Bahri Joni Malyan, Ervi Cofriyanti	162
Design and Build Application of Campus Parking Area for State Polytechnic of Sriwijaya Based on Smartphone	163
Leni Novianti, Devi Sartika , Dewi Irmawati, Ienda Meiriska	163
Implementation of Biometric Fingerprint Barbasis Security Doors with Attendance Database on Sriwijaya State Polytechnic	164
A.Bahri Joni M , Herlambang Saputra , Ahyar Supani , Indarto	164
Designing and Applying Flood Early Warning System with Fuzzy Logic Based on Rainfall and Water Level for Special of Palembang City	165
Ahyar Supani, Yuli Adriani.....	165
Performance of RUS and SMOTE Method on Twitter Spam Data Using Random Forest.....	166
Huda Ubaya and Ria Siti Juairiah	166
Mobile Android Based Geographic Information System (GIS) Software Development for Tourist Destination Seekers in Palembang City Using RASCH Model Measurements.....	167
Sanjaya, Kurniawan, Saputra, Azhar	167
GIS Android Mobile Based Software Development for Tourism Objects, Public Places List, Transportations List, and Culinary Places List Using Usability Measurement	168
M. Rudi Sanjaya, Dedy Kurniawan, Ariansyah Saputra, Iman Saladin B Azhar	168
TRACK 3	172
MANAGEMENT ECONOMICS, BUSINESS ADMINISTRATION, ACCOUNTING	172
Impact of Learning, Socialization and Financial Lifestyle on Student' Intention to Invest in Capital Market.....	172
Dewi Fadila, Hendra Satrawinata, Mariskha Z, Riska Maulana.....	172
The Effect Of Capital Readiness And E-Commerce Utilization On The Competitiveness Of Micro Small And Medium Enterprises (Msmes) Woven Palembang.....	173
Dimensions of Village Expenditure in Development Sector	174



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Srijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Zulkifli Zulkifli, Rita Martini, Sukmini Hartati, Endah Widyastuti.....	174
Comparison Analysis of Organic Rice and an Organic Rice Added Value Approach.....	175
Dwi Eva Nirmagustina, Sri Handayani and Luluk Irawati	175
Analysis of Political Connection, Profitability and Capital Intensity Against Tax Avoidance in Coal Companies on The Indonesia Stock Exchange.....	176
Rizki Fitri Amalia.....	176
Human Resource Role and Application of Technology in the Fourth Industrial Revolution	177
Relationship Model among Employee Engagement, Organizational Commitment and Employee Performance	178
Munparidi, L.Suhairi Hazizma & A.Jalaludin Sayuti.....	178
The Effect of Customer Orientation and Service Quality on Trust and Customer Loyalty	179
Gst Ayu Oka Widarti, Esya Alhadi, Elvia Zahara, Titi Andriani.....	179
Fetty Maretha, Yulia Pebrianti, Rini, Lisnini.....	180
E-government Policy, Leadership Commitment, Apparatus Resources Development, and Their Implications on Public Service Performance.....	181
Koesharijadi, Hardiyansyah and Muhamad Akbar.....	181
Industrial Clasterization to Improve The Competitiveness of Small and Medium Industries in The City of Palembang	182
Evada Dewata, Yuli Antina Aryani, Yuliana Sari, Aladin	182
The Influence Of Competence, Leadership, Motivation Work Impact On The Commitment Of Civil State Apparatus In The Office Of The Governor South Sumatera Province	183
Sopian.A.R, Periansya, Ardiyan Natoen, Indra Satriawan.....	183
Analysis Method Economic Value Added (EVA) of Cosmetics Companies Listed on the Stock Exchange Period 2013-2017.....	184
Lupikawaty, Alhamdari, Bustan	184
Anggeraini Oktarida, Eka Jumarni Fithri, Lambok Vera Riama, Sri Hartati	185
The Effect of Hospital Image And Service Quality on Customer Loyalty Through Customer Satisfaction as Intervening Variables in Siti Khadijah Hospital in Palembang City.....	186
Susi Ardiani, Sarikadarwati, Henny Yulsiati, Sandrayati.....	186
The Impact of Village Fund Program Implementation towards Society Welfare in Indonesia	187



The 3rd FIRST 2019
(FORUM IN RESEARCH, SCIENCE, AND TECHNOLOGY)
International Conference

Jl. Sriwijaya Negara Bukit Besar Palembang 30139 South Sumatera – Indonesia
phone +62711 353414 Fax: +62711 355918



Yevi Dwitayanti, Maria Maria, Nurhasanah Nurhasanah, Rosy Armaini	187
Determinants of Village Financial Management Accountability (Study of Villages in Pampangan Sub-District, OKI Regency and Rambutan Sub-District, Banyuasin Regency)	188
Desi Indriasari, Kartika Rachma Sari, Kiagus Zainal Arifin, Choiruddin	188
Evaluation of Sales Price within Calculation Cost of Good Production SMEs Pempek Ilir Barat I and Bukit Kecil District Palembang	189
Elisa, Marieska Lupikawaty, Yusleli Herawati, Purwati.....	189
The Effect of Taxpayer Awareness and Tax Sanctions on Compliance In Paying Land And Building Taxes in Bukit Kecil Sub-District of Palembang.....	190
M. Husni Mubarak, Faridah, Nelly Masnila.....	190
The Environmental Compliance Management of Palm Oil Plantation in Ogan Komering Ilir Regency, Sumatera Selatan, Indonesia	191
M. Yusuf, Yusrizal Firdaus, Markoni Badri, AlHusori	191
Attitude, Motivation, and Parental Involvement towards Students' Reading Comprehension Achievement	192
Nurul Aryanti, Welly Ardiansyah, Murwani Ujihanti	192
Relationship between GPA, Length of Study, and Competence with The Length of Time to Get A Job at Alumni of The Mathematics and Natural Sciences, University of Sriwijaya.....	193
Ali Amran ¹ , Irmeilyana ¹ * and Anita Desiani ¹	193
Testing the Role of Charismatic Leadership, Psychological Climate, and OCB on Resilience	194
Wustari L. Mangundjaya	194
Individual Readiness For Change and Affective Commitment To Change: The Mediation Effect Of Technology Readiness On Public Sector	195
Hermina Agustina Mahendrati, Wustari Mangundjaya.....	195
Leader-Member Exchange and Affective Commitment to Change: Mediating Role of Change Self-Efficacy	196
Dwi Andriani Puspitasari, Wustari L Mangundjaya.....	196
Testing Mediation of Psychological Empowerment, Work Engagement to Affective Commitment to Change	197
Susilo ¹ , Wustari L. Mangundjaya ²	197
Aim, Concept, and Objectives of Education in Islam	198



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Suroso ¹ , Wasitoh Meirani ² , Muhammad Erwin ³ , Ayu Puspasari ⁴	198
Testing the Impacts of Organizational Justice on Affective Commitment to Change with Work Engagement as Mediator.....	199
Yurnalis, Wustari Mangundjaya	199
The Effect of Directed Reading - Thinking Activity on Students' Critical Thinking Abilities.....	200
Eliyeny, Herman, Sunani, Muhammad Nadjmuddin	200
The Development of Teaching Material Speaking 2 Based on Communicative Approach for Students in English Department of State Polytechnic of Sriwijaya.....	201
Darmaliana, Risnawati, Risa, Sri Endah Kusmartini.....	201
Exploring Linkage among Experiential Value, Destination Image and Revisit Intention in Natural-based Tourism.....	202
Heri Setiawan, Taufiq Marwa, Zakaria Wahab, Muchsin Sagaf	202
Students' Perception of English Blended Learning in State Polytechnic of Sriwijaya.....	203
Munaja Rahma, Zakaria, Moehammad Ridhwan.....	203
Online Transportation Technology and Women's Driver Communication Skills.....	204
Pridson Mandiangan, Desloehal Djumrianti, Hanifati	204
The Importance of The Language Experience Approach (LEA) in Teaching Reading Comprehension to The Third Semester of Engineering Students in State Polytechnic of Sriwijaya	205
Zulkifli zulkifli, nian evawati, koryati koryati.....	205
The Effect of Organization Climate on Performance with Job Satisfaction as an Intervening Variable	206
Paisal Paisal, Afrizawati Afrizawati, Divianto Divianto, Yahya	206
The Clustering of Paddy Fields in The Province of South Sumatera as an Input for The Government in Determining Policy.....	207
Suryati, Ahmad Sanmorino	207
The Public Service Quality of The Library Services at The Library Unit of State Polytechnic of Sriwijaya	208
Deri Darfin, Zulkarnaini, Ridwan Effendi, Robinson,.....	208
The Effectiveness of Blended Learning Approach on Essay Writing Subject.....	209
Sri Gustiani, Yusri, Tiur Simanjuntak, Evi Agustinasari.....	209



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Analysis of Student Services at State Polytechnic of Sriwijaya	210
Hadi Winarko, Zaliah, Aimi.....	210
The Effect of Culinary Knowledge and Culinary Experience on Local Culinary Attractiveness.....	211
Heri Setiawan ¹ , Abd. Hamid ² , Ummasyroh ³ & Jusmawi Bustan ⁴	211
Criminal Law Policy In The Crime Of Persecution Carried Out By People Who Come From Outside Orang Rimba Group Against Members Of Orang Rimba Tribe Around The Bukit Duabelas National Park, Jambi Province, Indonesia	212

The Effect of Rectangular Parallel Key Manufacturing Process Parameters Made with Stereolithography DLP 3D Printer Technology Against Impact Strength

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Abstract. This study aims to determine the effect of the thickness of the Layer and Exposure Time on the strength, impact toughness applied to the prototype of the reduction gear post, test specimens made using SLA DLP 3D Printer with 3D UV Resin Anycubic material and referring to ASTM D-256. In this research, creating objects using SLA DLP 3D Printer uses CAD data which is then converted into G-Code with Creation Workshop software. Factors investigated were layer thickness, exposure time with response impact strength using Charpy method of test specimens. The test result data were analyzed using ANOVA with type 2 factorial level design, 2 factorial interaction design (2FI), and replication 3 modelled by Design-Expert software. The results of the analysis revealed that the main factor that had the most influence on the impact strength of the test specimens was the layer Thickness factor with a percentage contribution of 52%, while the interaction between Layer Thickness and Exposure Time contributed 6%. Based on impact testing with a layer thickness parameter of 0.05 millimetres and an Exposure Time of 15 seconds, the optimal results are an average impact price of the Charpy method 0.005600 Joule/mm².

1. Introduction

Technological developments at this time have experienced very rapid progress, one of which is 3D printing technology or also known as additive manufacturing. 3D printing technology is the process of making solid objects from a digital file. This three-dimensional object printing process is known as additive manufacturing. This technology is applied in various fields of engineering and industry such as airplanes, bioengineering, medical devices, medical implants, and automotive products. There are many additive manufacturing systems available on the market such as stereolithography (SLA), fused deposition modeling (FDM), direct metal deposition (DMD), selective laser sintering (SLS), inkjet modeling (IJM) and stereo-lithography (SLA). [1]

The development of Digital Light Processing (DLP) 3D printer technology has made DLP a more widely used method today. Moreover, the DLP method is considered an interesting technology because it is able to print objects with a fairly fast time because the printing method is done per layer. However, the lack of standardization in the world of 3D printing and this knowledge makes research on the optimization of the process of the 3D printing machine very important.

The success of a 3-dimensional printing process is very dependent on the selection of appropriate and appropriate parameters. Determination of optimal process parameters is a very challenging job



because differences in the specifications of one printing with another will certainly affect the optimal combination of parameters. Some previous studies have indeed carried out the optimization of some process parameters in the slicer software in order to get the best print results. However, each machine also has different optimum settings so that an optimal parameter in a machine may not be compatible with other machines. Of these problems, there arises the need for research to find the parameter settings in the 3D printer to produce objects with maximum quality [2].

2. Methodology

The materials and methods used in this study are as follows:

- 3D UV Resin: This resin is a liquid (resin monomer and photoinitiator) that is used to make impact testing specimens with dimensions of 50mm x 10mm x 10mm, ASTM D 256 which is assisted by a digital printer (DLP) Digital Light Processing (DLP) printing device through a projector [3].
- Stereolithography (SLA): DLP 3D Printer acts as a print specimen for impact testing by radiation from DLP projectors with a dimension of 380mm x 280mm x 1000mm.



Figure 1. 3D UV resin

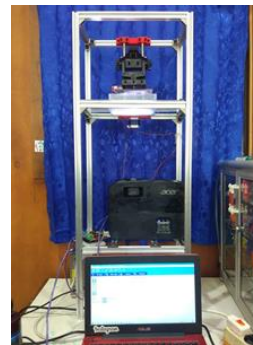


Figure 2. SLA DLP 3D Printer

- Process parameters: Process parameters are one of the process variables that can affect the quality of a printed product. In this study, the focus is on Layer Thickness and Exposure Time [4]. Table 1 shows the varying layer thickness used for the study.

Table 1. Layer thickness level

Parameter	Level
Layer Thickness (Z-axis)	0,025 mm
	0,05 mm

The second process parameter is the exposure time, the exposure time is the duration at which the resin is exposed under the light source for each layer. Table 2 shows the varied Exposure Time used for research.

Table 2. Exposure time level

Parameter	Level
Exposure Time	10 second
	15 second

- Experimental description: Specimens are material for testing, using 3D CAD software and then converted to stereolithography (STL) format. The STL file is then continued to the slicing process by the software used by the SLA DLP 3D printer and can set process parameters such

as table 1 and table 2. The geometry dimensions for specimen printing based on ASTM D 256 are conditioned for impact testing.

- **Impact Testing and Experimental Settings:** The impact test is a shock load test on something that we will examine. Impact test specimens were prepared using the above method used for testing the Charpy method [5]. The basic formula for calculating the value of the resilience value that will be used for testing this impact is:

$$HI = \frac{E_{srp}}{A} \quad (1)$$

Where:

HI : *Impact Value (Joule/mm²)*

E_{srp} : *Energy absorbed (Joule)*

A : *The cross-sectional area below the notch (mm²)*

Two independent process parameter variables to be examined are shown in table 1 and table 2. Statistical analysis of the data is carried out using expert design software, analysis of variance (ANOVA) provides a study of the variations that exist in the results of experiments conducted and tests of statistical significance, *P* value, is determined according to the total error criteria by considering a 95% confidence level. The influence of a factor will be significant if the critical level value (*P*) is lower than 0.05, discarding meaningless parameters for values *P* more than 0.05 [6].



Figure 3. Impact testing machine



a) Before



b) After

Figure 4. Specimens before and after impact test

3. Results and discussion

Toughness value of the specimens was measured in a mechanical laboratory using an Impact testing machine based on ASTM D 256 standards, each specimen was tested 3 times, the same conditions and randomly. The results can be seen in table 4.

3.1 Impact Testing and Experimental Settings

The effect of layer thickness and exposure time on the value of toughness is tabulated in Table 3.

Where:

LT = layer thickness

ET = exposure time

Table 3. Toughness test result

Specimens	Width	Thickness	Notch	Energy		Broken Cross-sectional area	Impact value
	mm	mm	mm	Kg.Cm	N.m (joule)	mm ²	Joule/mm ²
LT: 0.025 mm ET: 10 s	10	10	2	0.9	0,08829	80	0,001104
LT: 0.025 mm ET: 10 s	10	10	2	0,8	0,07848	80	0,000981
LT: 0.025 mm ET: 10 s	10	10	2	1,1	0,10791	80	0,001349
LT: 0.025 mm ET: 15 s	10	10	2	3,3	0,32373	80	0,004047
LT: 0.025 mm ET: 15 s	10	10	2	3,5	0,34335	80	0,004292
LT: 0.025 mm ET: 15 s	10	10	2	3,2	0,31392	80	0,003924
LT: 0.05 mm ET: 10 s	10	10	2	3,5	0,34335	80	0,004292
LT: 0.05 mm ET: 10 s	10	10	2	3,7	0,36297	80	0,004537
LT: 0.05 mm ET: 10 s	10	10	2	3,6	0,35316	80	0,004415
LT: 0.05 mm ET: 15 s	10	10	2	4,5	0,44145	80	0,005518
LT: 0.05 mm ET: 15 s	10	10	2	4,8	0,47088	80	0,005886
LT: 0.05 mm ET: 15 s	10	10	2	4,4	0,43164	80	0,005396

From table 3 is the result of 12 times the impact testing using the Charpy method and it can be concluded that the value of the right toughness value is the processing thickness of the 0.05 mm layer thickness and the exposure time of 15 s .

3.2 Analysis of variance (ANOVA)

To identify the effect of Layer Thickness and Exposure Time for impact test specimens, the analysis results were analyzed using analysis of variance (ANOVA). This analysis is a calculation technique that allows estimating the contribution of each factor quantitatively to all measurements of the response results by identifying hypothesis testing about the influence of the controlled factors and their interactions. Hypothesis (H_0) was tested that there was no influence of factors on the value of the specimen's test strength. Results from ANOVA using software design experts are shown in table 5. Model F-values of 286.18 indicates this model is significant. There is only a 0.01% chance that an F-value of this magnitude can occur due to noise. A value of "Prob> F" less than 0.0500 indicates a significant model term.

Layer thickness factor:

$$(B) = (0,01715-0,0003005) / 0,03255 = 52\%$$

Exposure time factor:

$$(C) = (0,01278-0,0003005) / 0,03255 = 38\%$$

Interaction Factor between layer thickness and exposure time:

$$(AC) = (0.01278-0,0003005) / 0,03255 = 6\%.$$

Layer thickness factor:

$$(B) = (0,01715-0,0003005) / 0,03255 = 52\%$$

Exposure time factor:

$$(C) = (0,01278-0,0003005) / 0,03255 = 38\%$$

Interaction Factor between Layer thickness and Exposure Time:

$$(AC) = (0.01278-0,0003005) / 0,03255 = 6\%.$$

Table 4. Summary design

Factor	Name	Units	Type	Subtype	Min	Max	Coded	Values	Mean	Std. Dev.
A	Layer Thickness	mm	Numeric	Continuous	0,025	0,05	-1,000=0,025	1,000=0,05	0,0375	0,0130558
B	Exposure Time	s	Numeric	Continuous	10	15	-1,000=10	1,000=15	12.5	2,61116

Response	Name	Units	Obs	Analysis	Min	Max	Mean	Std. Dev.	Ratio	Trans	Model
R1	Impact Test	Joule/mm ²	12	Factorial	0,000981	0,005886	0,00381175	0,00172028	6	None	2FI

Table 5. Constant 3D-Printing process settings

Source	Sum Of Squares	df	Mean Square	F Value	p-value Prob>F	
Model	3,225E-005	3	1,075E-005	286,18	<0,0001	Significant
A-Layer Thickness	1,715E-005	1	1,715E-005	456,60	<0,0001	
B-Exposure Time	1,278E-005	1	1,278E-005	340,26	<0,0001	
AB	2,317E-006	1	2,317E-006	61,68	<0,0001	
Pure Error	3,005E-007	8	3,757E-008			
Cor Total	3,255E-005	11				

Design-Expert® Software
Impact Test

Color points by value of
Impact Test:
0,005886
0,000981

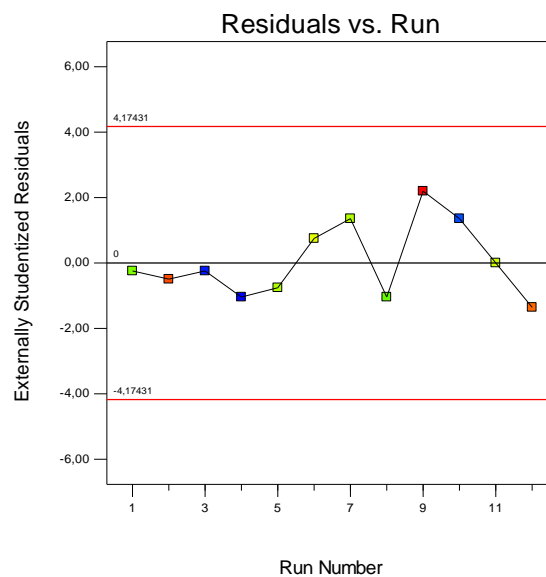


Figure 5. Independent residual graph of impact value

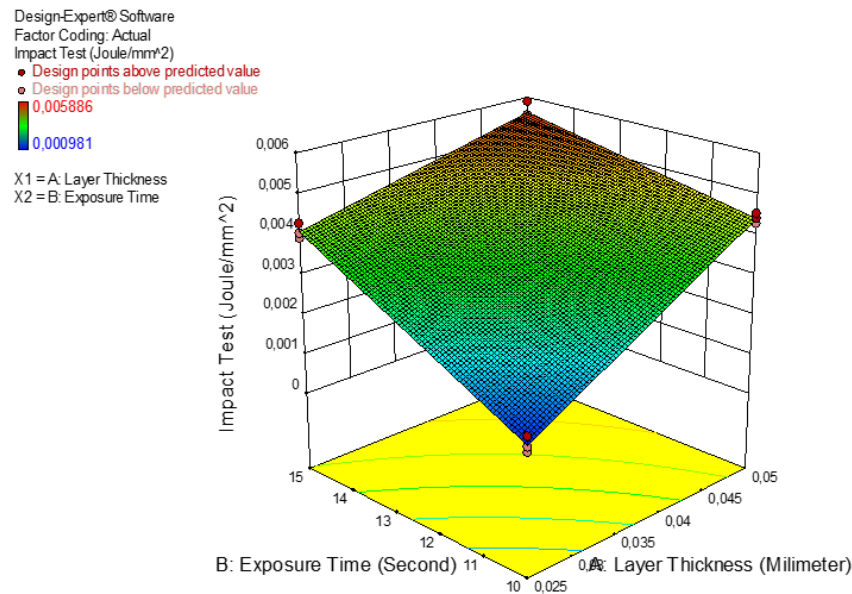


Figure 6. 3D graphics effect of factors on impact test values

4. Conclusion

Based on the results of testing and data analysis, conclusions can be drawn, as follows:

1. It is known that the optimal parameters and the influence of factors on the impact strength of the Charpy method of test specimens were made using additive manufacturing methods.
2. Based on the Impact testing Charpy method, the results of the thickness layer and exposure time parameters are 0.05 millimetres and 15 seconds
4. From the test, the layer thickness is 0.05 millimetres and Exposure Time 15 second, the optimal result is the average value of the impact value using the Charpy method is 0.005600 Joule / mm².
5. From the analysis results obtained that affect the level of strength and toughness is the layer thickness testing

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CERTIFICATE OF APPRECIATION

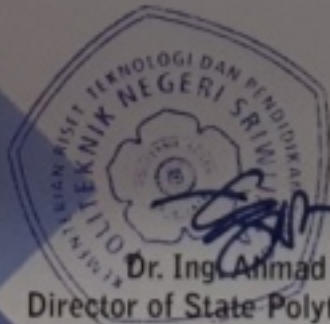
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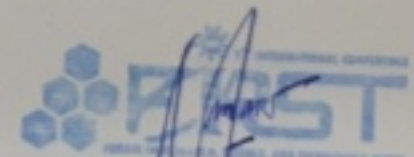
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