

Proceedings of 2019 The 2nd International Conference on Software Engineering and Information Management (ICSIM 2019)

Workshop
2019 The 2nd International Conference on
Big Data and Smart Computing
(ICBDSC 2019)



**Bali, Indonesia
January 10-13, 2019**





**The Association for Computing Machinery
2 Penn Plaza, Suite 701
New York New York 10121-0701**

ACM COPYRIGHT NOTICE. Copyright © 2019 by the Association for Computing Machinery, Inc. Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Publications Dept., ACM, Inc., fax +1 (212) 869-0481, or permissions@acm.org.

For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, +1-978-750-8400, +1-978-750-4470 (fax).

ACM ISBN: 978-1-4503-6642-7

The 2nd International Conference on Software Engineering and Information Management (ICSIM 2019)

Workshop

2019 2nd International Conference on Big Data and Smart Computing (ICBDSC 2019)

Table of Contents

Preface	viii
Conference Committees	ix
 Computer Theory and Technology	
A Scalable Operational Framework for Requirements Validation Using Semantic and Functional Models .. 1 <i>Issa Atoum</i>	
Mackey-Glass Chaotic Time Series Prediction Using Modified RBF Neural Networks 7 <i>Akhmad Faqih, Aldo Pratama Lianto, Benyamin Kusumoputro</i>	
An Enhanced Accuracy of a Prediction Model Having a Modified Genetic Algorithm with Cross-Average Crossover 12 <i>Markdy Y. Orong, Ariel M. Sison, Ruji P. Medina</i>	
An Overview of Learning Algorithms and Inference Techniques on Restricted Boltzmann Machines (RBMs) 16 <i>Esti Merindasari, M. Rahmat Widyanto, T. Basaruddin</i>	
An Analysis of Parameters of Convolutional Neural Network for Fire Detection 21 <i>Geum-Young Son, Marshall, Jangsik Park, Dong-Hee Lee</i>	
Optimization of Heterogeneous Sensor Networks with Clustering Mechanism Using Game Theory Algorithm 25 <i>Nina Hendrarini, Muhamad Asvial, Riri Fitri Sari</i>	

An Improved Initialization Method using Firefly Movement and Light Intensity for Better Clustering Performance	30
--	----

Maria Lolita G. Masangcap, Ariel M. Sison, Ruji P. Medina

A Study on ELM(Election pledge management for Local governors Model) Based on Machine Learning-Focused on On-Nara Document System-	35
--	----

Hong-Jae Lee, Kyeong-Seok Han , Tae-Hyun Kwon , Sang-Ung Han

Computer and Network Engineering

A Computer System Quality metric for Infrastructure with Configuration Files' Changes	39
---	----

Noriko Hanakawa, Masaki Obana

Security and Cost Optimization Auditing for Amazon Web Services	44
---	----

An Quoc Huy, Phan Duy Hung

Grid Base Energy Efficient Coverage Aware Routing Protocol for Wireless Sensor Network	49
--	----

Kusum Lata Jain, Smarnika Mohapatra

Telecom Network Monitoring and Fault Isolation with Visual Analytics	54
--	----

Preethi Subramanian, Sellappan Palaniappan

Analysis of SSD Internal Cache Problem in a Key-Value Store System	59
--	----

Won Seob Jeong, Yongseok Won, Won Woo Ro

Software Engineering and Application Design

Quality Function Deployment Analysis in Selecting Software Development Methodology: Case Study of ABC-CORP	63
--	----

Ciptoning Hestomo, Eko K. Budiardjo, Alex Ferdinansyah

A Productivity Framework for Software Development Literature Review	69
---	----

Steven Delaney, Doug Schmidt

A New Method of Latin-to-Balinese Script Transliteration based on Noto Sans Balinese Font and Dictionary Data Structure	75
---	----

G. Indrawan, I K. Paramarta, K. Agustini

JavaRelationshipGraphs (JRG): Transforming Java Projects into Graphs using Neo4j Graph Databases	80
--	----

Ritu Arora, Sanjay Goel

Automated Modular Invertebrate Research Environment Using Software Embedded Systems	85
---	----

Mehdi Mekni, Ashish Jayan

Literature Review on Test Case Generation Approach.....	91
---	----

Novi Setiani, Ridi Ferdiana, Paulus Insap Santosa, Rudy Hartanto

A Diversified Feature Extraction Approach for Program Similarity Analysis	96
<i>Ying Wang, Dahai Jin, Yunzhan Gong</i>	
A Systematic Literature Review of Improved Knowledge Management in Agile Software Development .	102
<i>Mochamad Umar Al Hafidz, Dana Indra Sensuse</i>	
Using Interactive Mouthguard as Alternative Control Method and Improve Mobile Gaming Experience with Selfadaptive Human-Computer Interface	106
<i>Shih-Chieh, Liao, Fong-Gong, Wu, Shu-Hsuan, Feng</i>	
Assessment of Test Maturity Model: A Comparative Study for Process Improvement.....	110
<i>Muhammad A. T. Laksono , Eko K. Budiardjo, Alex Ferdinansyah</i>	
PredICT: A Mobile Application for Predicting the Students' Career using Naïve Bayes Algorithm	119
<i>Risty M. Acerado, Roselia C. Morco, John Richard Santos, Janina Jasmin Carpio, Hannah Aubrey Isanan</i>	
How To Build Behavioral Intention On Start Up Business Of Mobile Application	124
<i>Joseph M J Renwarin</i>	
Requirement Elicitation Framework for Child Learning Application - A Research Plan	129
<i>Mira Kania Sabariah, Paulus Insap Santosa, Ridi Ferdiana</i>	

Data Mining and Big Data Technology

Data Mining Technique To Get Characteristics Customers of Bendesa Hotel With K-MEANS Algorithm	134
<i>I G Karang Komala Putra, Gede Indrawan, I Made Candiasa</i>	
Modified Anti-Monotone Support Pruning on FP Tree for Improved Frequent Pattern Generation	138
<i>Roseclaremath A. Caroro, Ariel M. Sison, Ruji P. Medina</i>	
Pricing Personal Data Based on Information Entropy	143
<i>Yuncheng Shen, Bing Guo, Yan Shen, Xuliang Duan, Xiangqian Dong, Hong Zhang</i>	
Measles Metapopulation Modeling using Ideal Flow of Transportation Networks.....	147
<i>Jann Railey Montalan, Maria Regina Justina Estuar, Kardi Teknomo, Roselle Wednesday Gardon</i>	
A Managerial Framework for Intelligent Big Data Analytics	152
<i>Zhaohao Sun, Yanxia Huo</i>	
Revealing High-Frequency Trading Provision of Liquidity with Visualization	157
<i>Michael Hirsch, Dianne Cook, Paul Lajbcygier, Rob Hyndman</i>	
Analysis of Outlier Data using Parallel Maximum Likelihood Estimator	166
<i>Yekti Widyaningsih, Devvi Sarwinda, Anis Y. Yasinta</i>	
Heterogeneous Data Integration using Confidence Estimation of Unseen Visual Data for Zero-shot Learning	171

Image Processing

Enhancing Facial Component Analysis.....	175
<i>Siska Pebiana, M. Rahmat Widyanto, T. Basaruddin, Dewi Yanti Liliana</i>	
Performance Evaluation of Enhanced RC6 Permutation-Diffusion Operation in Securing Images	180
<i>Catherine Bhel B. Aguila, Ariel M. Sison, Ruji P. Medina</i>	
Analysis of Frequency on Sound of Genta Based on Fast Fourier Transform Method	185
<i>I Gede Aris Gunadi, I Gusti Nyoman Yudi Hartawan</i>	
Person Re-identification through Clustering and Partial Label Smoothing Regularization	189
<i>Jean-Paul Ainam, Ke Qin, Guisong Liu, Guangchun Luo</i>	
Real Time Floor Sitting Posture Monitoring using K-Means Clustering	194
<i>Iwan Aang Soenandi, Meriastuti Ginting, Budi Harsono</i>	
Mapping the Buried Pipelines from GPR and GPS Data	199
<i>Xiren Zhou, Huanhuan Chen, Jinlong Li</i>	

Information System Design and Application

Social Networking Sites as Communication Tool for Dengue Related Healthcare and Wellness Information	204
<i>Rathimala Kannan, Kannan Ramakrishnan, Adedapo Oluwaseyi Ojo</i>	
Data Analytics for Veterinary Clinic using Predictive Analysis Technique and Segmentation Algorithm ...	208
<i>Mariella P. Buot, Risty M. Acerado , Beulah Grace A. Duque, Roselia C. Morco, Jemimah A. Padilla</i>	
Development of Instrument for Assessing Information Systems Continuance Use	213
<i>Mohd Zuhan Bin Mohd Zain, Ab Razak Bin Che Hussin</i>	
Building Digital Knowledge System Through Mobile Interfaces: The Case Study Of Mobile Application For Diabetes Management	218
<i>Maneesh Mathai Koottunkal, Athula Ginige, Uma Srinivasan, Federico Girosi</i>	
A Context-Aware Multi-Channel Messaging Framework for African Banks: Design and Implementation	224
<i>Olusola SALAMI, Jabu MTSWENI</i>	
Applying Hybrid Stimulation to Increase the Efficiency of a Medication Reminder	231
<i>Hsiu-Ching Lu, Kai-Yu Tsai</i>	
A Study on Traditional Medicine Ontology	235
<i>Suganya Selvaraj, Eunmi Choi</i>	

E-commerce and E-government

Integrated e-Business System Architecture for Small and Medium Enterprises	240
<i>Ni Made Satvika Iswari, Eko K. Budiardjo, Zainal A. Hasibuan</i>	
Proposition of Rank-Based Stepwise Interactive Visualization for Customer Segmentation in E-Commerce	244
<i>Tan Kok Sheng , Preethi Subramanian</i>	
E-Government Usability Evaluation: Insights from A Systematic Literature Review	249
<i>Ria Lyzara, Betty Purwandari, Muhammad Fadhil Zulfikar, Harry Budi Santoso, Iis Solichah</i>	
Evaluating the Development of E-Government in Indonesia	254
<i>Alvedi Sabani, Hepu Deng, Vinh Thai</i>	

Management Science and Operations Strategy

Innovative Tourism Navigation Operation Process and Decision Making	259
<i>Chia-Chieh Lee, Fong-Gong Wu</i>	
Enhancing Public Accountability through Digitalization of River Basin Management: The Case of Garang River	264
<i>Wijanto Hadipuro, Djoko Suwarno, Suyanto Edward Antonius</i>	
Street vendor management – Why not?	268
<i>Hoang Huu Son, Tran Thi Phuong Lien, Nguyen Tien Thao, Nguyen Tuan Nam, Hoang Van Anh</i>	

Information Education and Learning

BERKOOLIAH: Utilizing Social Media to Encourage Youths in Pursuing Higher Education	274
<i>Fadelie Deby Subandi, Eko Hermanto, Nanda Shafira Keumala, Dyah Ayu Dewianti Putri, Sherly S. Turnip</i>	
Developing Interactive Bible Learning Model Based on Mobile for Children	279
<i>Hadi Sutopo, Hindriyanto D. Purnomo, Silaen Sondang Maria, Swati Lee, Altobeli Lobodally, Arie Setiawan Prasida</i>	

Preface

It is our great pleasure and honor to bring you to this collection of articles from the 2019 2nd International Conference on Software Engineering and Information Management (ICSIM 2019) and its workshop 2019 2nd International Conference on Big Data and Smart Computing (ICBDSC 2019) which were held in Bali, Indonesia on January 10th - 13th, 2019.

The primary focus of this conference was to bring together academicians, researchers and scientists for knowledge sharing in various area of software engineering, information management, big data and smart computing. The ICSIM 2019 and its workshop ICBDSC 2019 served as a good platform for scientist community where participants met to exchange ideas.

The evaluation of all the papers was performed based on the reports from anonymous reviewers, who were qualified in the fields of software engineering, information management, big data and smart computing. We received 106 papers, and 56 papers were selected to presentations coming from countries and regions: Canada, USA, China, South Africa, Malaysia, Philippines, Indonesia, Jordan, Japan, India, Turkey, Viet Nam, Australia, South Korea, United Kingdom, Papua New Guinea, and Taiwan.

We would like to thank our keynote speakers who were pleased to make contributions to our conference and shared their new research ideas with us. They are Prof. Rajkumar Buyya, IEEE Fellow, Director of Cloud Computing and Distributed Systems (CLOUDS) Lab, The University of Melbourne, Australia and CEO of Manjrasoft Pvt Ltd, Melbourne, Australia; Dr. Eko K. Budiardjo from University of Indonesia, Indonesia; and Prof. Dr. I Nengah Suparta from Universitas Pendidikan Ganesha (Undiksha), Indonesia.

We also express our heartfelt appreciation to our chairs, sponsors, program chairs, technical committee members, organizing committee members, authors and delegates, who made a lot of efforts and contributions. Thanks to their support and help, we have held this conference successfully and always keep making progress. Finally, we also would like to take the opportunity to thank all reviewers who reviewed a huge number of papers. Last but not least, I would like to express our gratitude to local organizing committee members for their efficient assistances in holding the conference.

Yours sincerely,

Conference Chair

Dr. Hadi Sutopo
Kalbis Institute, Indonesia

Conference Committees

Conference Chairs

Dr. Hadi Sutopo, Kalbis Institute, Indonesia

Prof. Dr. I Nengah Suparta, Universitas Pendidikan Ganesha (Undiksha), Indonesia

Prof. Nabil EL Kadhi, University of Buraimi, Sultanate of Oman

Program Chairs

Prof. Dr. Eko K. Budiardjo, University of Indonesia, Indonesia

Prof. Mohamed Sbihi, Mohammed V University in Rabat Morocco, Morocco

Local Organizing Committee

Dr. Ketut Agustini, Universitas Pendidikan Ganesha, Indonesia

I Made Agus Wirawan, Universitas Pendidikan Ganesha, Indonesia

I Gede Mahendra Darmawiguna, Universitas Pendidikan Ganesha, Indonesia

I Gede Aditra Pradnyana, Universitas Pendidikan Ganesha, Indonesia

Technical Committee

Prof. Dr. Ir. Eko Sudiyono, M.Kom, Universitas Kristen Satya Wacana, Indonesia

Prof. Dr. Ir. Maria Angela Kartawidjaja, Universitas Katolik Indonesia Atma Jaya, Indonesia

Prof. M. Surendra Prasad Babu, Universitas Katolik Indonesia Atma Jaya, Indonesia

Dr. Evizal Abdul Kadir, ST, M.Eng, Universitas Islam Riau, Indonesia

Prof. Abdeslam El Fergougui, Moulay Ismail University, Morocco

Asst. Prof. Murat Karakaya, Atilim University, Turkey

Prof.(Dr.) Anuranjan Misra, Noida International University, India

Prof. Hamzi Rachida;university batna2,Algeria

Asst. Prof. Nithinant Thammakoranonta, National Institute of Development Administration, Singapore

Prof. Rajaa Saidi, Rabat IT Center and SI2M Laboratory, Morocco

Prof. Moulay Driss Rahmani, Mohammed V University in Rabat, Morocco

Asst. Prof Yassine Laadidi, FSTS, Morocco

Assoc. Prof. EZZATI Abdullah, Hassan First University, Morocco

Asst. Prof. Karim Guennoun, Hassania Engineering School (EHTP), Morocco

Lecturer EDDREN LAW YI FENG, Universiti Tenaga Nasional, Malaysia

Assoc.Prof. Bi-Ru Dai, National Taiwan University of Science and Technology, Taiwan

Prof. Nacer Eddine Zarour, Constantine 2- A. Mehri University, Algeria

Asst. Prof. Emsaieb Geepalla, Sebha University, Libya

Prof. Mostafa Hanoune, University Hassan 2 of Casablanca, Morocco

Asst. Prof. Jaroslav Rozman, Brno University of Technology, Czech Republic

Prof. Prabhat K. Mahanti, University of New Brunswick, Canada

Dr. Gabriele Mencagli, University of Pisa, Italy

Dr. CHUA Chin Heng Matthew, National University of Singapore, Singapore

Dr. Malka N. Halgamuge, The University of Melbourne, Australian

Dr Amir H. Alavi, Michigan State University, USA.

Dr. Michael Opoku Agyeman, The University of Northampton, UK

Dr. Ghizlane ORHANO, Faculté des Sciences, Université Mohammed V, Rabat, Maroc
 Dr. Lahoucine EL MAIMOUNI, Ibn Zohr University, Morocco
 Dr. Jiannan Zhai, Florida Atlantic University, USA
 Assoc. Prof. Ahmad Taher Azar, Benha University, Egypt
 Dr. Paulus Insap Santosa, Universitas Gajah Mada, Indonesia
 Dr. Fuhua (Oscar) Lin, Athabasca University Alberta, Canada
 Dr. KokSheik Wong, Monash University Malaysia, Malaysia
 Dr. Lipur Sugiyanta, Universitas Negeri Jakarta, Indonesia
 M. Jamal Deen, McMaster University, Canada
 Dr. Wan Abdul Rahim Wan Mohd Isa, Universiti Teknologi MARA, Malaysia
 Dr. Jabu Mtsweni, Council of Scientific and Industrial Research (CSIR), South Africa
 Asst Prof. Madhu Nakirekanti, Vardhaman College of Engineering, India
 Prof. Altobeli Lobodally, Kalbis Institute, Indonesia
 Dr. Wijanto Hadipuro, Soegijapranata Catholic University, Indonesia
 Dr. Issa Atoum, The World Islamic Sciences and Education, Jordan
 Asst Prof. Boran Sekeroglu, Near East University, Turkey
 Dr. Roselia Morco, Technological Institute of the Philippines, Philippines
 Dr. Xiren Zhou, University of Science and Technology of China, China
 Dr. Ketut Agustini, Universitas Pendidikan Ganesha, Indonesia
 Asst. Prof. Masaki Obana, Osaka Institute of Technology, Japan
 Dr. Joseph M J Renwarin, Institut Teknologi dan Bisnis Kalbis (Kalbis Institute) Indonesia
 Dr. Gede Indrawan, Universitas Pendidikan Ganesha (Undiksha), Indonesia
 Asst. Prof. Roseclaremth Caroro, Misamis University, Philippines
 Prof. Ariel Sison, Emilio Aguinaldo College, Philippines
 Prof. Dong-Hee Lee, Kyung Sung University, South Korea
 Asst. Prof. Markdy Orong, Misamis University, Philippines
 Prof. Hepu Deng, RMIT University, Australia
 Dr. Gede Rasben Dantes, Universitas Pendidikan Ganesha, Indonesia
 Dr. Sularso Budilaksono, Universitas Persada Indonesia YAI, Indonesia
 Dr. Roselia C. Morco, Technological Institute of the Philippines, Philippines
 Dr. Kanokwatt ShiangJan, University of Phayao, Thailand
 Yulius Denny Prabowo, Kalbis Institute, Indonesia
 Prof. Khaldi Mohamed, Abdelmalek Essaadi University, Morocco
 Prof. Youness Tabii, University of Abdelmalek Essaâdi, Morocco
 Assoc. Prof. M. Arioua, University of Abdelmalek Essaadi, Morocco
 Mounir Arioua, University of Abdelmalek Essaadi Tetouan-Tanger, Morocco
 Prof. Mostafa Bellafkih, Networks Laboratory, Morocco
 Sbai El Hassan, University of MY Ismail- Meknes, Morocco
 Dr. Marouane El Mabrouk, Abdelmalek Essaadi University, Morocco
 Prof. Imane Haddar, National Institute of Posts and Telecommunications, Morocco
 Prof. Onur Demirörs, Middle East Technical University, Turkey
 Assoc. Prof. Dr. Ebru Vesile Ocalir, Gazi University, Turkey
 Prof. Ahmed M. Khedr, University of Sharjah, UAE
 Dr. Khaled Hamad, University of Sharjah, UAE
 Prof. Wageeh El-Askary, Menoufiya University, Egypt
 Assoc. Prof. Abd Elrahman G. Osman, National Center of Research, Sudan

Prof. Imtiaz Ahmad, Kuwait University, Kuwait
Asst. Prof. Bruneo Dario, University of Messina, Italy
Asst. Prof. Dr. Gulustan Dogan, Yildiz Technical University, Turkey
Prof. Tzung-Pei Hong, National University of Kaohsiung, Taiwan
Assoc. Prof. Bart Custers, Leiden University, Netherlands
Dr. Preethi Subramanian, Asia Pacific University of Technology and Innovation, Malaysia
Prof. Zhaohao Sun, PNG University of Technology, Papua New Guinea
Asst. Prof. Abhishek Kumar, MDSU Ajmer, India
Dr. Iwan Aang Soenandi, Krida Wacana Christian University, Indonesia
Assoc. Prof. Rajendrakumar Anantrao Patil, College of Engineering Pune, India
Prof. Kyeong-Seok HAN, Soongsil University, Korea
Dr. Paulo Batista, University of Évora, Portugal

Real Time Floor Sitting Posture Monitoring using K-Means Clustering

Iwan Aang Soenandi

Department of Industrial Engineering
Faculty of Engineering & Computer
Science

Krida Wacana Christian University
Tanjung Duren Raya No. 4 Jakarta
11470, Indonesia

iwan.as@ukrida.ac.id

Meriastuti Ginting

Department of Industrial Engineering
Faculty of Engineering & Computer
Science

Krida Wacana Christian University
Tanjung Duren Raya No. 4 Jakarta
11470, Indonesia

meriastuti.ginting@ukrida.ac.id

Budi Harsono

Department of Electrical Engineering
Faculty of Engineering & Computer
Science

Krida Wacana Christian University
Tanjung Duren Raya No. 4 Jakarta
11470, Indonesia

budi.harsono@ukrida.ac.id

ABSTRACT

The production of *Emping Melinjo* is one of cottage industries in *Cilegon, Banten*, which has a great potential to grow because of the high demand of the product. The major workforces in the production are females who do the labor at home. However, due to the traditional practice in the activity, workforces conduct their activities while sitting on the floor and this turned to be a potential health problem during work, such as LBP (Low Back Pain). In this paper, we proposed to build the data acquisition system for working posture and build the monitoring system that can prevent static postures. This proposed system is based on positioning posture with data clustering method using pressure measurement by 4 position sensors. Based on these 5 clusters, we defined the tracking postures as: in the middle position, backward position, forward sitting posture, and laterally tilted left or right sitting posture.

CCS Concepts

•Computing methodologies→Machine learning→Learning paradigms→Unsupervised learning→Cluster analysis

Keywords

Low Back Pain; Sensor; Static Sitting Posture; Data Acquisition; Clustering.

1. INTRODUCTION

The production of *Emping melinjo* is one of agroindustry-products which have a great potential to be developed since it contributed more on economic growth by creating job opportunities and alleviating poverty. In the current situation, this industry appeals well as a family economic activity in which it is easily implemented, can be done as part-time job and does not require any special skill so that rural women or housewives can run both public role and domestic role at the same time. Commonly, this

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org

ICSIM 2019, January 10–13, 2019, Bali, Indonesia

© 2019 Association for Computing Machinery.

ACM ISBN 978-1-4503-6642-7/19/01...\$15.00

<https://doi.org/10.1145/3305160.3305209>

production activity is performed manually on the floor and this job was classified as a repetitive task, implying that it has major risk factor that is associated with musculoskeletal symptoms. As a nature of traditional, cottage industries, on-floor or ground sitting postures are unsurprisingly popular, as portrayed in Figure 1. References often assume such awkward sitting postures, if maintained for prolonged period, would likely be a risk factor for low back pain (LBP)[1][2]. Thus, the purposes of this study are to assess the movement of body postures in real-time on-floor work and to identify the static and awkward sitting postures during work in definite interval.

The optimal occupational sitting position and sitting behavior has been extensively discussed in the literature during recent years. They discussed about the thought of an ideal sitting position with upright posture has been strongly questioned [3] and has been slowly replaced by the concept of “Dynamic Sitting”. A literature review conducted by Pynt et al.(2001) [4] suggests that there is no ideal sitting posture. According to these authors, some regular movements and a good seated posture is essential for preventing LBP [5][6].

In this case, pressure sensors have been widely used to identify the working posture in real time. In previous research, many systems tended to use components like force sensitive resistors (FSR) that connected to circuit boards (PCBs) [7]. Furthermore, all this sensors are attached to microcontrollers such as Arduino to get real time data acquisition using laptop.

Recent advances in real time measurement and data mining problems have proposed the use of machine learning algorithms in many researches. In this case we are agree that machine learning algorithms have the advantage of minimizing errors by training the problems through optimization and tuning and have recently been used in various practices, such as classification of sitting postures [8–12]. However, in the classification of sitting postures, the system needs to be calibrated (trained) well. In this study, we would like to propose another perspective of machine learning by using clustering method to analyze the on-floor sitting position and classify data with identical characteristics into certain classes in which the similarity of intra-class is maximized or minimized [13]. The limitation of this study is the data was obtained from female worker only and ruled out the environmental factors.

2. METHODS

2.1 Definition of Floor Sitting Posture

The initial step in this research was analyzing the posture of workers during approximately 5 hours of working a day. The

workers did their activity in on-floor sitting position as presented in Figure 1. This step included the analysis of the relation between sitting posture to LBP, which was completed by questionnaire spread to random female workers in the cottage industry area and by using SPSS to process the data.



Figure 1. The on-floor working posture

The results of SPSS are as shown in Table 1, indicating that there was a significant correlation between working posture, particularly static posture, to the LBP. In detail, the LBP was correlated to static position with a correlation efficient of 0.786 by Kendall's test and 0.870 by Spearman test.

Next, based on the observation to the working posture, we assumed the classification of the on-floor sitting postures were as follows: middle position, backward position, forward sitting posture, and laterally tilted to the left or right sitting posture. From this classification, we analyzed the number of objects in the clusters which were considered to be representing the working postures in the process of *emping* production

Table 1. Correlation analysis between LBP and static position

		Correlations	
		LBP	Static Position
Kendall'stau_b	LBP	Correlation Coefficient	1.000
		Sig. (2-tailed)	.786**
		N	20
Static Position	LBP	Correlation Coefficient	.786**
		Sig. (2-tailed)	1.000
		N	20
Spearman'srho	LBP	Correlation Coefficient	1.000
		Sig. (2-tailed)	.870**
		N	20
Static Position	LBP	Correlation Coefficient	.870**
		Sig. (2-tailed)	1.000
		N	20

** Correlation is significant at the 0.01 level (2-tailed).

2.2 System

This research was developed based on concept that the pressure sensing interfaces have demonstrated a good accuracy in the detection and tracking of posture for research purpose. In our work, we used the fabric based pressure sensor namely FSR Interlink 406 Square form; with the advantages of its flexibility in placement position, not expensive and easy to connect with microcontroller [14]. Due to the fabric nature of this sensing method, it has vast potential to be embedded into several common objects that we daily interact with. We used conductive fabric-based sensors on a chair to monitor real time movements in a

user's sitting posture. The positioning of sensors S1, S2, S3 and S4 is shown in Figure 2.

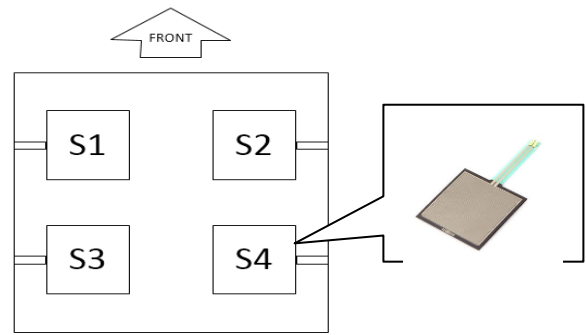


Figure 2. The arrangement and structure of FSR pressure sensor

In this study, we divided our system into 2 phases. Firstly, we set the system as real time data acquisition to collect the posture data during all-day work using Excel PLX-DAQ. Next, we designed the system to monitor the good practice of ground-sitting working postures and movements by using 4 sensors to collect the data within 3 minutes interval. This arrangement is unique to our system.

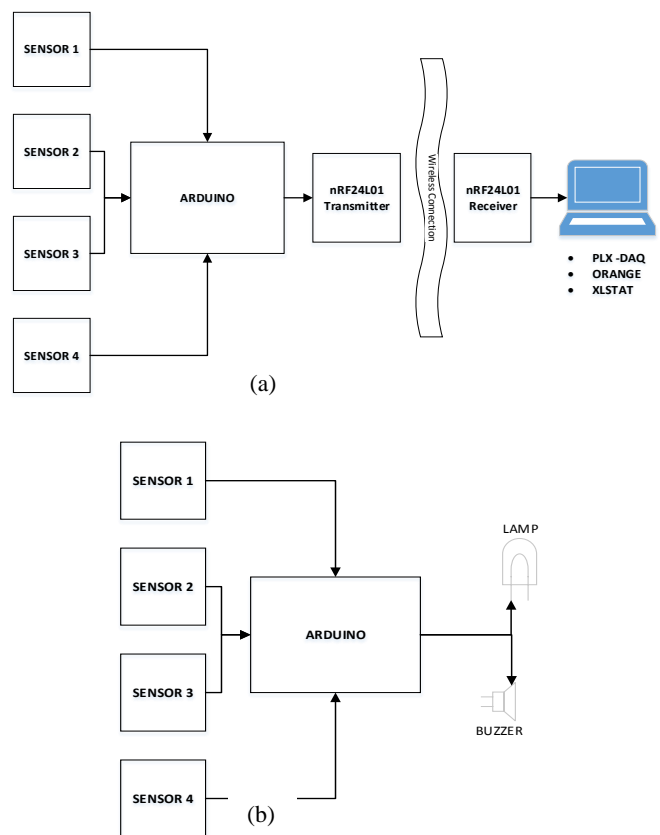


Figure 3. The structure of two modes of proposed system (a) Data acquisition mode, and (b) Monitoring mode

The main components of the sensor cushion are described in Figure 3 as data acquisition then applied for monitoring mode, using seat (foam cushion) that attached the four square-formed pressure sensors FSR Interlink 406, NRF24L01 wireless communication and a power bank for power supply. All

components were connected to Arduino Uno Microcontroller that encased in the lower left side of the seat cushion. The encased panel has lamp to notify the user about the connection and power status, and the alert for work posture.

3. RESULT AND DISCUSSION

3.1 Clustering

It is necessary to get real-time data during the working time for initial step of clustering, thus the system was set as a data acquisition system. Additionally, we have developed the system using wireless data acquisition system to improve the convenience in the time-consuming data acquisition process.

In real-time we set the real-time data collecting with interval of 1 minute while the working hour was 4 hours a day, resulting the dataset obtained was 240 data of work postures for each female worker. To obtain proportional data within each posture, we have briefed the female workers to move their body in five certain ways in each interval.

Next, we analyzed these data using Orange data mining software to find the optimal cluster of the data as schemed in Figure 4.

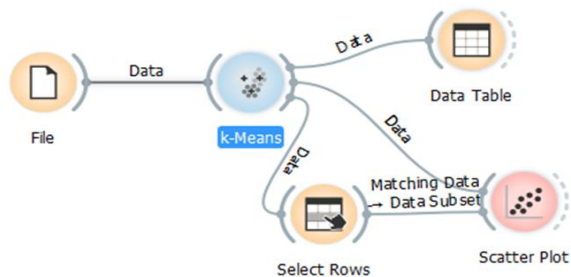


Figure 4. The model of K-Means Algorithm in Orange

In this work, we used scoring with Silhouette (heuristic) to find out the optimal cluster while for distance measurement we employed Euclidean method and random initialization. Data analysis performed using Orange resulted in output showing the optimal cluster for 4 working-hour data was 5 Cluster (k=5), as shown in Figure 5.

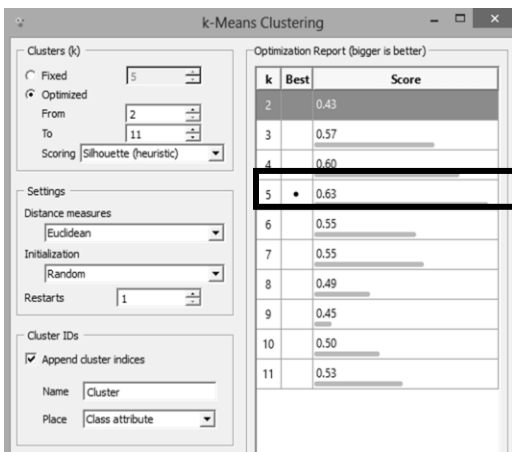
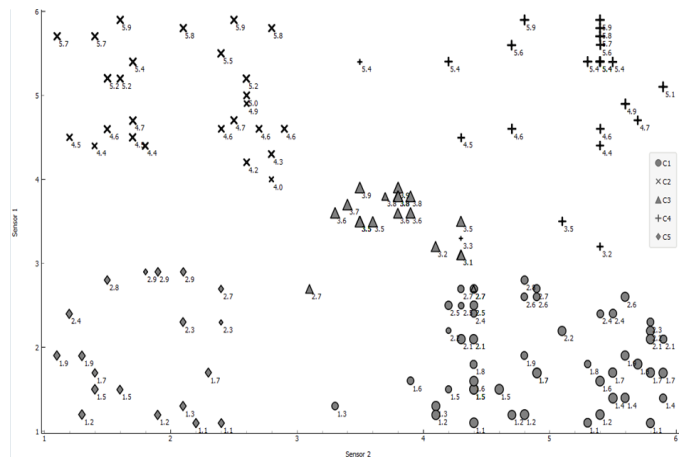


Figure 5. The number of cluster optimization report

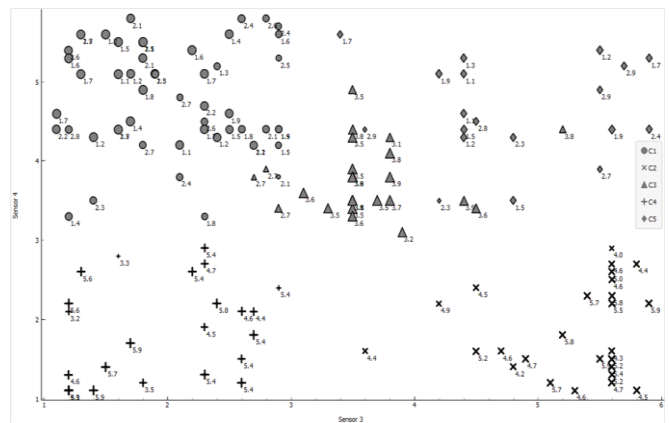
3.2 Tracking postures

For tracking posture monitoring, we determined the most optimal number of cluster was 5 (k=5). The optimal cluster obtained from

Orange data mining software and as well the output of the scatterplot is shown in Figure 6.



(a)



(b)

Figure 6. The Scatterplot of (a) Sensor 1 and 2 , (b) Sensor 3 and 4

Based on these 5 clusters, we defined the tracking postures as: in the middle position, backward position, forward sitting posture, and laterally tilted left or right sitting posture.

Next, we run the K-means algorithm in XLSTAT to discover the centroid of each cluster, shown in Table 2, and some results from each class are shown in Table 3. These centroids were set into the rules in Arduino to track the posture movement.

Table 2. Centroid Coordinate of each cluster

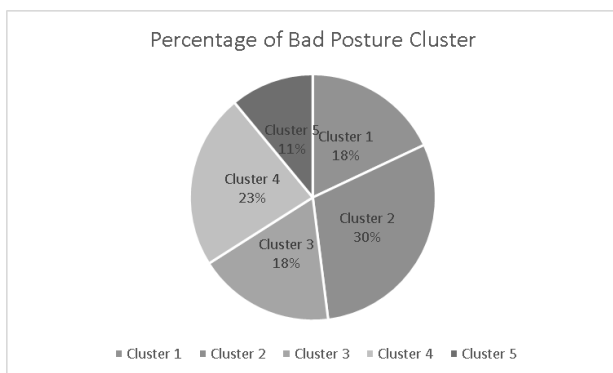
Class	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Within-class variance
1	4.875	2.150	5.319	1.869	1.326
2	1.921	5.095	1.979	4.747	1.676
3	5.004	5.113	1.965	1.883	1.703
4	1.963	1.811	4.795	4.637	1.594
5	3.609	3.774	3.696	3.770	0.535

Table 3. Clustering by good posture class

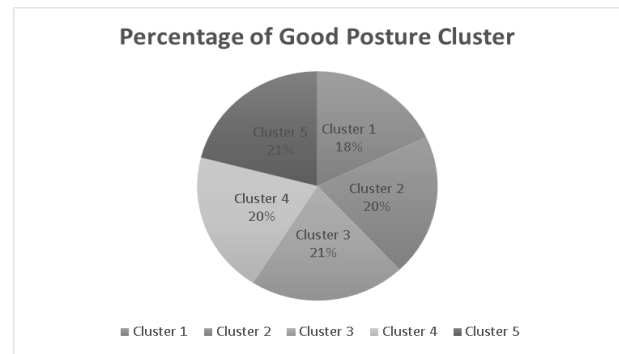
Class	1	2	3	4	5
Objects	44	47	51	47	51
Sum of weights	44	47	51	47	51
Within-class variance	1.326	1.676	1.703	1.594	0.535
Minimum distance to centroid	0.682	0.592	0.831	0.557	0.277
Average distance to centroid	1.074	1.225	1.224	1.196	0.640
Maximum distance to centroid	1.953	1.903	2.131	1.764	1.644

Table 4. Clustering by bad posture class

Class	1	2	3	4	5
Objects	44	72	42	55	27
Sum of weights	44	72	42	55	27
Within-class variance	1.323	1.461	0.664	1.703	1.594
Minimum distance to centroid	0.706	0.475	0.312	0.831	0.557
Average distance to centroid	1.097	1.161	0.707	1.224	1.196
Maximum distance to centroid	1.908	2.058	1.758	2.131	1.764



(a)



(b)

Figure 7. (a) The pie chart of bad posture clustering ,(b) The pie chart of good posture clustering

3.3 Discussion

In this study, we proposed a system to monitor five on-floor sitting positions by mounting only four low-cost load cells onto the seat cushion to obtain real-time data during all-day working time using clustering method. The system consisted of two modes: data acquisition mode and another mode for tracking or monitoring the working posture in real time basis.

The results of K-means optimal clustering using Orange data mining software disclosed that five position (k=5) was the most optimal number for clustering the pressure sensors data with highest silhouette score of 0.63. With this 5 clusters of: middle position, backward position, forward sitting posture, and laterally tilted left or right sitting posture, we proposed the system monitoring to prevent bad work posture using Arduino that was supplied with lamp and buzzer.

As a result of tracking the working position using clustering method, by assessing the number of objects in each cluster and comparing it to the other clusters, this system has succeeded to recognize the differences of working postures between each worker. When the number of objects of each cluster is relatively uniform, it represents that the operator conducted good working postures, and vice versa. Furthermore, this system was connected with buzzer to inform the working condition of bad postures. After we tested the system during real working time in this *emping melinjo* cottage industry, the system has succeeded in reducing the occurrences of bad postures, especially static working postures within the time interval of 3 minutes..

4. SUMMARY

To summarize, this present study has demonstrated the ability of sensor technology along with machine learning analyses to accurately cluster the various on-floor sitting positions. The appliance of such novel approaches, namely performing direct assessment with real time system with buzzer, could be a promising option for development as to prevent bad working posture due to on-floor sitting during work, which may cause LBP specially for repetitive working type. Future studies will also explore how the reliable of related measures correlate with operator performance or injury.

5. ACKNOWLEDGMENTS

The research was financially supported by Department of Research Institutions and Community Service from Krida Wacana Christian University, Jakarta, as recorded in the contract number 18/UKKW/LPPM-FTIK/Lit/XI/2017.

6. REFERENCES

- [1] Solomonow, M., Baratta, R.V., Banks, A., Freudenberger, C. and Zhou, B.H., 2003. Flexion-relaxation response to static lumbar flexion in males and females. *Clinical Biomechanics*, 18, 273–279.
- [2] Keawduangdee, P., Puntumetakul, R., Swangnetr, M., Laohasiriwong, W., Settheetham, D., Yamauchi, J., & Boucaut, R. 2015. Prevalence of low back pain and associated factors among farmers during the rice transplanting process. *Journal of Physical Therapy Science*, 27(7), 2239–2245.
- [3] Marx, G., Wirth, D., 1996. Dynamisches Sitzen” im Vergleich zu statischen Sitzhaltungen-eine experimentelle Studie. *Z. für Arbeitswiss.* 50, 51-58.
- [4] Pynt, J., Higgs, J., Mackey, M., 2001. Seeking the optimal posture of the seated lumbar spine. *Physiother. Theory Pract.* 17, 5-21.
- [5] Baumgartner, D., Zemp, R., List, R., Stoop, M., Naxera, J., Elsig, J.P., Lorenzetti, S., 2012. The spinal curvature of three different sitting positions analysed in an open MRI scanner. *The Scientific World Journal*, 184016.
- [6] Zemp R, Matteo T, Stefan P, et al., 2016. Application of Machine Learning Approaches for Classifying Sitting Posture Based on Force and Acceleration Sensors. *BioMed Research International*, Article ID 5978489.
- [7] Labeodan, T.; Aduda, K.; Zeiler, W.; Hoving, FF. Experimental evaluation of the performance of chair sensors in an office space for occupancy detection and occupancy-driven control. *Energy Build.* 2016, 111, 195–206. Seoul, Korea, 14–17 October 2012.
- [8] Zhu, M.; Martínez, A.M.; Tan, H.Z. 2003. Template-based Recognition of Static Sitting Postures. *IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit. Workshop* 5, 1–6.
- [9] Meyer, J.; Arnrich, B.; Schumm, J.; Troster, G. 2010. Design and modeling of a textile pressure sensor for sitting posture classification. *IEEE Sens. J.* 10, 1391–1398.
- [10] Ma, C.; Li, W.; Gravina, R.; Fortino, G. 2017. Posture detection based on smart cushion for wheelchair users. *Sensors* 17, 719.
- [11] Bowman, M., Debray, S. K., and Peterson, L. L. 1993. Reasoning about naming systems. *ACM Trans. Program. Lang. Syst.* 15, 5 (Nov. 1993), 795-825.
- [12] Soenandi, I. A., Djatna T., Suryani A., Irzaman, 2017. Real-time optimization using gradient adaptive selection and classification from infrared sensors measurement for esterification oleic acid with glycerol. *International Journal of Intelligent Computing and Cybernetics* 10(2), 130-144.
- [13] Varghese, B. M., Unnikrishnan, A., Sciencist, G., Kochi, N. P. O. L., & Kochi. 2010. Clustering Student Data to Characterize Performance Patterns. *Int. J. Adv. Comput. Sci. Appl.* 138-140.
- [14] Giovanelli, D., & Farella, E. 2016. Force Sensing Resistor and Evaluation of Technology for Wearable Body Pressure Sensing. *Journal of Sensors*, 1–13.

Certificate

Certificate for Oral Presentation

This certificate is awarded to:

B2-0015
Budi Harsono

With Paper Title:

Real Time Floor Sitting Posture Monitoring using K-Means Clustering

For her/his attendance and delivery of an oral presentation in the 2nd International Conference on Software Engineering and Information Management (ICSIM 2019) and its workshop: the 2nd International Conference on Big Data and Smart Computing (ICBDSC 2019) held in Bali, Indonesia on January 10-13, 2019.



Conference Committee
ICSIM 2019 & ICBDSC 2019