2nd ASEIS 2019 and 4th PRN-CON

The 2nd International Conference on Applied Science, Engineering and Interdisciplinary Studies and The 4th Prachachuen Research Network International Conference

PROCEEDING BOOK

4-5TH JULY 2019

at Rajamangala University of Technology Thanyaburi

THAILAND


RAJAMANGALA UNIVERSITY OF TECHNOLOGY THANYABURI

Message from President

Rajamangala University of Technology Thanyaburi is the technology university which focuses on human resource development in science and technologies. We emphases on producing professional hands-on graduates, who are ready to work, research, invent, innovate and provide innovation research to the community and society which support industrial needs, and benefit the countries economic advancement.

On behalf of the university, board and staffs, we cordially invite all the participants from all over the world to attend "The 2nd International Conference on Applied Science, Engineering, and Interdisciplinary Studies 2019 (2nd ASEIS 2019). The aims of this conference are to exchange and to discuss information about the latest developments, trends, research, and future outlook in science and technology field. It also provides a stimulating and informative forum for discussion and a platform for collaborations among professional societies, also to enhance technical exchanges among participants through plenary lectures and technical sessions.

On this occasion, I sincerely hope that the outcome of this meeting will be another step to provide the opportunity for researchers and students of the Rajamangala University of Technology Thanyaburi, together with 18 Universities from Prachachuen Research Network University. We sincerely hope that ASEIS-2019 serves as an international platform for meeting researchers from around the world, widen professional contact and create new opportunities, including establishing new collaborations, which is useful for the development of research to improve quality both nationally and internationally

We sincerely invite you to participate in ASEIS 2019 in Bangkok, THAILAND

Virach Hotravaisaya

(Mr. Virach Hotravaisaya)
Acting President
Rajamangala University of Technology Thayaburi, Thailand

Message from Vice President

Rajamangala University of Technology Thanyaburi (RMUTT) has an intense commitment and in resolution to educate, develop learning processes and support academic research, which produces qualified graduates to society and global markets requirements. RMUTT offers courses and programs leading to officially recognized higher education from bachelor to doctorate degrees in several areas of study. Our 29,000 alumni members are among the scientists, engineers, researchers, and innovators in industry, universities, and government sections on professional levels.

The theme of "The 2nd International Conference on Applied Science, Engineering and Interdisciplinary Studies 2019 (2nd ASEIS 2019) and The 4th Prachachuen Research Network National and International Conference (4th PRN-CON)" is to provide open discussion and valuable feedback among prestigious researchers, with their most current and innovative achievements in applied science, engineering, and interdisciplinary studies. The conference will include plenary speech, keynote speeches, invited speeches, oral presentations and poster presentations. As an annual gathering, it provides an extensive platform for scientists, researchers and scholars to present their research results and discuss the practical challenges encountered and the solutions adopted. The previous conference ASEIS 2018 successfully held in last year, has attracted over 150 participants from 6 countries.

(Assistant Professor Dr. Sommai Pivsa-Art)
Vice President
Rajamangala University of Technology Thayaburi, Thailand

Message from Director of Institute of Research and Development

Institute of Research and Development (IRD), Rajamangala University of Technology Thanyaburi is committed in developing a research and enhancing a research quality to be internationally recognized. We realized the importance of disseminating research results to society and encourage researchers to extend their research, invention and innovation into commercialization.

The 2nd ASEIS 2019 together with 4th PRN-CON conference offers a wonderful opportunity for all the scientists, academicians, industry people and young researchers to meet at one place to share and gain knowledge through oral and poster presentations in the fields of technologies. Participants from the top international academic, government and private industry of different disciplines participate in ASEIS 2019 to identify new technology trends, development tools, product opportunities, R&D collaborations, and commercialization partners. It is an excellent event for students to meet and discuss with lead researchers. The conference covers all frontier topics such as information and technology, visual information processing and color vision, innovation and technology for engineering, technology for medical science and herb, nanotechnology and applied materials, applied science, business management and administration, and humanity and social sciences.

We appreciate all the generous from our guests, many universities and research organizations in Thailand and worldwide. We hope that this conference will give you valuable contacts and knowledge which be helpful for everyone.

Warunee Ariyawiriyanan

(Assistant Professor Dr. Warunee Ariyawiriyanan)
Director of Institute of Research and Development
Rajamangala University of Technology Thayaburi, Thailand

2nd ASEIS 2019 ORGANIZING COMMITTEE

Advisory Chair

Virach	Hotravaisaya	Rajamangala University of Technology Thanyaburi, Thailand
Sommai	Pivsa-art	Rajamangala University of Technology Thanyaburi, Thailand
Sirikhae	Pongsawat	Rajamangala University of Technology Thanyaburi, Thailand

International Program Committees

Sumio Iijima	Meijo University, Japan
Li Chun	Institute of Chinese Materia Medica, Quality Control Center, China
Khasanov Oleg Leonidovich	National Research Tomsk Polytechnic University, Russia
Sanjay A. DeoKar	SPPU Pune University, India
Frank Zheng	International education innovation division, China
Vincent C Sun	Chinese Culture University, Taiwan
Hideki Sakai	Osaka City University, Japan
Ken Kokubo	National Institute of Advanced Industrial Science and Technology, Japan
Tomoko Ota	Chuo Business Group, Japan

Program Committees

Warunee	Ariyawiriyanan	Rajamangala University of Technology Thanyaburi, Thailand
Jakkree	Srinonchat	Rajamangala University of Technology Thanyaburi, Thailand
Amnuay	Ruengwaree	Rajamangala University of Technology Thanyaburi, Thailand
Ikeda	Mitsuo	Rajamangala University of Technology Thanyaburi, Thailand
Chanprapha	Phuangsuwan	Rajamangala University of Technology Thanyaburi, Thailand
Sivakorn	Angthong	Rajamangala University of Technology Thanyaburi, Thailand
Wirachai	Roynarin	Rajamangala University of Technology Thanyaburi, Thailand
Chanai	Noisaeng	Rajamangala University of Technology Thanyaburi, Thailand
Warachet	Khobjai	Rajamangala University of Technology Thanyaburi, Thailand
Sorapong	Pavasupree	Rajamangala University of Technology Thanyaburi, Thailand
Salitta	Saribud	Rajamangala University of Technology Thanyaburi, Thailand
Piyachat	Burawat	Rajamangala University of Technology Thanyaburi, Thailand
Pakornkiat	Sawetmethikul	Rajamangala University of Technology Thanyaburi, Thailand
Chaipoth	Hualmanop	Rajamangala University of Technology Thanyaburi, Thailand
Prakorb	Chartpuk	Rajamangala University of Technology Phra Nakhon, Thailand
Sumai	Binbai	Phranakhon Rajabhat University, Thailand
Pinthusorn	Pasanajano	Rajamangala University of Technology Suvanabhumi, Nonthaburi, Thailand
Boonchai	Waleetorncheepsawat	Sukohthai Thammathirat Open University, Thailand
Ananya	Dechakhamphu	Ubon Ratchathani Rajabhat University, Thailand
Piyalak	Ngernchuklin	Thailand Institute of Scientific and Technological Research, Thailand
Pongsathon	Phapugrangkul	Thailand Institute of Scientific and Technological Research, Thailand

Publicity and Website Committee

Nipat Jongsawat	Rajamangala University of Technology Thanyaburi, Thailand
Niti witthayawiroj	Rajamangala University of Technology Thanyaburi, Thailand
Jittima Singto	Rajamangala University of Technology Thanyaburi, Thailand

Host

- Institute of Research and Development, RMUTT, Thailand
- Nagaoka University of Technology
- Tomsk Polytechnic University
- Stamford International University
- Srinakharinwirot University
- Kasetsart University
- Maijo University
- Suan Dusit University
- Rangsit University
- Lampang Inter-Tech College
- Bangkok University
- Sukhothai Thammathirat Open University
- Rajamangala University of Technology Suvanabhumi, Nonthaburi
- Rajamangala University of Technology Phra Nakhon
- Rajapruk university
- Phranakhon Rajabhat University
- Panyapiwat Institute of Management
- National Research Council of Thailand
- Dusit Thani College
- Dhurakij Pundit University
- Sripatum University
- Thailand Science Research and Innovation

Organization Chair

Sommai Pivsa-art	Rajamangala University of Technology Thanyaburi, Thailand

General Secretariat

Warunee Ariyawiriyanan	Rajamangala University of Technology Thanyaburi, Thailand

Design and Publishing Team

Kochakron Darapranitch	Rajamangala University of Technology Thanyaburi, Thailand
Nuthawan Thamawatcharakorn	Rajamangala University of Technology Thanyaburi, Thailand
Mayuree Joy-A-Ka	Rajamangala University of Technology Thanyaburi, Thailand
Monticha Ruttanapan	Rajamangala University of Technology Thanyaburi, Thailand
Chatwadee Saiyaitong	Rajamangala University of Technology Thanyaburi, Thailand
Patcharee Silva	Rajamangala University of Technology Thanyaburi, Thailand
Saranya Jantang	Rajamangala University of Technology Thanyaburi, Thailand

LIST OF 2nd ASEIS 2019 REVIEWERS

Tomoko Obama	Shizuoka University of Art and Culture, Japan
Adi Djoko Guritno	Gadjah Mada University, Indonesia
Yu Ma	Optical Division, National Institute of Metrology, P.R.China
Yoko Mizokami	Chiba University, Japan
Hideki Sakai	Osaka City University
Vincent C Sun	Chinese Culture University, Taiwan
Shoji Sunaga	Kyushu University, Japan
Sanjay A. DeoKa	ZEAL College of Engineering and Research, India
Eng Gee Lim	Xi'an Jiaotong-Liveerpool University, China
Jong-Chul Lee	KwangWoon University, Korea
Li Chun	Institute of Chinese Materia Medica, Quality Control Center, China
Irene B. Rodriguez	Marine Secience Institute University of the Philippines Dilliman Quezon City, Philippine
Sanda Vladimir-Knežević	Faculty of Pharmacy and Biochemistry, University of Zagreb, Republic of Croatia
Biljana Blazžeković	Faculty of Pharmacy and Biochemistry, University of Zagreb, Republic of Croatia
Hideaki Ohgaki	Kyoto University
Kouichi Miura	Kyoto University
Hitomi Ohara	Faculty Fiber Science and Engineering, Kyoto Institute of Technology
Takeshi YAO	Kagawa College
Yuichi ANADA	Hokkaido Information University
Yuji Aso	Kyoto Institute of Technology
LEONG Yew Wei	Institute of Materials Research and Engineering (Singapore)
Taro Sonobe	Kyoto University
Keiichi Ishihara	Kyoto University
Tetsuo Tezuka	Kyoto University
Yasuaki Kishimoto	Kyoto University
Koichi Miura	Kyoto University
H.Unesaki	Kyoto University
Tomoko Ota	Chuo Business Group, Japan
Yu-Qiu Yang	Donghua University, China
Yew Wei Leong	Institute of Materials Research and Engineering (IMRE), Singapore
Tomoya Takeda	Kyoto Ryo En, Japan
Mitsunori Suda	Suda Store Co., Ltd, Japan
Nobuyoshi Kajioka	Daikyo Nishikawa Corporation, Japan
Hiroyuki Nishimoto	Takeda Chemical Industries, Co., Ltd, Japan
Yuji Fujita	Mitsubishi Chemical Corporation, Japan
Tohru Morii	Shonal Institute of Technology, Japan

Kazuhisa Tou	Mazda Motor corporation, Japan
Kengo Nodo	Nodo Seisakusho co., Ltd, Japan
Ryo Marui	Marui Textile Machinery co., Ltd, Japan
Mikako Ito	Keiseikai, Japan
Takeshi Senba	Kyoto Municipal Institute of Industrial Technology and Culture, Japan
Muhammad Sukri Saud	Universiti Teknologi Malaysia
Yusri Kamin	Universiti Teknologi Malaysia
Megat Aman Zahiri B Megat Zakaria	Universiti Teknologi Malaysia
Ana	Universitas Pendidikan Indonesia
Dedy Suryadi	Universitas Pendidikan Indonesia
Kiattisak Sangpradit	Rajamangala University of Technology Thanyaburi, Thailand
Sivakorn Angthong	Rajamangala University of Technology Thanyaburi, Thailand
Wirachai Roynarin	Rajamangala University of Technology Thanyaburi, Thailand
Lalita Siriwattananon	Rajamangala University of Technology Thanyaburi, Thailand
Warinthon Poonsri	Rajamangala University of Technology Thanyaburi, Thailand
Jaturong Lungkapin	Rajamangala University of Technology Thanyaburi, Thailand
Grianggai Samseemoung	Rajamangala University of Technology Thanyaburi, Thailand
Chanai Noisaeng	Rajamangala University of Technology Thanyaburi, Thailand
Monta Limthongkul	Rajamangala University of Technology Thanyaburi, Thailand
Sorapong Pavasupree	Rajamangala University of Technology Thanyaburi, Thailand
Amorn Chaiyasat	Rajamangala University of Technology Thanyaburi, Thailand
Thammasak Rojviroon	Rajamangala University of Technology Thanyaburi, Thailand
Sumonman Naimlang	Rajamangala University of Technology Thanyaburi, Thailand
Pakornkiat Sawetmethikul	Rajamangala University of Technology Thanyaburi, Thailand
Somporn Tulee	Rajamangala University of Technology Thanyaburi, Thailand
Jaipak Burapajatana	Rajamangala University of Technology Thanyaburi, Thailand
Kiatisak Punlumjeak	Rajamangala University of Technology Thanyaburi, Thailand
Sutthiporn Boonsong	Rajamangala University of Technology Thanyaburi, Thailand
Nuchnapa Tangboriboon	Kasetsart University
Suntree Sangjan	Kasetsart University
Supanida Winitchai	Kasetsart University
Nattapong Phanthuna	Rajamangala University of Technology Phra Nakhon
Suchada Katedee	Rajamangala University of Technology Phra Nakhon
Widchaporn Taipjutorus	Rajamangala University of Technology Phra Nakhon
Preecha Sakarung	Rajamangala University of Technology Suvarnabhumi
Somkiat Udomhunsakul	Rajamangala University of Technology Suvarnabhumi
Chaiyant Boonmee	Rajamangala University of Technology Suvarnabhumi
Amnat Jumrusjarongpol	Rajamangala University of Technology Suvarnabhumi
Khomdet Phapatanaburi	Rajamangala University of Technology Isan

Conference Program of 2nd ASEIS 2019 and 4thPRN-CON: July 4-5, 2019

July 4, 2019	
9.00-10.00	Registration at Songthanapitak Meeting Room and Welcome Drink at Victoria Room, 1st Fl.
10.00-10.10	Opening Remarks by Assoc.Prof.Dr. Prasert Pinprathomrat, Senator, THAILAND
10.10-10.50	**PL: Prof. Dr. Sumio Iijima, JAPAN Topic:** Nanoscience and electron microscopy
10.50-11.15	**KE01: Prof. Dr. Li Chun, CHINA Topic:** Biological activities based quality control of Medicinal plants using in Chinese Medicine
11.15-11.40	**KE02: Prof. Dr.Khasanov Oleg Leonidovich, RUSSIA Topic:** Properties of transparent luminescent nanoceramics doped with rare earth ions
11.40-12.05	**KE03: Prof.Dr.Sanjay A. DeoKar, INDIA Topic:**Application of Artificial Intelligence in Roof Top Solar PV net metering Grid Systems.
12.05-12.30	Announcement Prachachuen Research Network-Young Researcher Award 2019
12.30-13.30	Lunch at Victoria Room, 1st Fl.

July 4,2019	**Parallel Sessions at RMUTT Central Building, 10-11th Fl.**

Session 1: Information and Technology		**Session 2: Visual Information Processing and Color Vision**		**Session 3: Technology and Innovation for Engineering**		**Session 4: Medical Science and Herb**		**Session 5: Nanotechnology and Applied Materials**		**Session 6: Business Management and Administration (PRN National & International Conference)**		**Session 7: Humanity and Social Sciences (PRN National & International Conference)**	
Room	**1001**	**1002**		**1003**		**1004**		**1005**		**1101**		**1006**	
Chairs	Asst.Prof.Dr. Jakkree Srinonchat	Prof.Dr.Ikeda Mitsuo		Asst.Prof.Dr.Sivakorn Angthong		Dr.Chanai Noisaeng		Prof.Dr.Khasanov Oleg Leonidovich		Asst.Prof.Dr. Salitta Saribud		Asst.Prof.Dr.Pakornkiat Sawetmethikul	
Co-Chairs	Asst.Prof.Dr. Amnuay Ruengwaree	Dr.Chanprapha Phuangsuwan		Asst.Prof.Dr.Wirachai Roynarin		Asst.Prof.Warachet Khobjai		Dr.Prakorb Chartpuk Asst.Prof.Dr.Sorapong Pavasupree		Asst.Prof.Dr.Piyachat Burawat		Asst.Prof.Dr.Chaipoth Hualmanop	
14.00-14.25	S1IN1	14.00-14.25	S2IN1	14.00-14.15	S3O1	14.00-14.15	S4O1	14.00-14.25	S5IN1	14.00-14.15	S6O1TH	14.00-14.25	S7IN1
14.25-14.40	S2O1	14.25-14.40	S2O1	14.15-14.30	S3O2	14.15-14.30	S4O2	14.25-14.40	S5O1	14.15-14.30	S6O2TH	14.25-14.40	S7O1
14.40-14.55	S2O2	14.40-14.55	S2O2	14.30-14.45	S3O3	14.30-14.45	S4O3	14.40-14.55	S5O2	14.30-14.45	S6O3TH	14.40-14.55	S7O2
14.55-15.10	S2O3	14.55-15.10	S2O3	14.45-15.00	S3O4	14.45-14.55	Break	14.55-15.10	S5O3	14.45-15.00	S6O4TH	14.55-15.10	S7O3
15.10-15.25	S2O4	15.10-15.25	S2O4	15.00-15.15	S3O5			15.10-15.25	S5O4	15.00-15.15	S6O5TH	15.10-15.25	S7O4
15.25-15.40	S2O5	15.25-15.40	S2O5	15.15-15.25	Break			15.25-15.40	S5O5	15.15-15.30	S6O6TH	15.25-15.35	Break
15.40-15.50	Break	15.40-15.55	S2O6	15.25-15.40	S3O6			15.40-15.55	S5O6	15.30-15.40	Break	15.35-15.50	S7O5
15.50-16.05	S2O6	15.55-16.05	Break	15.40-15.55	S3O7			15.55-16.05	Break	15.40-15.55	S6O7TH	15.50-16.05	S7O6
16.05-16.20	S2O7	16.05-16.30	S2IN2	15.55-16.10	S3O8					15.55-16.10	S6O8TH	16.05-16.20	S7O7
16.20-16.35	S2O8	16.30-16.45	S2O7							16.10-16.25	S6O9TH	16.20-16.35	S7O8
16.35-16.50	S2O9	16.45-17.00	S2O8							16.25-16.40	S6O10TH	16.35-16.50	S7O9TH
16.50-17.05	S2O10	17.00-17.15	S2O9									16.50-17.05	S7O10TH
17.05-17.20	S2O11	17.15-17.30	S2O10										
17.20-17.35	S2O12	17.30-17.45	S2O11										
		17.45-18.00	S2O12										
14.00-18.00	**Poster Session Room 1007**												

CONTENT

CONTENT (CON'T)

INFORMATION AND TECHNOLOGY

Detection of Component Missing on Printed Circuit Boards by Image Processing using Pixel Counting Technique

C. Boonkong, and W. Ooppakaew*
Department of Electronics and Telecommunication Engineering Rajamangala University of Technology Thanyaburi, Pathumthani, 12110
E-mail: Chatchadaporn_b@mail.rmutt.ac.th, *Wichian.o@en.rmutt.ac.th

Abstract

In the process of assembling the electronic components on printed circuit board (PCB) is the part that necessary to inspect because of it is the main part for connecting the other part together If this part was missing, it may cause unavailable phone and getting error in the next assembling process. Currently, the manufacturer assigns the operator to inspect the damaged component on printed circuit board using visual inspection. When the operator has inspected the part for a long time, it may cause eye fatigue that affects error in inspecting. Therefore, this paper proposed the method to inspect the damaged component on the printed circuit board using pixel counting method with one hundred example pictures of printed circuit board (size:1478x1108). From the experimental results were found that the pixel counting method providing more efficiency than the traditional method by 92 percent approximately.

Keyword: Detection of component missing, pixel counting technique, image processing

I. INTRODUCTION

The main board of mobile phone consist of many electronic components inside. After the assembly of components on the printed circuit board, the inspection is needed to check that the components are correctly on the position as design. The missing components on printed circuit board is very important to check due to various components on printed circuit board are connecting the other parts together. If the component on printed circuit board was damaged, it will make the printed circuit board not carrying the electrical current to the phone parts regularly. In present, most industry need to inspect the missing component and circuit using digital image processing such as [1]. Using AOI machine to inspect the quality of printed circuit board is high efficient but the price is very expensive. Other researcher used Sobel boundary extraction [2] to find coordinate of missing component in sample image compared with original image but this technique cannot detect the small parts or overlapping parts.

The process of missing component inspection on the printed circuit board using pixel counting technique is counting the numbers of white pixel. The procedure for counting the numbers of white pixel consist of converting RGB image to binary image [3] which has 2 contrast levels: white and black level. For fast image conversion, using binary image and adjust the suitable value of threshold is needed. Then the complement function is used to invert binary image. Calculating 4 coordinates of the object with bounding box method and sum function to summarize the pixel are utilized for analysis.

Finally, the experimental result found that pixel counting method has capability to inspect the missing component on printed circuit board around 92 percent and can detect overlapping parts efficiently. However, this technique will be implemented on the real hardware to prove that it can be inspected the missing components on the mobile phone main circuit boards.

II. METHODS

Binary image

Binary image is the image that displayed in black and white level, the image data in each points were defined by 1-bit binary value which 1 value is white point and 0 value is black point on image as figure 1

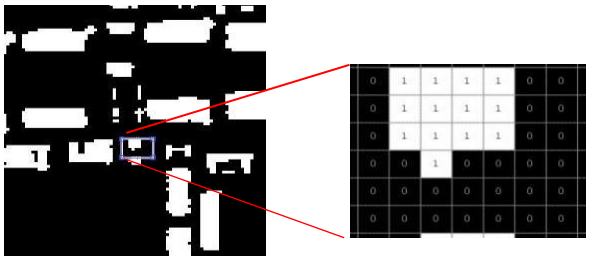


Fig. 1 Binary image

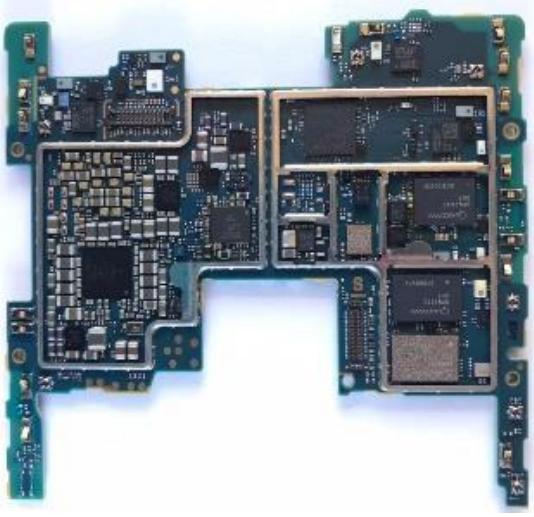
The creating of binary image finished with threshold technique by comparing between the first image point and constant value which called "threshold" that has value between 0-255 as equation 1

$$g(i,j) = \begin{cases} 1, for\ f(I,j) \geq T \\ 0, for\ f(I,j) < T \end{cases} \quad (1)$$

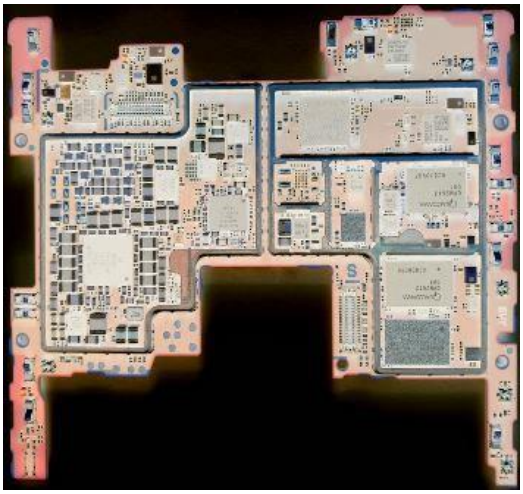
Where f is the input images, g is binary images, T is constant (Threshold Techniques), g(i,j)=1 is visual element of the object, g(i,j)=0 is background image elements [4]

Complement image

The complement of binary image which makes the opposite binary value from black to white and white to black as figure 2.



(a)



(b)

Fig. 2 (a) Color image (b) Complement image

Bounding box

Bounding box is the function that estimates [5] the center of object in detected area when defining the center point for object. The function will create rectangular box surrounds the object by creating black and white object to calculate the coordinates of rectangle and then let the minimum value and maximum value at each axis as equation 2

$$W = (maxX-minX)$$
$$H = (maxY-minY)$$
$$R = [minx\ minY\ wigth\ height] \quad (2)$$

Where *W* is the width, *H* is the height and *R* is the stored value creates a rectangle that is at the top.

Pixel counting

The counting of the numbers of adjacent pixel, all of couple of pixels in the same group must has connection line that consists of other pixel in arranged group which not has way between the different group of couple pixel. The process of pixel counting is releasing a number's group for each pixel; the pixel in the different groups obtained a different number in this algorithm. The complement binary image stores in 2-dimensional matrix at n×m size, with image pixel is 1 and background pixel is 0. Then sum function is used to summarize the pixel of the image. Finally, finding the percentage of image is calculate showing the expected results as figure 3.

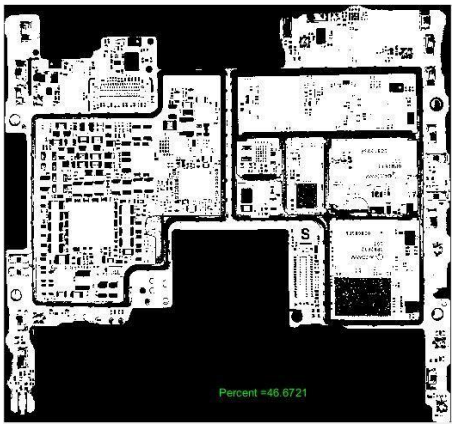


Fig. 3 Pixel counting

III. METHODS AND EXPERIMENT

The one hundred printed circuit board photos with the size 1478 × 1108 pixel from digital cameras are used to this experiment. There is an analysis process as follows.

The experimental procedure is getting an original color image which obtained from camera. Then converting the color image to complement binary image for finding a top white pixel, bottom white pixel, left white pixel and right white pixel is processed. The program will create rectangular box to enclose the desired object after counting the numbers of white pixel. If the percentage of white pixel is between 46-49.5 percent, the result shows that the components on printed circuit board were not missing. However, if the percentage of white pixel is higher than 50 percent. It means that the components on printed circuit board were missing.

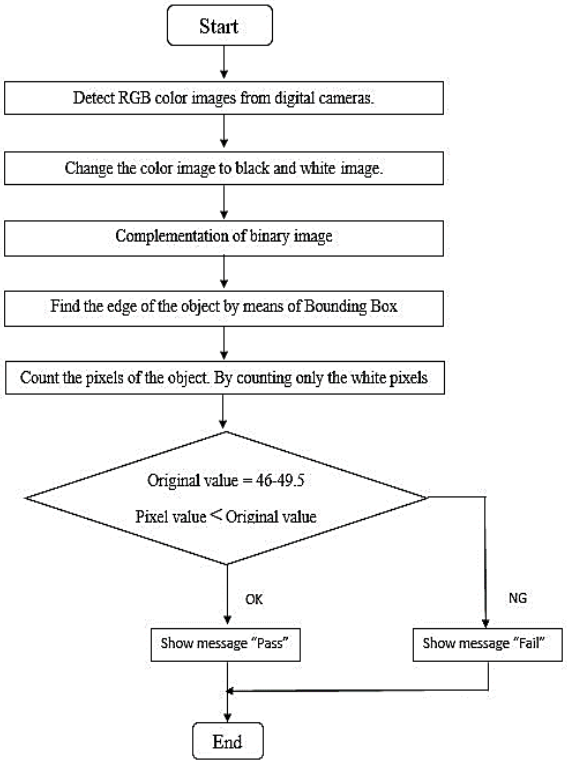
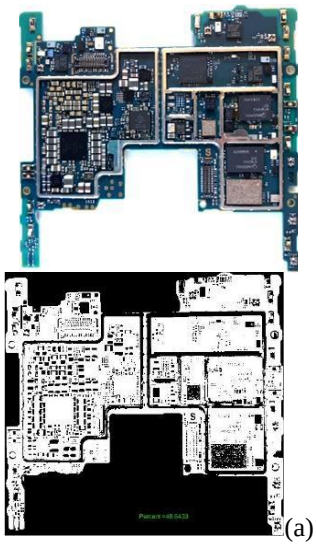


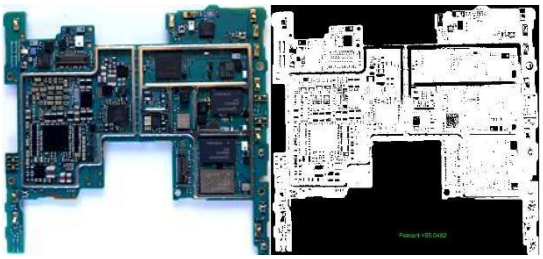
Fig. 4 Experimental procedure

Table 1 The result of missing component on printed circuit board inspection from 100 images using white pixel counting with the maximum pixel value and minimum pixel value as follow:

printed circuit board	Minimum pixel value	Maximum pixel value
Component Missing on Printed Circuit Boards	49.9720	61.1445
Component completely on Printed Circuit Boards	46.1557	49.5647



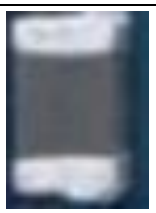
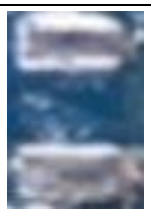
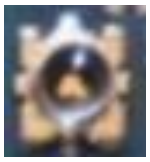
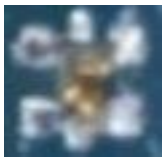
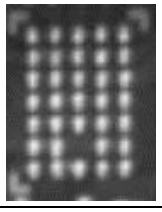
(a)



(b)

Fig. 5 (a) Component missing on printed circuit boards
(b) Component completely on printed circuit boards

Table 2 Component prototype on printed circuit boards and component missing on printed circuit boards from digital cameras

Position name	Component Prototype	Component Missing
Component		
Connecter		
Hold		
Spring		
IC		

IV. RESULTS

The inspection of the missing component on printed circuit board with pixel counting method using 100 sample images, it found that the method can inspect the missing component on printed circuit board around 92 images and getting error from method around 8 images as shows in table 3

Table 3 The result of missing components on printed circuit board inspection from 100 images

Examination	The program detect that missing	The program detect that completely
Component Missing on Printed Circuit Boards	92	8

From the result in table 3 found that the pixel counting method can inspect the missing component on printed circuit board at accuracy around 92 percent and error percentage is 8 percent that caused by brightness while taking the image. Therefore, the research will consider this factor for developing the inspecting system in the future.

V. CONCLUSION

In this paper proposed the technique of missing component on printed circuit board using pixel counting providing more efficiency than the traditional method by 92 percent and error percentage is 8 percent that caused by brightness while taking the image.

REFERENCES

[1] J. Srinonchata and S. Sirimark, "Enhancement Machine Vision System Using Morphology Technique," *ICISIP2014*, pp. 194-198, Sep. 2014.

[2] S. Reuxngsri and S. Sriaumphan., "Detection suspicious object with digital image processing," Project of Telecommunications Engineering Suranaree University of Technology, 2009.

[3] B. Phatarajaruwan., *"Fandamentais of Digital image Processing,"* SE-ED's textbook Bangkok, pp. 98-99, 2013.

[4] S. Tantigiti., "Image Processing for Detecting Dengue Virus from WBC," Thesis of Science Information Technology Siam University, 2016.

[5] M. B. abu K. and M. V. Raghunadh., "Vehicle Number Plate Detection and Recognition using Bounding Box Method," *ICACCCT*, pp. 106-110, 2016.

IoT based Low-cost soil moisture sensor with cloud computing & LoRa technology

Thinnawat Jangjing and Boonyarit Kumkhet*
Department of Electronic & Telecommunication Engineering, Rajamangala University of Technology Thanyaburi, Pathum Thani, Thailand
*E-Mail: boonyarit.k@en.rmutt.ac.th

Abstract

Today, agriculture is affected by climate change, resulting in factors for plant growth and product, such as temperature, humidity, minerals, soil, and water, that has changed dramatically. IoT technology, that is integrated with agriculture to increase effective and reducing wastage in agriculture. Our research proposed the prototypes, which focuses on low-cost soil moisture and temperature sensor node. The node prototype consists of the soil moisture sensor, that is designed to have 4 copper rods. A copper rod is on the ground and 3 other copper rods for measure moisture of the soil from the ground surface with 20, 40 and 60 cm. depth respectively, humidity and temperature sensor (DHT21), and also LoRa module (Heltec esp32 LoRa sx1276). The data transmission section of a node used LoRa module sx1276 model, that is transmitting both bands of frequency 924MHz for communication between the node and other node and 2.4GHz (WLAN) for communication between the node and cloud storage (The Things Network). The prototypes were experimental of soil moisture sensor node able to store data of humidity and temperature above the ground and under the surface of the ground 20, 40 and 60 cm. The result has shown the average accuracy of the prototype more than 95%. Additional, the transmission range of LoRa module is approximate to 630 meters (Line-of-sight: LOS) and about 180 meters (Non-line-of-sight: NLOS) and nodes also store data in cloud storage 30 times per hour.

Keyword: IoT based, Low-cost, Soil moisture sensor, Cloud computing, LoRa

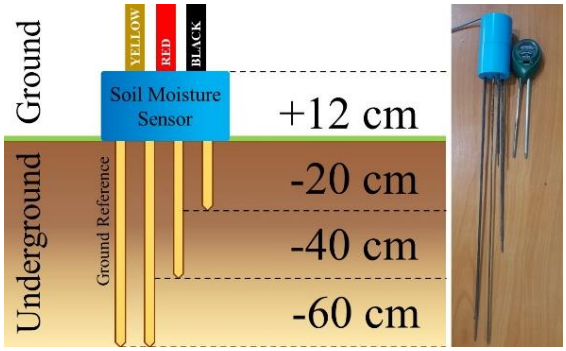
I. INTRODUCTION

At present, agriculture has integrated the use of IoT technology together with agriculture, which makes agriculture more efficient and productive. Because IoT has the ability to monitoring the environment, store data, and control agriculture precisely. In addition, it can support work areas from small to large. And also have a variety of monitoring and control devices to choose according to the needs of users. Measuring the amount of water in the soil or the amount of moisture in the soil. Is an examination of factors that have a significant impact on the growth of the area. Which the standard method for measuring moisture in the soil. Must use the oven to make the soil dry with the heat of 105 degrees and then calculate the lost weight of the water in the soil. This method requires time and collecting the sample to test. In addition, the soil that was tested cannot used to test again in the same position [1]. For this reason, soil moisture measurement using electronic sensors are an alternative way to measure the time that is not long, not collecting the sample, and not destructive. The techniques for measuring using electronic sensors have many technics such as time-domain reflectometer, dielectric, capacitance, and impedance sensors. In this paper, we have chosen the technique to measure the electrical resistance in the soil. Which is a widely used technique. In this way, the copper rod will inserted into the ground by having the distance between each copper rods placed in the same gap [2]. The sensor measures the conductivity of the soil. If the amount of moisture in the soil is high, the conductivity will be high and the resistance value will be low. On the other hand, the amount of moisture in the soil is low, the conductivity is low and the resistance value is high by changing the amount of water in that soil moisture measurement is important in agriculture to help agriculture to manage water management more efficiently. In addition, it can reduce the amount of water in agriculture, increase productivity and quality of production, and can control the moisture of the soil during the growth of plants as well.

II. LOW-COST SOIL MOISTURE SENSOR

The sensor prototype is design with a focus on multi-level underground moisture measurement (Fig. 1) for the reason that the roots of each plant are of equal length and width of the roots. For example, the roots of the perennial plants will have more depth of roots than the herbaceous plant. Therefore, if we measure moisture with a depth of 10-30 cm, only one value will result in insufficient moisture data for accurate analysis. For this reason, we designed the soil moisture sensor used 4 copper rods with different length. That consist size 60 cm 2 pieces (one for ground reference and other for 60 cm impedance measurement), 40 cm 1 piece, and 20 cm 1 piece. The

distance between each copper rods placed in the same gap and encapsulated with resin to maintain the gap between each copper rod. Then used PVC pipe and pipe cover to improving strength for handling and waterproof sensor. The prototype is more dept.



(a) (b)

Fig. 1 (a) Design of sensor (b) Prototype of sensor

III. PROCEDURE

In this section, we present the IoT system, that system was designed for agricultural purposes where there is a need for monitoring the environment in a wide area and data collection about the environment and agricultural, which needed to be analyzed. Moreover, this system can be adapted in agriculture and others.

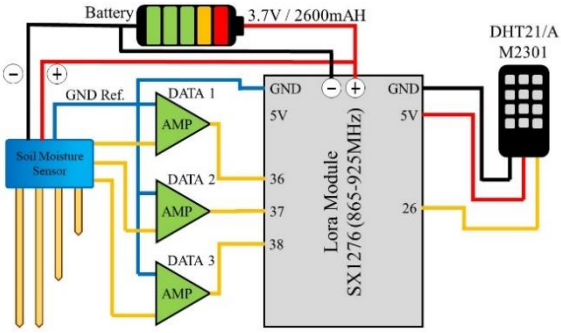


Fig. 2 The inside diagram the low-cost soil moisture node

The system consists of 2 sections. The first section is the LoRa node (Data transmission) consists of 4 parts. The first part is the processing part used Heltec WiFi LoRa v2 board, which is an ESP32 processing board with LoRa base (SX1276: frequency band 923MHz). The second part is monitoring device consist of the low- cost soil moisture sensor (Prototype) and DHT21 is temperature and humidity sensor. The third part is LM393 responsibility amplifies the signal received from the prototype sensor before transmitting to LoRa board that pin 36, 37, and 38 (Analog pin). The four part is Battery 3.7V 2600mAH. The second section is the LoRa base, which is operation about network connection and data storage by Raspberry Pi 3 Model B+ with LoRa module (RFM95: frequency band 923MHz).

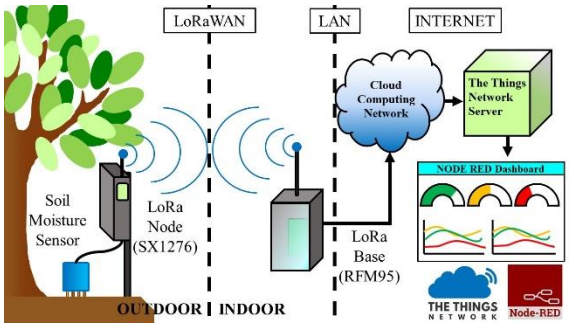


Fig. 3 IoT based Low-cost soil moisture sensor with cloud computing & LoRa technology system

The connecting all devices in the proposed IoT system. First step the LoRa node will be responsible for the measurement of temperature, humidity in the air, and 3 levels of soil moisture measurement. Second step it sent the data by frequency 923MHz to the LoRa base for processing data and routing network by Raspberry Pi. That has a connection to the cloud server of TTN (The Things Network) for processing data stored in the cloud and users can retrieve historical data through the TTN website and can view moisture and temperature data in graphical form via Node RED dashboard.

IV EXPERIMENTS METHOD AND RESULTS

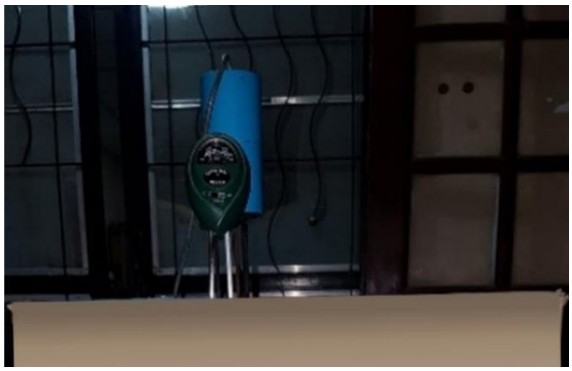


Fig. 4 The experiment of Low-cost soil moisture sensor

The experiment of the IoT based Low-cost soil moisture system. It divided 2 parts according to the working part in the system. The first part is sensor parts. The experiment of the sensor part, we measure soil moisture by stabbing the copper rods of the sensor into the ground and then measuring the signal and voltage with an oscilloscope. We divided the experiment case into 2 cases. In the first case, the moisture in the soil is low. When testing the pressure, it appeared that the voltage is about 5 volts because the sensor is connected to chip LM393 is voltage dual comparators chip. Therefore, when the soil moisture

content is low (the resistance in the soil is high), make the resistance value of the chip is low down. Causing the voltage flowing through the chip to be high. On the other hand, when the soil moisture content is high (the resistance in the soil is low) will make the voltage flowing through the chip to be low as shown in Fig. 5.

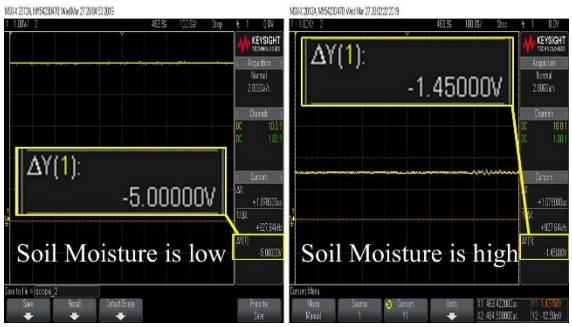


Fig. 5 The signal and voltage of prototype sensor

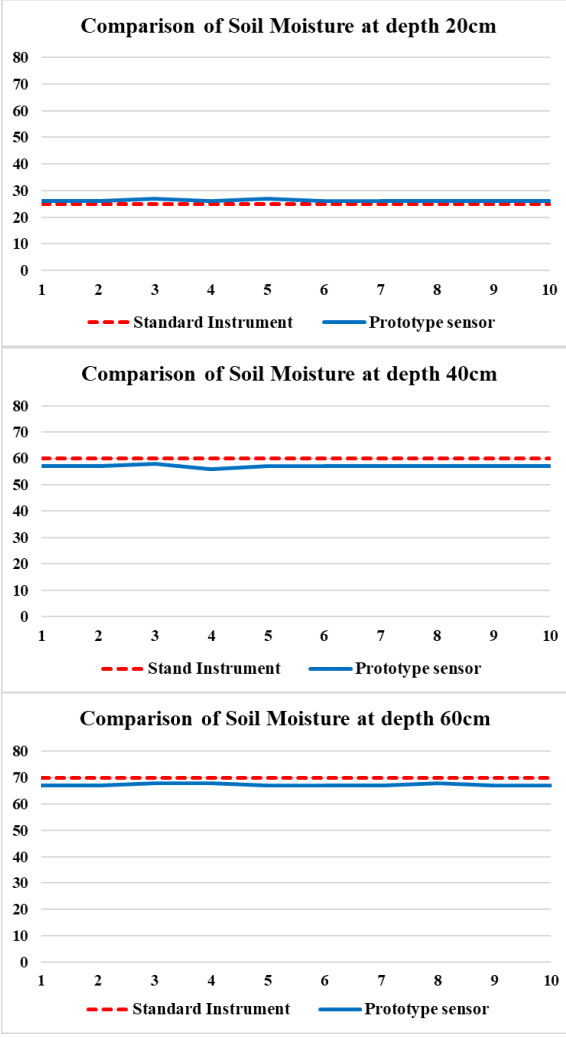


Fig. 6 Comparison of soil moisture at depth 20cm, 40cm, and 60cm

In addition, there is a comparison of the measurement of soil moisture in the sensor and measuring instruments at 3 levels of depth, 20cm, 40cm, and 60cm respectively for the analysis of the efficiency and accuracy of the master sensor. As shown in Fig. 6, the results show that the soil moisture data from the prototype sensor has an error of about 5 percent in every depth when comparing results with standard instruments.

The second part is the presentation of data communication and network connections. From Fig. 7, we have used LoRa technology to communicate data between ESP32 LoRa SX1276 nodes and base stations. We use the frequency band 923MHz (Bandwidth 500 KHz). The base station acts as a gateway that supports multiple data transmission simultaneously nodes (in this paper, tested at 3 nodes). The base station consists of LoRa receiver module (RFM95), which is connect to Raspberry Pi 3 model B+. Raspberry pi responsibility as an intermediary between LoRaWAN and the Internet network that acts as a data forwarder after receiving data from the sensor to the cloud. The cloud displays the information received in hexadecimal number (Fig. 8) that show data 30 times per hour. Therefore, we have to convert data from base hexadecimal number to decimal number, get the correct information. In addition, we also offer data in graphic information through the Node RED dashboard, as shown in Fig. 9.

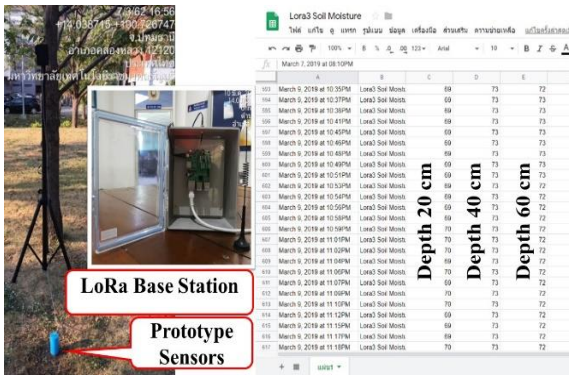


Fig. 7 The experiment of the proposed IOT based with LoRaWAN

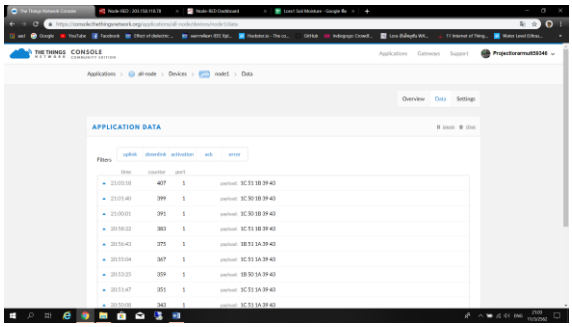


Fig. 8 Webpage the Things Network (TTN)

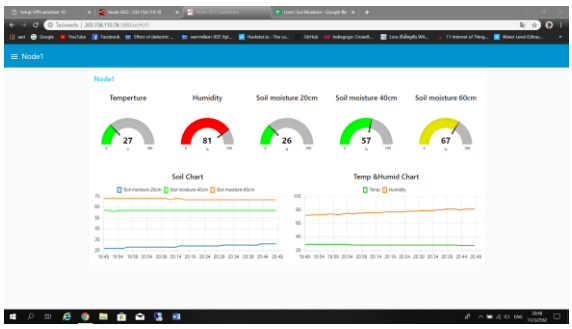


Fig. 9 Webpage Node RED dashboard

The system can send data from the LoRa node to the LoRa base station with a distance of 637 meters for the line of sight propagation (LOS) shown in Fig. 10 and 180 meters for non-visual diffusion (NLOS) shown in Fig. 11. Which Fig.9 and Fig.10 get from the program Google Map, by defining the location from the GPS signal and fill in program Google Map, Which for the distance between the LoRa node with LoRa base station.

Fig. 10 Line of sight propagation (LOS)

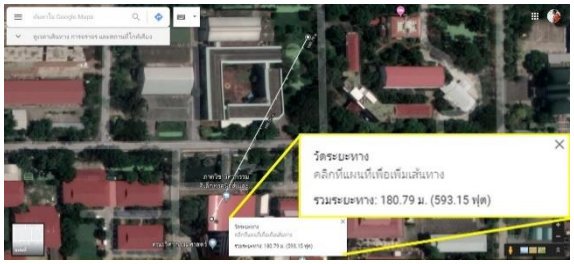


Fig. 11 Non line of sight propagation (NLOS)

V. CONCLUSION

The prototype node has accuracy in measuring soil moisture in depth 3 levels and cooperation with DHT21 that measures humidity and temperature in the air. In addition, the node has the ability to transmit data signals up to 630 meters, and it has data is stored on the cloud network 30 times per hour. Therefore, this prototype system is suitable for applying to agriculture by collecting soil moisture, humidity, and temperature data for analysis to find suitable seed and plants for that planting area.

ACKNOWLEDGEMENT

This paper was support by the Department of Electronics and Telecommunication Engineering (RMUTT). We thank our colleagues from Mr. Panuwat Tueanyang and Mr. Kulawat Deesri who assembly prototype and assisted the research. We thank Asst. Prof. Dr. Paitoon Rakluea and Mr. Pubet Sangmahamad assistance and comments that greatly improved the manuscript.

REFERENCES

[1] J. P. Walker, G. R. Willgoose, and J. D. Kalma, “In situ measurement of soil moisture: a comparison of techniques,” *Journal of Hydrology*, vol. 293, no. 4, pp. 85–99, 2004.

[2] C. kumar sahu, and P. Behera, “A low cost smart irrigation control system,” *2nd International Conference Electronics and Communication Systems*, ICECS, Sambalpur, Indai, 2015, pp. 1146–1152.

[3] Danco Davcev, Kosta Mitreski, Stefan Trajkovic, Viktor Nikolovski, and Nikola Koteli., “IoT agriculture system based on LoRaWAN,” *14th IEEE International Workshop on Factory Communication Systems*, WFCS, June 13-15, 2018.

[4] M. S. Kumar, T. R. Chandra, D. P. Kumar, and M. S. Manikandan. “Monitoring moisture of soil using low cost homemade Soil Moisture Sensor and Arduino UNO,” ICACCS 2016, Coimbatore, INDIA, January 22 - 23, 2016.

[5] S. Das, B. Pal, P. Das, M. Sasmal, P. Ghosh, “Design and Development of Arduino based Automatic Soil Moisture Monitoring System for Optimum use of Water in Agricultural Fields,” *IJOER*, vol. 3, no. 5, pp.15-19, 2017.

An exploratory study of school safety application development: Preventing children from getting trapped in a school van

Sumai Binbai[1*], Rungruang Musiri[2], Wiyada Triyawong[1], Phonthip Phetbarom[1]
Suthada Yueakyen[1] and Jittrapa Yolai[1]
[1]Department of Computer Education, College of Teacher Education, Phranakhon Rajabhat University, Bangkhen, Bangkok, Thailand
[2]Department of Information Technology Management, Faculty of Industrial Technology, Phranakhon Rajabhat University, Bangkhen, Bangkok, Thailand
[*]E-mail: noina_sb@hotmail.com

Abstract

One of the most crucial factors affecting guardians' decision-making concerning school choice is transportation safety. Over the past decades, a number of Thai school students have been reported dead due to their being trapped in school vans. Given the severity of the incident, this study aims to develop an application that might provide solutions to the problem. Specifically, the study developed an application titled PCTV app with a twofold goal: To enable students, teachers and drivers to effectively use the application. Four different tools were used, namely 1) PCTV application; 2) PCTV application effectiveness evaluation form; 3) PCTV application usage evaluation form; and 4) user satisfaction assessment form. Participants, consisting of students, teachers, drivers and guardians, were purposively selected from private schools in Bangkok, Thailand. Salient findings are as follows: 1) PCTV application is deemed effective given the expert assessment; 2) PCTV application could be used effectively to prevent children from getting trapped in the school van; and 3) PCTV application was perceived as highly satisfactory.

Keywords: application, school van, school safety

I. INTRODUCTION

Students and Children were trapped in a school van or were trapped in a car is the hot issue appeared in newspaper for a decade. The statistics showed that from 2014 to 2018 there were 106 regrettable events of children were trapped in a car and a school van, 5 of them died and 4 died because were got trapped in a school van. Most of them were 3-7 years old. (Thai Post News, 2019) Causes of these sad events were from parents and teachers neglected their children under responsibility. The children died because they were trapped more than 5 hours in a hot van and less air.

The children were trapped in a van becomes very big problems that have been occurred continually in Thailand. However most of events were happened under the private sectors responsibility which ministry of education cannot took control or eliminated these bad situations. However the government announced to all schools and teachers that they have to keep an eye on their children. (Matichon Online, 2018)

The government unit try to solve the problem of children get trapped in a van such as; take control by law of transportation, (Government Gazette, 2013) ministry regulation about school bus control, transportation permit for private sectors, educate children with survival program, educate parents to take care of their kids, etc. However these are the methods for solving the latest problem which cannot t help the kids from getting trapped in a school van. The young kids always panic and out of control themselves when they get trapped in a van, the best thing that they can do is shout and try to survive by instinct.

Therefore, this study try to find the way to prevent the children from getting trapped in a school van. We found that mobile application is very useful for all users to look after their kids when they get on and get off the van. We decided to study about an exploratory study of school safety application development: Preventing children from getting trapped in a school van by using mobile application as it was called PCTV application.

II. METHODS

Research Objectives

The research object were; 1) to develop an application for preventing children from getting trapped in a school van, 2) to study the efficiency of application for preventing children from getting trapped in a school van, and 3) to study the guardians' satisfaction from using application.

Participants

This research had 4 types of users include of drivers, teachers, students and guardians. There were 30 samples for using PCTV application.

Methodology

The PCTV application was developed by 7 procedures of research and development include these steps;

1) Studying document and gathering information from users.
2) Analyzing and designing system.
3) Developing system
4) Installing and testing system
5) Producing the handbook and training users
6) Implementing system
7) Evaluating system efficiency and satisfaction of users

By these steps, the instruments of this research were reviewed and approved by professional in information technology and educational technology. The PCTV application was developed by these software program; 1) sublime text3 program used for creating application system, 2) MySQL used for developing database on application system, and 3) PHP, HTML, JavaScript, CSS and SQL also used for running on language system.

III. RESULTS AND DISCUSSION

The research results showed 3 aspects include of 1) features of PCTV application, 2) efficiency of PCTV application, and 3) users' satisfaction on PCTV application as follows:

1. The features of PCTV application consist of results from users' need analysis and system analysis and design by Use Case Diagram as these details.

1.1 Result from users' need analysis can show as table 1.

Table 1 Result from users' need analysis

Member	Right and Management system
Admin (School officer)	• Log in into system
	• Add/delete/edit member's information
	• Add/delete/edit student's information
	• Add/delete/edit school van information
	• **Manage to support getting on – getting off a school van**
Teacher	• Scan QR code from student ID card for checking list of student
	• Real-time check the status of students
Driver	• Scan QR code from student ID card for checking list of student
	• Real-time check the status of students
Guardian	• Real-time check the status of students

From table 1 showed the result of users' need analysis which categorized in 4 group include admin or school officer, teacher, driver and guardian. Each group of user can access and manage information on PCTV application in different way. The admin is a person who can add/delete/edit information of students and members in application for managing to support getting on-getting off a school van. The other group are teacher and driver can use PCTV application by scanning QR code from students' ID card for checking list of students get on-get off a school van and real time check status of students in a school van as well as the guardians.

1.2 Result of system analysis and design by Use Case Diagram showed as figure 1.

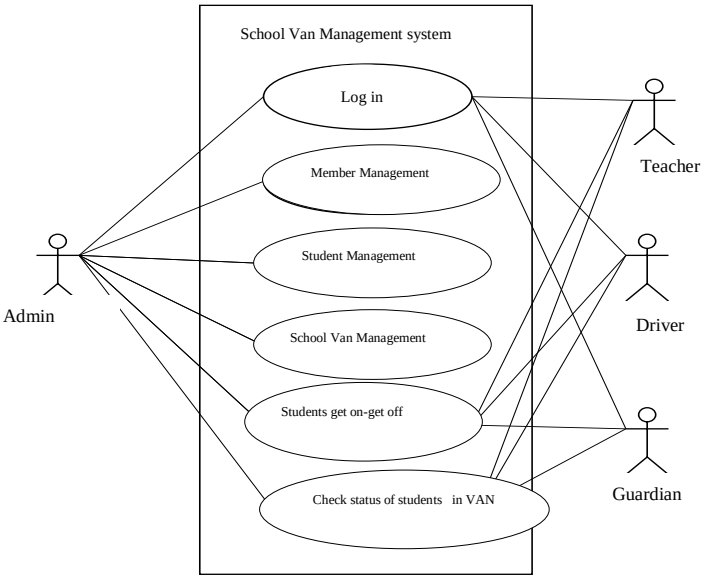


Fig. 1 Use Case Diagram of application system analysis and design.

The result from figure 1 showed the school van management system which used to control and follow up students in a school van. This system was conducted by Use Case Diagram.

1.3 The features of PCTV application can present as figure 2-5.

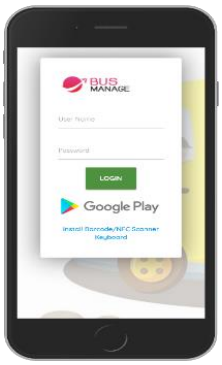


Fig. 2 Log in display screen

The figure 2 showed the screen display for member's login to system by clicking on www.busmanage.com

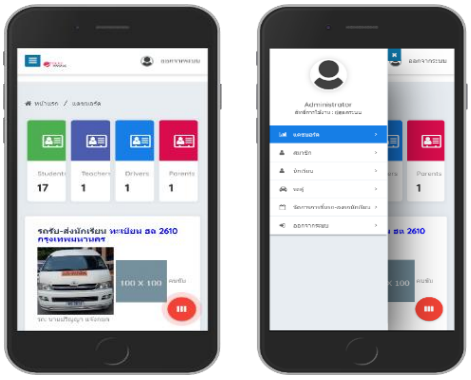


Fig. **3** screen display of admin

This figure present the screen display of admin after logging in. They can add/delete/edit/manage system and information in application.

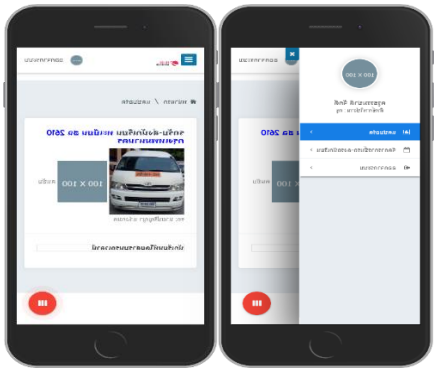


Fig. **4** Screen display of teacher

This figure present the screen display of teacher after logging in. They can scan QR code of students' ID card and check their students in a van as real time.

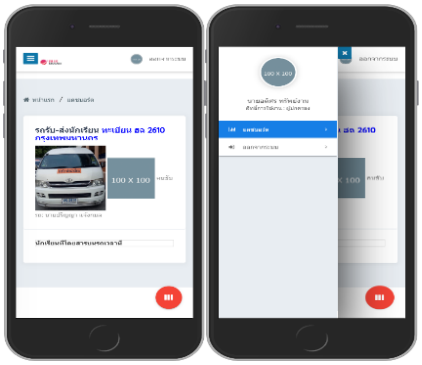


Fig. **5** Screen display of guardian

This figure present the screen display of guardian who can follow up their kids as real time tracking in a school van by searching the license plate which children get on.

2. The efficiency of application for preventing children getting trapped in a school van

The PCTV application was reviewed and evaluate by Information Technology and Educational Technology experts. The result showed in table 2.

Table 2 the efficiency score of PCTV application

Items	efficiency score		
	$\bar{X}$	S.D	Result
Application system usage			
I. Downloading & Installing application are running on mobile without error.	3.66	0.57	high level
II. Log in system is simply for all users.	4.33	0.57	high level
III. Menu bar is optional for user.	4.66	0.57	Highest level
IV. Adding-deleting data into application is easy and simple.	4.33	0.57	High level
V. QR code scan is functional usage.	4.66	0.57	Highest level
VI. Importing data into system is simple and easy.	4.00	1	High level
Display screen and processing			
VII. Display screen is clear.	4.66	0.57	Highest level
VIII. Font size is clear.	4.66	0.57	Highest level
VIIII. Pictures are clear.	4.00	0.00	High level
X. Application displays on full screen.	5.00	0.00	Highest level
XI. Speed processing is continually use.	4.66	0.57	Highest level
XII. Processing is accuracy and reliability.	4.66	0.57	Highest level
Security of application system			
XIII. Log on system is only permitted by admin.	4.33	0.57	High level
XIV. System is logged out automatically when stop using application	4.00	1.00	High level
XV. System has user privacy protection	4.33	0.57	High level
Average score	**4.40**	**0.26**	**High level**

The result from table 2 showed that the experts approved the PCTV application had score of efficiency at high level with the average score 4.40 and S.D. 0.26. The average score described that the PCTV application was efficient and appropriate to use for preventing children getting trapped in a school van.

3. The satisfaction of users

This part showed the result of users' satisfaction after using PCTV application for preventing children getting trapped in a school van as table 3.

Table 3 the users' satisfaction score

Items	Satisfaction score		
	$\bar{X}$	S.D	Result
Application system usage			
I. Downloading & Installing application are running on mobile without error.	4.50	0.70	high level
II. Log in system is simply for all users.	4.00	0.00	high level
III. Menu bar is optional for user.	3.50	0.70	Highest level
IV. Adding-deleting data into application is easy and simple.	4.00	0.00	High level
V. QR code scan is functional usage.	4.00	0.00	Highest level
VI. Importing data into system is simple and easy.	4.00	0.00	High level
Display screen and processing			
VII. Display screen is clear.	4.50	0.70	Highest level
VIII. Font size is clear.	4.00	0.00	High level
VIIII. Pictures are clear.	4.00	0.00	High level
X. Application displays on full screen.	4.00	0.00	High level
XI. Speed processing is continually use.	4.00	0.00	High level
XII. Processing is accuracy and reliability.	4.00	0.00	High level
Security of application system			
XIII. Log on system is only permitted by admin.	4.00	0.00	High level
XIV. System is logged out automatically when stop using application	3.50	0.70	High level
XV. System has user privacy protection	4.00	0.00	High level
Average score	**4.00**	**0.32**	**High level**

The result from table 3 showed that the users' satisfaction toward the PCTV application usage. The table present that average score 4.00 and S.D. 0.32. The average score described that the users satisfied the PCTV application at high level. The average score described that most of users satisfied the PCTV application with high satisfaction. This result means the PCTV can use for preventing children getting trapped in a school van.

IV. CONCLUSION

This research conclude with 3 results include the features of the PCTV application which appropriate for all users (admin, teacher, driver and guardian), the PCTV application was approved by experts that it was efficient to use for preventing children getting trapped from a school van, and the users approved that the PCTV application was very impressive for them and make them sure for using this application to prevent children getting trapped from a school van. The guardian feels happy to the application because they can look after and follow their kids as real time after they get on the school van. These results were positive acceptation from experts and users because the PCTV application was developed by users' need analysis and system was designed suitably for all group users. The PCTV application concerned about the application system

usage which developed by sublime text3 program (Tutorial Point, 2018; Peleg, 2013) that can solve linker errors and problems solving abilities. Moreover, the PCTV was developed as mobile application which was familiar with users that they can use easily.

ACKNOWLEDGEMENT

This research is successful with cooperative between lecturers and students from computer education program and information technology management program in Phranakhon Rajabhat University. Moreover, we would like to thank you for Principal, teachers, drivers, students and guardians from Patai Udom Suksa School. And give the respect to all experts who gave fruitful advices for developing the application.

REFERENCES

[1] Child Safety Promotion and Injury Prevention Research Center. (2018, Dec 12). "*Educate children to survive when get trapped in a car or van*". [Online]. Available: http://csip.org/wordpress/2018/06/21 /#more-9111

[2] Government Gazette. (2019, Feb 3). "*Transportation Law 1979 and edited version 2013*". [Online]. Available: http://www.police6.go.th/police6/pdf/road_traffic_act.pdf. pp. 1-45.

[3] Matichon Online. (2019, Dec 20) "*Brainstorm for solving problem the children getting trapped in a car*". [Online]. Available: https: / / www. matichon. co. th/ local/ quality-life/news_134756.

[4] D. Peleg, "*Mastering Sublime Text*". Birmingham, Packt Publishing, pp. 1-110, 2013.

[5] Thai Post News. (2019, May 30). *"In the past 5 years, children were trapped in car 106 events and died 5"*. [Online]. Available: *https://www.sanook.com/news/7768238/*

[6] Tutorial Point. (2018, Dec 2) "*Sublime Text*". [Online].Available:*https://www.tutorialspoint.com/sublime_text/sublime_text_tutorial.pdf*

Promoting Hyacinth handicraft on web application

Pinthusorn Pasanajano*, Pissamai Saichompoo and Kullanid Niyomras

Department of Computer Science, Faculty of Science and Technology, Rajamangala University of Technology Suvanabhumi, Nonthaburi, THAILAND
*Corresponding Author E-mail: asst.prof.pin@gmail.com

Abstract

The purpose of this research is to promote Hyacinth handicraft products based on web application with make order, select products, register member, customer service, summary report and payment notification. The research method is System Development Life Cycle (SDLC) that involves many phases, including planning, design, building, testing, implementing and evaluating. The database of this research is MySQL which facilities effective management of databases. Graphical representation of the high-level system scope in this research is Use Case Diagram that can be helpful in communicating with the end user of the system. The result of this research is useful for customer who want to order hyacinth handicraft products and it is better way to get their orders. Customer can also learn about how to make water hyacinth handicrafts from web application. The conclusion of this research showed that the overall evaluation result of the use of content, presentation of content, display usage and processing usage were at a good level ($\bar{x}$ = 4.13, 4.19, 4.06 and 4.17). It can be said that web application of Hyacinth handicraft is easy to use and can also promote Hyacinth handicraft every time and everywhere.

Keyword: web application, Hyacinth, MySQL

I. INTRODUCTION

Water hyacinth is weed that cause trouble for people in many countries around the world. It can also spread as fast as they can. Even in drought area that it can exist for many years. So, water hyacinth become a water weed that causes problems for water sources. It is still an obstacle to irrigation, resulting in the speed of water in the canal and river. The researchers have created web application to promote hyacinth handicraft products from water hyacinth. This can sell handicraft products from water hyacinth and demonstrate how to create hyacinth handicrafts. Therefore, it is an alternative that makes easier for people to access technology any time and place.

II. METHODS

The research method is System Development Life Cycle (SDLC) that involves many phases, including planning, design, building, testing, implementing and evaluating. The database of this research is MySQL which facilities effective management of databases. Graphical representation of the high-level system scope in this research is Use Case Diagram that can be helpful in communicating with the end user of the system. Research scope is divided both system administrator and customers. System administrator can use the online selling system, manage customer data, manage products and analyze the best seller product. Customers can log in system, edit their information and order products.

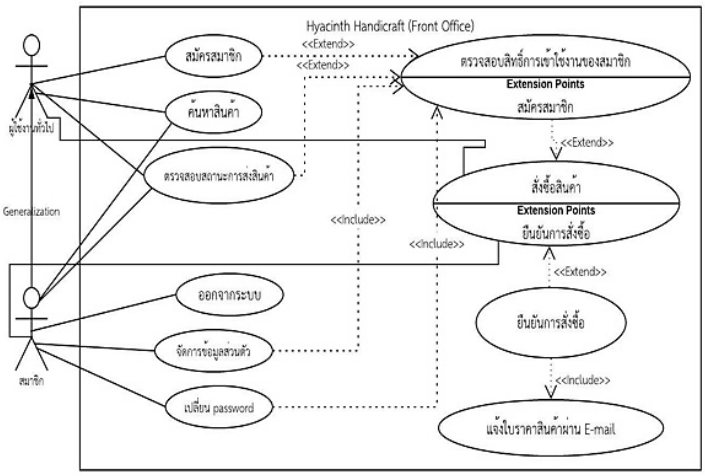


Fig. 1 Use Diagram of Promoting Hyacinth handicraft on web application

III. RESULTS

The result of this research proposed three sections: administrator, member, and user. Administrator can manage and add products, review customer's order, and review status of order.

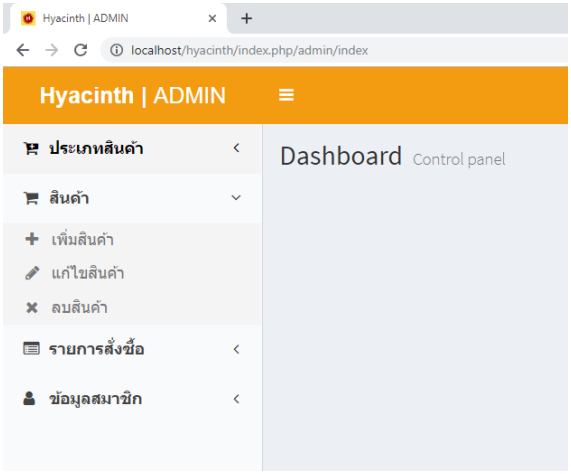


Fig. 2 Admin Page of Promoting Hyacinth handicraft on web application

All of customers have to fill in the form before order products. They should put name, address, phone number, e-mail and set up username and password.

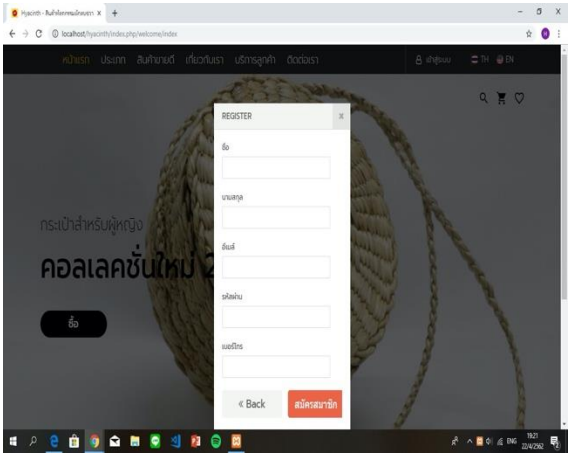


Fig. 3 Member register

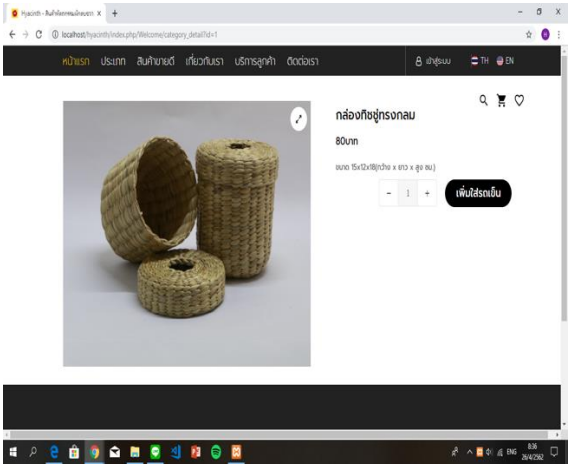


Fig. 4 Member puts selected products in the basket

The efficiency result of Promoting Hyacinth handicraft on web application shown in Table 1.

IV. CONCLUSION

The conclusion of this research showed that the overall evaluation result of the use of content, presentation of content, display usage and processing usage were at a good level ($\bar{x}$ = 4.13, 4.19, 4.06 and 4.17). It can be said that web application of Hyacinth handicraft is easy to use and can also promote Hyacinth handicraft every time and everywhere.

REFERENCES

[1] W. Choi, "Automated testing of graphical user interfaces: A new algorithm and challenges," in *Proc. 2013 ACM Workshop on Mobile Development Life- cycle (MobileDeLi)*. New York, NY, USA: ACM, 2013, pp. 27–28.

[2] J.J. Garrett, "The Elements of User Experience: User-Centered Design for the Web and Beyond," 2nd ed. Berkeley: New Riders, 2011.

[3] H.T. Iwarere and T.O. "Fakokunde, Consumers' Perception of Product and Service Quality and Price in the Nigerian Fast Food Industry: A Case of Selected Outlets in Ekiti State, Nigeria" *European Journal of Social Sciences*, vol. 19, no. 2, pp. 198-207, 2011.

[4] M. Kuniavsky, "Smart Things: Ubiquitous Computing User Experience Design," 1st ed. Burlington: Morgan Kaufmann, 2010.

Table 1 The efficiency result of Promoting Hyacinth handicraft on web application

Items	$\bar{X}$	S.D.	Result
1. Use of content			
1.1 Relevance	4.25	0.55	High
1.2 Easy to use	3.85	0.49	High
1.3 Outstanding display	4.25	0.79	High
1.4 Knowledge of content	4.15	0.75	High
Average score of use of content	4.13	0.15	High
2. Presentation of content			
2.1 Suitable of content	4.10	0.85	High
2.2 Correct of content	4.25	0.72	High
2.3 Attractive content	4.30	0.57	High
2.4 Easy to read	4.10	0.79	High
Average score of presentation of content	4.19	0.12	High
3. Display usage			
3.1 Appropriate Screen	4.15	0.67	High
3.2 Outstanding Picture	4.00	0.56	High
3.3 Appropriate font	4.25	0.72	High
3.4 Design of display	4.10	0.64	High
3.5 Each menu is easy to use	3.80	0.83	High
Average score of display usage	4.06	0.10	High
4. Processing usage			
4.1 Easy to access information	4.40	0.60	High
4.2 Searching information	4.00	0.65	High
4.3 Level of processing speed	3.95	0.76	High
4.4 Correctness of information	4.10	0.64	High
4.5 Clarity of picture	4.40	0.68	High
Average score of processing usage	4.17	0.06	High

VISUAL INFORMATION PROCESSING AND COLOR VISION

Theory and practice of color measurement

Hideki Sakai[1*], and Hiroyuki Iyota[2]
[1*]Graduate School of Human Life Science, Osaka City University, Osaka, Japan
[2]Graduate School of Engineering, Osaka City University, Osaka, Japan
[*]E-Mail: hsakai@life.osaka-cu.ac.jp

Abstract

The color we perceive on an object's surface depends not only on the object itself, but also on the light source and observer. Therefore, to compare measured colors, the standard procedures recommended by the Commission Internationale de l'Eclairage (CIE) should be followed. However, these do not work well for rough and non-uniform surfaces of complex shaped objects, such as rocks, wood, and food. This is because the CIE standards assume a flat and uniform object surface. To solve this problem, we propose an integrating sphere with a movable light-trapping plate for illumination to measure color distributions of rough and non-uniform surfaces. It is a spherical dome whose inner surface is painted white, and large enough for objects to be placed on a stage in the middle of the dome. An illuminating light source is placed below the stage so that objects can only be illuminated by indirect diffused light. This dome illumination makes it possible to obtain unshaded images of rough surfaces.

Keyword: Colorimetry, tristimulus values, CIE standards, integrating sphere.

I. INTRODUCTION

Evaluating color is not as easy as evaluating physical quantities, such as weight and length. This is because color is not simply the spectrum data of electromagnetic waves, but also involves human perception. The color we perceive on an object's surface depends not only on the object itself, but also on the light source and observer, as illustrated in Fig. 1. In other words, we see different colors, even on the same object's surface under different light sources (spectral distribution, intensity, and geometry of illumination) and/or different observing conditions (observing geometry and adaptation state of an observer's eyes and brain).

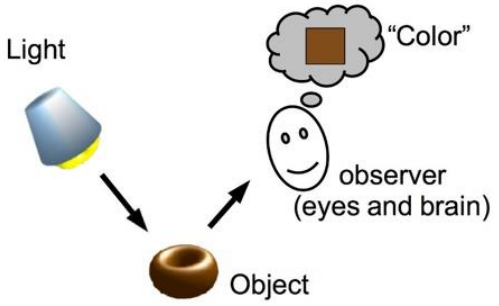


Fig. 1 To see color, a light source, an object, and an observer are required.

Generally, we perceive reflectance, not the intensity of reflected light, as clearly demonstrated by Adelson's checker shadow illusion [1]. We see different colors on a "white" surface in shadow and on a "black" surface in full light, although they both have the same reflected light intensity [2]. This implies that to determine an object's color under non-uniform illumination, it will need to be evaluated with our own eyes in the final step, even if an image of the object is recorded with a well-calibrated camera.

Therefore, to evaluate the colors of an object's surface with instruments, uniform illuminations must be used. If we record the intensity of the reflected light from an object's surface under uniform illumination, it can be easily transformed into the colorimetric values that we perceive. It is important to note that the same light sources and observing conditions must be used, as described in Section II. This procedure allows for a comparison of the measured colors.

II. COLOR MEASUREMENT THEORY

A standard light source and standard observer should be used to measure the colors of an object's surface. The Commission Internationale de l'Eclairage (CIE) recommend the standard illuminant D65 (daylight with color temperature of 6500 K), and the standard observer (CIE 1931 color-matching function). They also recommend using one of the standard illumination/observation geometries, as illustrated in Fig. 2.

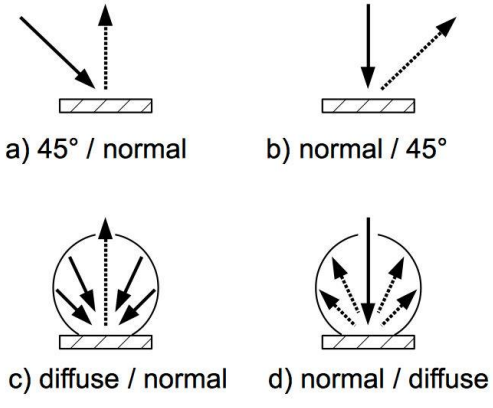


Fig. 2 Illumination/observation geometries for color measurements as recommended by the CIE. The solid and dotted arrows indicate the illumination and observing directions, respectively

The tristimulus values *X*, *Y*, and *Z* of an object's surface color are then obtained. These values, obtained under uniform illumination, are the fundamental quantities of colorimetry. They can be easily transformed into various color attributes, such as Hue, Value, and Chroma in the Munsell color system, or lightness (*L**), redness-greenness (*a**), and yellowness-blueness (*b**) attributes in the CIE 1976 *L*a*b** color space.

III. PRACTICE OF COLOR MEASUREMENT

There are many CIE-conformed colorimeters available in the marketplace. They are usually contact-type and work perfectly for flat and uniform object surfaces, and the tristimulus values can be obtained instantly. However, they do not work well for rough and/or non-uniform surfaces of complex shaped objects, such as rocks, wood, or food. For such surfaces, non-contact measurements are required, and a user must set up the illumination and colorimeter separately [3]. These operations are not easy. Moreover, even for the CIE recommended illumination/observation geometries in Fig. 2, shadows may be cast on an object's surface. This is because the CIE standards assume a flat and uniform object surface.

To solve this problem, we propose an integrating sphere with a movable light-trapping plate for illumination, to measure the color distributions of rough and non-uniform surfaces, as illustrated in Fig. 3 [4]. It is a spherical dome whose inner surface is painted white, and large enough for objects to be placed on a stage in the middle of the dome. An illuminating light source is placed below the stage, enabling the illumination of objects by indirect diffused light. This dome illumination provides an unshaded image of rough surfaces when observed from the top of the dome. Note that without a light trap the unshaded images are specular component-included (SCI). With a light trap in one position, a part of the image is specular component-excluded (SCE). When the light trap is moved to another position, another part of the image becomes SCE. Then, after moving the light trap all over the upper inner surface of the dome, all parts of the SCE image are obtained and can be merged into a complete SCE image. In addition, the gloss distribution can be derived by comparing the SCI and SCE images because their difference is caused by the glossiness of an object's surface.

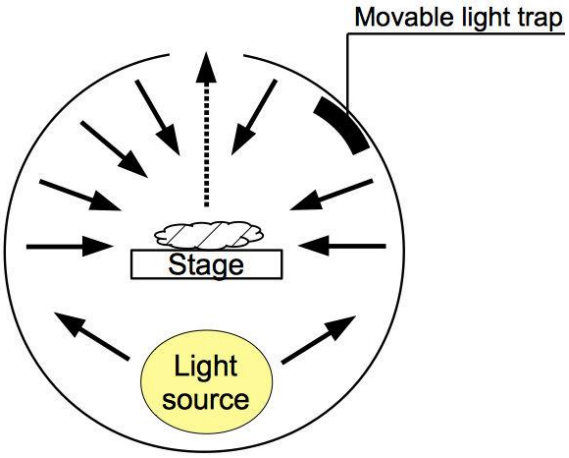


Fig. 3 Illumination/observation geometry of rough surfaces. A movable light trap cuts the illumination at a particular direction.

REFERENCES

[1] EH. Adelson. (2019, May 13). *Checkershadow Illusion*, Available: http://persci.mit.edu/gallery/checkershadow

[2] Y. Nayatani, H. Sakai. "Complexity of the Color Appearance of Objects with Nonuniform Illumination," *Color Research and Application*, vol. 32, pp. 372-377, 2007.

[3] H. Iyota, H. Sakai, "In-situ Color Measurement and Photo-Dome Photographing System for Food Quality Analysis," *Proc. of the International Congress on Food Engineering and Technology (IFET2012)*, pp.1-7, 2012.

[4] H. Sakai, M. Isomi, H. Iyota, "Non-contact colorimetric measurement using dome illumination for complex shape objects," *Proc. of the 4th Asian Color Association Conference*, pp.183-186, 2018.

In-situ Color Measurement in Steam Oven for Food Quality Analysis

Hiroyuki Iyota[1*], and Hideki Sakai[2]
[1]Graduate School of Engineering, Osaka City University, Osaka, Japan
[2]Graduate School of Human Life Science, Osaka City University, Osaka, Japan
[*]E-Mail: iyota@eng.osaka-cu.ac.jp

Abstract

We introduce a colorimetric method for visual evaluation of foods, an in-situ color measurement during food processing in two types of steam ovens using a spectrometer and a glass fiber probe. A crumb of sliced white bread was used as the sample foodstuff to demonstrate the performance of the method. The baking process and the quality of the baked product were investigated. The food color change was found to be affected by the steam mole fraction (humidity) in the oven chamber depending on the operation mode. Producing delicious-looking food is one of the qualities required incoming cooking equipment. The color measurement method introduced is very useful for evaluating cooking equipment from the visual aspects of foods.

Keyword: Spectroscopy, Baking process, Steam oven

I. INTRODUCTION

Color is one of the most important factors in determining food quality. The first quality judgment made by a consumer about a food at the point of sale is based on its appearance. Color is strongly related to the taste, smell, and texture of foods. These factors should be used for maintaining quality throughout and at the end of processing. Thus, color measurement methods and objective evaluations of food color are essential for improving food quality. However, conventional colorimetric apparatus is not applicable to the measurement of color during food processing because such processes usually involve high temperatures and wet surfaces. Furthermore, food color and corresponding images are affected by observation conditions such as light source direction, distribution of space, intensity, light spectrum, and observational direction. Therefore, careful consideration of these conditions is necessary for properly recording food color information.

In this report, we introduce an in-situ measurement during food processing under high temperature using a spectrometer and a glass fiber probe cited from our previous report [1]. To demonstrate the performances of the method, a sliced white bread was used as the sample foodstuff using two types of steam ovens for home use (A) and for commercial use (B). We baked bread samples in an oven at a temperature of 200 ˚C under three humidity conditions/modes. Then, the effects of humidity of heating media on baking process/color change were investigated.

II. METHODS

Microwave steam oven (A)

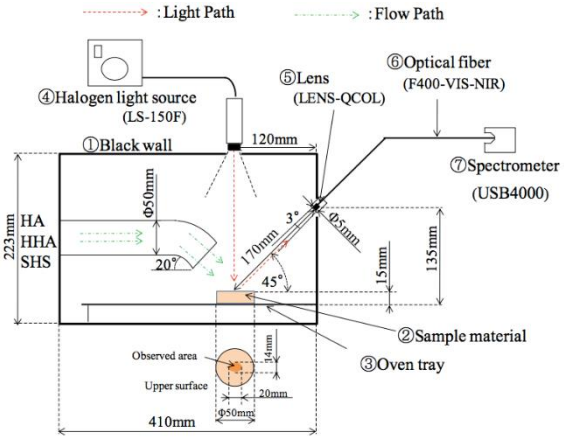


Fig. 1 In-situ measurement setup (Microwave steam oven for home use)

Fig. 1 shows the optical measurement devices and their dimensions used for in-situ color measurement. The measurements occurred every 5 s in a steam microwave oven designed for home use (Panasonic Corporation, NE-V300), modified for this research. The heating medium was supplied to the chamber, its sectional flow velocity was set to 1.2 m/s, from the left side through the Pyrex glass pipe and suctioned from the chamber by a small exhaust blower placed outside of the oven. The condition of the heating media at the inlet was regulated to a predetermined temperature and steam mole fraction. In our experiment, the temperature was set to 200 ˚C and three valid steam mole fractions—hot air (HA), high humidity air (HHA), and superheated steam (SHS)—were used [2-4]. The core temperature, T_c, of the material was measured during the coloring process. The chamber is constructed by 4 black walls, glossy gray plate for the bottom and glass window with punched metal having the ability to shield microwaves in front.

Steam convection oven (B)

A commercially marketed steam convection oven (Tanico Corporation, Model TSCO-4GBN2), designed for a commercial kitchen but modified for this research, was used as the experimental equipment. A schematic model of the oven is shown in Fig. 2. For the measurement of color and humidity, a few small holes and windows were made in the upper side of the chamber (9), which was 510 mm wide, 390 mm high, and 390 mm deep. The humidity was continuously measured by monitoring the surface temperature (T_{wet}) of a small, wet spherical gauze (13) with a diameter of 6 mm placed in the chamber.

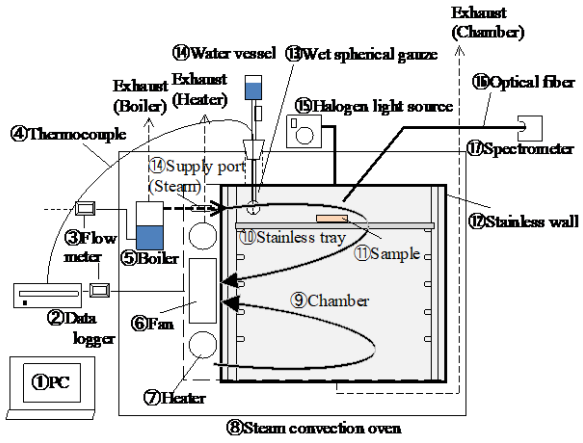


Fig. 2 In-situ measurement setup (Steam convection oven)

In situ color measurement was performed under three pre-set programmed steam operation modes: heating without the supply of steam (HA), a sequence of supplying steam for 20 s and stopping for 160 s (SHS_low), and a sequence of supplying steam for 30 s and stopping for 25 s (SHS_high). Each test was performed three times. The flow velocity of air near the sample, measured for reference at room temperature in room air without supplying steam, was around 3.3 m/s.

Common In-situ measurement conditions

The characteristics and measurement conditions from the viewpoint of color measurement are as follows:

(1) Light source
Illuminating angle: Normal
Type: Continuous spectrum light (Halogen lamp)

(2) Observer
Observing angle: 45 deg.
Type: Spectral reflectance
Spectrometer (Ocean Optics, Inc., USB4000)
Glass fiber (StellarNet, Inc., F400-VIS-NIR)
Detected information: Average of observed area

(3) Reference
White diffuse surface (Labsphere, Inc. Spectralon)

(4) Object and condition
Object: Breadcrumb with a diameter of 50 mm during heating on black tray
Temperature: 200°C

Derivation of colorimetric values

The relative reflectance spectrum of the sample, ρ(λ), is derived from the reflectance spectrum of a white diffuser, $\rho_{std}(\lambda)$, and of a sample using Eq. (1).

$$\rho(\lambda) = \rho_{sample}(\lambda) / \rho_{std}(\lambda) \quad (1)$$

III. RESULTS AND DISCUSSION

The measured sample data are shown in Fig. 3. The spectral reflectance across the whole band decreased as time elapsed. There was a greater decrease in reflectance in the shorter band than in the longer band.

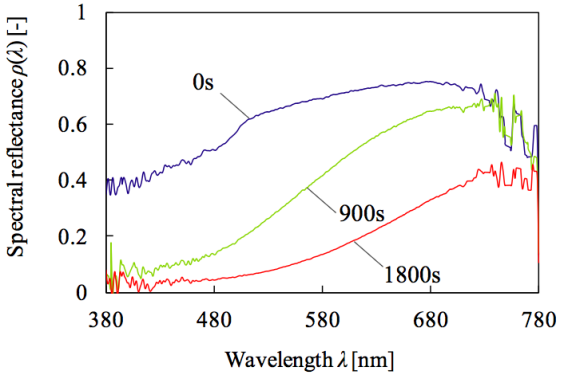


Fig. 3 Reflectance of bread crumb during heating

Next, we converted these spectral data to colorimetric values. First, the tristimulus values *X*, *Y*, and *Z* were calculated using the following equations:

$$X = K\int_{380}^{780} S(\lambda)\rho(\lambda)\bar{x}(\lambda)d\lambda$$
$$Y = K\int_{380}^{780} S(\lambda)\rho(\lambda)\bar{y}(\lambda)d\lambda \quad (2)$$
$$Z = K\int_{380}^{780} S(\lambda)\rho(\lambda)\bar{z}(\lambda)d\lambda$$

where, S(λ) is the daylight D65 spectral intensity, and x(λ), y(λ), and z(λ) are the color-matching functions of a standard colorimetric observer. K is a normalizing constant defined as Eq. (3).

$$K = \frac{100}{\int_{380}^{780} S(\lambda)\bar{y}(\lambda)d\lambda} \quad (3)$$

The tristimulus values X, Y, and Z are, however, not correlated with color attributes such as lightness, chroma, and hue. They are usually transformed to well-correlated values with color attributes using a color appearance model; the CIE 1976 $L^*a^*b^*$ color space is widely used and is also used in this paper.

Microwave steam oven (A)

Figs. 3 (a)–(c) show the values of L^*, a^*, and b^* during heating in microwave steam oven. The core temperatures of the sample, T_c, are illustrated in these figures.

The browning process with time for each heating media can be understood from these figures. For instance, under the SHS condition, the value of L^* decreased from around 85 to 35, as shown in Fig. 3(a). It was faster than under other conditions of HA and HHA. The values of a^* and b^* increased from the time L^* started to decrease, then a^* started to decrease slightly at about 650 s. The value of b^* also decreased from about 500 s, and returned to almost its initial value, as shown in Figs. 3(b) and (c).

Steam convection oven (B)

Fig. 4 shows the color change of the sample in a color bar with RGB values converted from the L^*, a^*, and b^* values of measured spectra (Note: this figure shows the original color only on well-calibrated sRGB monitor). Below the color bar, the values of L^* are shown in a diagram. Under each condition, up to around 180 s, the value of L^* was approximately 90. At 180 s, L^* began to decrease owing to browning of the sample.

The browning of the bread was primarily caused by the Maillard reaction between free amino acids and reducing sugars under high temperature. Under the SHS_high condition, the value of L^* decreased faster than under the other conditions. The reason for this could be an increase in the free amino acids and reducing sugars owing to the high dew point temperature and steam condensation on the sample surface at an early stage [5]. However, the amount of condensate on the surface of the bread would be less than other food samples because the thermal conductivity and heat capacity (per unit volume) of the bread are smaller and because it has high porosity and low moisture content.

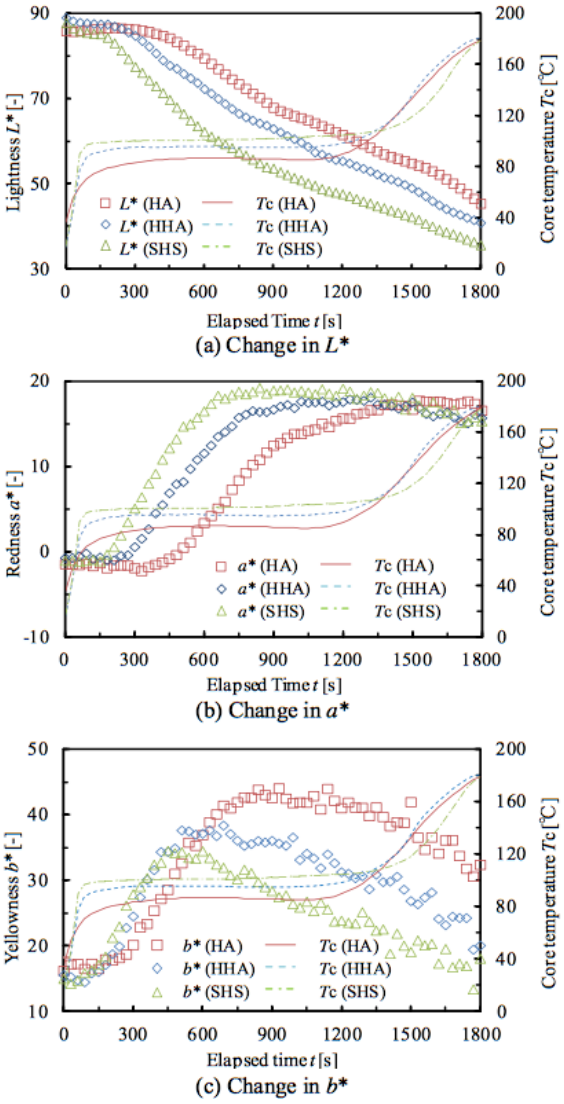


Fig. 4 Color and temperature changes in MW steam oven for home use

To investigate the accuracy of this color measurement analysis and method, a color chart (X-Rite, Inc., ColorChecker Classic), which consists of 24 precisely calibrated color chips, was used as a reference. After cutting the chart into 24 pieces, each piece having a different color was measured in the oven under room temperature. The average color difference between the standard reference values of the chart and the measured values for L*, a*, and b* of the 24 colors was 1.81, 4.07, and 10.92, respectively. The measured L* were in good agreement with the standard reference values. However, the differences were observed between the measured and standard values of a^* and b^*; this was primarily caused by the light reflected from the stainless walls and tray onto the sample. The stainless walls in the chamber were covered with a black sheet to estimate the effect of the light reflected from the walls; after covering the walls, the difference between the standard reference values of the chart

and the measured values for L^*, a^*, and b^* decreased to 0.55, 2.28, and 3.39, respectively.

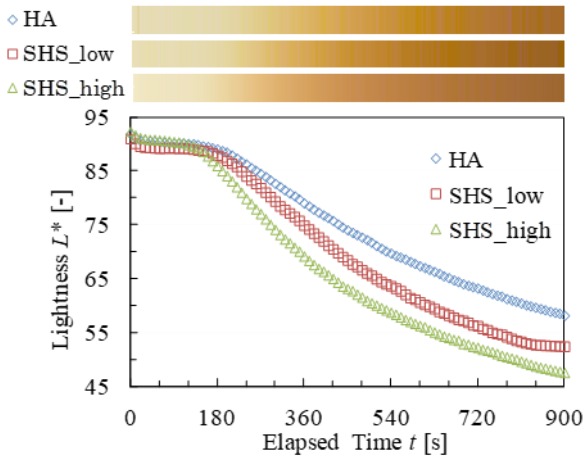


Fig. 5 Color changes in steam convection oven for commercial use

IV. CONCLUSION

There is a strong relationship between color and emotion [6, 7]. It is known that properly browned toast, fish, steak, and other foods stimulate the appetite. Producing delicious-looking food is one of the qualities required of cooking equipment. The European standard [8] says that, for example, the browning of white bread by grill is acceptable within a lightness range of L^* = 74.1 to 41.5. It seems, however, that the preferred color of food strongly depends on ethnic or cultural background. Therefore, the measurement of food colors in this report is just a first step in evaluating food color quality. For the next step, it is necessary to accumulate preference data on food color and to develop a browning control method for cooking equipment. We have been developed a new experimental system which have regulation ability of heating condition more precisely to investigate the optimization of heating process in terms of food color [9].

The progress of this research requires collaboration among the food, color, and mechanical fields, as well as input from the theoretical and industrial viewpoints.

REFERENCES

[1] H. Iyota, H. Sakai, and M. Mamiya, "Color Measurement Methods for Optimization of Oven Operation (Baking of Sliced Bread with Superheated Steam and Hot Air)," *Food Science and Technology Research*, vol. 19(6), pp. 939-947, 2013.

[2] H. Iyota, N. Nishimura, T. Onuma, and T. Nomura, "Drying of sliced raw potatoes in superheated steam and hot air," *Drying Technol.* vol. 19, pp. 1411-1424, 2001.

[3] Y. Namsanguan, W. Tia, S. Devahastin, and S. Soponronnarit, "Drying kinetics and quality of shrimp undergoing different two-stage drying processes," *Drying Technol*, vol. 22, pp. 759-778, 2004.

[4] A. S. Mujumdar, "Research and development in drying: Recent trends and future prospects," *Drying Technol*, vol. 22, pp. 1-26, 2004.

[5] H. Iyota, N. Nishimura, M. Yoshida, and T. Nomura, "Simulation of superheated steam drying considering initial steam condensation," *Drying Technol*, vol. 19, pp. 1425-1440, 2001.

[6] Y. Nayatani, and H. Sakai, "Proposal for selecting two-color combinations with various affections. Part I: Introduction of the Method," *Color Research and Application*, vol. 34, pp. 128-134, 2009.

[7] H. Sakai, and Y. Nayatani, "Proposal for selecting two-color combinations with various affections. Part II: Demonstration of the System," *Color Research and Application*, vol. 34, pp. 135-140, 2009.

[8] European Standard, *EN 50304: 2009+A1:2010, BSEN 60350:2009*. Electric cooking ranges, hobs, ovens and grills for household use. Methods for measuring performance, 2009.

[9] Y. Tanada, H. Iyota, H. Sakai and K. Fukuchi, "Development of Heating Test Equipment for Improved Utilization of Superheated Steam: Monitoring Color Change in Food at High Temperature," *Proc. of the 4th Asia Color Association Conference*, pp. 258-262, 2018.

Color Naming Boundary Comparison on Young and Elderly

B. Waleetorncheepsawat[1*], S. Theerathammakorn[1], and T. Obama[2]
[1]School of Science and Technology, Sukohthai Thammathirat Open University, Nonthaburi, Thailand
[2]Department of Space and Architecture, Faculty of Design, Shizuoka University of Art and Culture, Shizuoka, Japan
[*]E-Mail: bwddstou@gmail.com (Phone +668 1811 5521)

Abstract

This research aimed to investigate the color naming boundary comparison on young and elderly. The experimental subjects were comprised of 15 elderlies with the age of 60 -70 years old and 30 young people with the age of 25 – 35 years. The subjects determined the printed color of 1,046 color patches and sorted them out into 12 category color boxes (Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Pink and Brown). In case of no decision on color patch into the 12 color boxes, the patch was put into "Out" box. The viewing conditions were LED lamp with 2 correlated color temperatures (CCTs) of 6500 and 2700 K, with illuminance of 700 lux, and 0/45 degree observer. CIELAB, CIELCH color space of color patches, and color difference from reference color were evaluated and MANOVA was applied in terms of statistical analysis. The results revealed that the categorical colors affected on CIE L*a*b* significantly whereas group age and lighting condition had no significant difference. In addition, the categorical colors of elderly under 2700 K presented remarkable color difference compared to elderly under 6500 K, young under 6500 K and 2700 K. The findings suggested that the interaction between color categories and different groups of aging people and also using color design under different lighting condition should be considered.

Keyword: color naming, illumination, elderly vision, color temperature

I. INTRODUCTION

The population of elderly in Thailand is increasing. Elderly color vision deteriorated when they are getting aged, mostly due to the increasing degree of cataract. To name colors identification correctly in our daily visual task, the database of color boundary naming for each basic color terms should be observed.

Berlin and Kay [1] proposed that there are 11 basic color terms which are Red, Orange, Yellow, Yellow-Green, Green, Blue-Green, Blue, Purple, Pink, Brown, White, Gray, and Black. The proposed color terms were commonly used in many languages which may correspond to universal perceptual color categories. Ishida [2] investigated the color identification obtained from photopic to mesopic illumination levels based on 11 basic color terms. His result shows the different color perception especially under mesopic illumination. Kawamoto [3] investigated the effect of illuminance (three levels: 10, 100, 1000 lx) on the viewing of color. The sample color chips were judged under illuminance to match the designed Munsell color chips of 11 categories. He reported that the color identification was deteriorated when either the illuminance was low (10 lx), or the lightness of the chips was low in the elderly. He also found that there were some color chips whose categorization was same regardless of observer group or illuminance in the categories of black, blue, purple and green. Sagawa [4] applied the color matching test to study the spans of categorical colors under 500 lx and 0.5 lx. He used predefined 286 color samples to match the 20 reference colors.

The previous research has done on illumination levels investigation of white light. Some were comparing elderly and young adult observers. The quite small number of color chips aim on main and clear color, and limit the gradation of colors between main colors which are in our daily life. The judgement of fine gradation of color change will reflect more reality we face in our daily life. The investigation of colors perceived under different color temperature of light source have not when directly compared, especially when it view by different age groups.

II. METHODS

Apparatus

The experimental room was constructed in the size of 1.8 x 1.8 meter wide and 2.3 meter high. Wall was painted dull white color. Experimental room was decorated like living room. The Panasonic LED light (HH-LC714A) was fit on the ceiling in the middle of the room. The light was adjustable for color temperature and illumination power. A table was put in the middle of the room under the light. Subject sit under the light and view color patch on the surface of table at the distance of 1.5 meter from the light. The light was adjusted for daylight of 6,500K at 700 lx in the first round of experiment, and adjusted to 2,700

K at 700 lx in the second round of experiment. The experimental setup is shown in Fig. 1

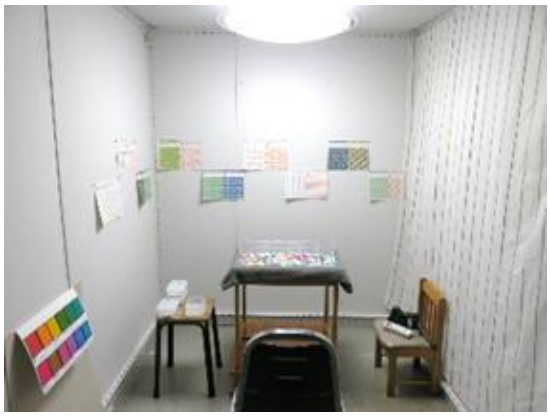


Fig. 1 Experimental room

Procedure

Subjects experimented under daylight and incandescent light of 700 lx in the living atmosphere. The 1,046 printed color patches from Toyo Ink were used to represent the overall color variety throughout color gamut. The 12 color basic color terms were used for target color naming of color patches. They are Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Brown, and Pink. Color patches that cannot assign into those colors were put into OUT box. There were 45 subjects participated in this research: 30 young subjects age between 25-35 years and 15 elderlies age between 60-70 years old. Subjects were recruited by testing Farnworth 100 Hue Test to screen out the color deficiency subjects. Subjects get paid for doing experiment.

Fig. 2 Experiment setup and procedure

III. RESULTS AND DISCUSSION

The data obtained from subjects were the selected color chips with codes of Toyo Ink database. The codes were referred to the L*a*b* value of each color chip. The frequency each color chips selected by subjects were plotted in the graphs in Fig 3 and Fig 4. The CIELAB data of each selected color under each color name then calculated for average L*a*b* of that color name, and a*b* value plotted in the graph in Fig 5. To see the relation of each factors experimented, the statistical analysis of multivariate analysis of variance (MANOVA) was done in SPSS and show the result in Table 1.

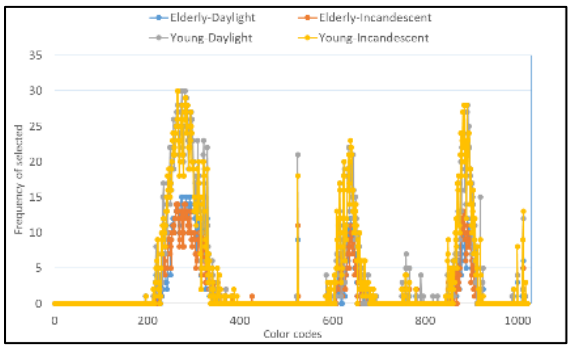


Fig. 3 Frequency of selected color chip of Green color.

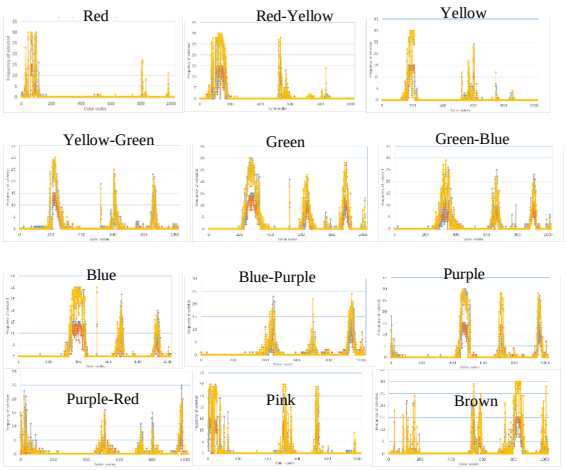


Fig. 4 Frequency of selected color chip for each of 12 color names.

Fig. 3 shows the results of frequency for each color chip that has been chosen as Green color. The horizontal axis demonstrated the chip number from 1 to 1,046. The vertical axis is the frequency of selected as the color name. Since the number of subject for elderly and young are not the same (15 vs 30) the base for frequency of selected are different for elderly and young. However the selection for color name of each chip are agreeable throughout the color space, as seen in graph of "Elderly-Daylight", "Young-Daylight", "Elderly-Incandescent", and "Young-Incandescent". We can see that the pattern of chosen color for elderly and young, under daylight or incandescent light are in the same pattern. The decision to assign to a color naming for each color chips based mainly on its color rather than the age group or the illumination.

Fig. 4 demonstrate the pattern of frequency distribution of all 12 colors obtained from elderly and young subjects experimented under daylight and incandescent light. Each color has similar frequency pattern as explained in Fig. 3.

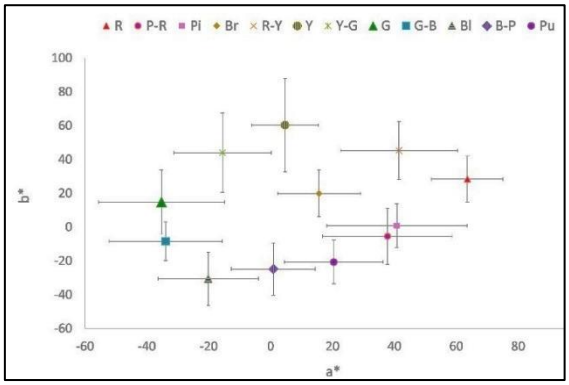


Fig. 5 The a*b* value of 12 color names obtained from elderly and young subjects experimented under daylight and incandescent light.

The color naming boundary of 12 color names traced from the average CIELAB color value of each color chip that has been selected as the given color name. The graph in Fig. 4 represent the a*b* coordinate of each color. The horizontal axis is the a* and vertical axis is the b*. The average color value of the 12 color names are plotted with the symbol of each color. The standard deviation of the a* and b* of each color represent the boundary of that color. Most of the colors are well distributed across the color gamut, except for the Purple-Red and Pink that are very close together.

Table 1. The result of multivariate analysis of variance (MANOVA) of Lighting, Age groups, and Color names by Wilks' Lambda statistic.

Result	Wilks' Lamda statistic	F	Sig.
Intercept (cross)	.081	356352.833b	0.000
Color name	.071	11222.254	0.000
Group (Elderly and Young)	1.000	.b	
Group detail (Elderly-Daylight, Young-Daylight, Elderly-Incandescent, Young-Incandescent)	1.000	.b	
Light type	1.000	.b	
Color name*Group	1.000	.b	
Color name*Group detail	1.000	.b	
Color name*light type	1.000	.b	
Group*Group detail	1.000	.b	
Group*light type	1.000	.b	
Group detail*light type	1.000	.b	
Color name*Group*Group detail	1.000	.b	
Color name*Group*light type	1.000	.b	
Color name*Group detail*light type	1.000	.b	
Group*Group detail*light type	1.000	.b	
Color name*Group*Group detail*light type	1.000	.b	

IV. CONCLUSION

For the color naming boundary of 12 color names: Red, Red-Yellow, Yellow, Yellow-Green, Green, Green-Blue, Blue, Blue-Purple, Purple, Purple-Red, Brown, and Pink, result showed that color naming judgement for elderly and young are not significantly different, either under daylight or incandescent light. The result from this study can ascertain young designer to use the 12 basic colors in the visual sign design that the given color within its boundary can be used successfully for elderly as well as the young, either under daylight or incandescent light. Look into the distribution of color names, we found that most of the colors are well distributed across the color gamut, except for the Purple-Red and Pink that quite close together. We would suggest to pick either Purple-Red or Pink but not both of them together.

The 12 color terms used in this research were derived from the concept of Berlin and Kay basic color terms. However, only chromatic colors were included, and achromatic color not included. In this research the achromatic colors were not included. Further study might include the achromatic colors as well as the colors with addition of white such as Light Blue, which actually one of the basic color for Thai people, but not define as main color by the concept of Berlin and Kay. The cross cultural color naming boundary also worth investigated.

ACKNOWLEDGEMENT

The author would like to thank Sukhothai Thammathirat Open University for granting the fund for the research of COLOR NAMING BOUNDARY COMPARISON ON YOUNG AND ELDERLY. We thank Toyo Ink for disclosing information on

database of the color chip. We also thank the young and elderly subjects that participate in this experiment.

REFERENCES

[1] B. BERLIN and P. KAY, *"Basic Color Terms: Their Universality and Evolution,"* University of California Press, Berkeley, 1958.

[2] M. Ikeda, and T. Obama. "Desaturation of Color by Environment Light in Cataract Eyes," *Color Research and Application,* vol. 33, pp. 142-147, 2008.

[3] T. Ishida. "Color Identification Data Obtained from Photopic to Mesopic Illuminance Levels," *Color Research and Application*, vol. 27, pp. 252-259, 2002.

[4] K. Kawamoto, T. Wake, and H. Wake. "Effect of illuminance on color cateforization by basic terms – comparison between young adults and elderly people on the photopic levels," *Color Science Association of Japan (CSAJ 2013)*, pp. 83-92, 2013.

[5] K. Sagawa, and T. Yasuro, "Spans of Categorical Colours Measured by Similarity of Colours," *Proceedings of the 25th Session of the CIE*, San Diego, USA, vol.1, D1-64 - D1-67, 2003.

The flexible plate Light-emitting diode lamp for lighting in the limited area

Waiyawut Wuthiastasarn*, Jirasak Prechaveerakul, Nuttawut Dairup, and Sirawat Sairat
Department of Imaging and Audio Technology, Faculty of Mass Communication Technology,
Rajamangala University of Technology Thanyaburi, Pratumthani, Thailand
*E-Mail: waiyawut_w@rmutt.ac.th

Abstract

Light-emitting diode (LED) lamps use frequently in studio and outdoor lighting nowadays. But in the working place some area is narrower than instruments for lighting for production stage. Therefore, it is difficult to set lighting equipment. The usefulness of lighting equipment is for setting and hiding on scene. This paper presents the intensive performance of the flexible plate Light-emitting diode (LED) in studio luminaires by set up the experiment in the actual studio environment. It is too comfortable to set lighting because the flexible plate of Light-emitting diode (LED) lamp can shape many shape form for lighting cool light and warm light in narrow areas. The results of test configuration were set lighting in studio and performance shown in this paper comprise of the lighting distribution parameters.

Keyword: Flexible plate, Light-Emitting Diode (LED), Cool light and Warm light

I. INTRODUCTION

The imaging of film and television broadcasting program is made of lighting because light is a source of things that can appear and seen. Sometimes its produce by the natural light but sometimes by artificial light in the studios. Then the artificial lighting is so important in this process because the production of all content must process in the industrial style in mass media. Then it usually works all day and night. Nowadays, a studio lighting system mainly utilizes the Light-emitting diode (LED) for production stage. So the Light-Emitting Diode (LED) lamp is becoming more and more popular to be used as a replacement for the natural ones.

The theories and Equations to test configurations and intensive experimental results are thoroughly elaborated in this article.

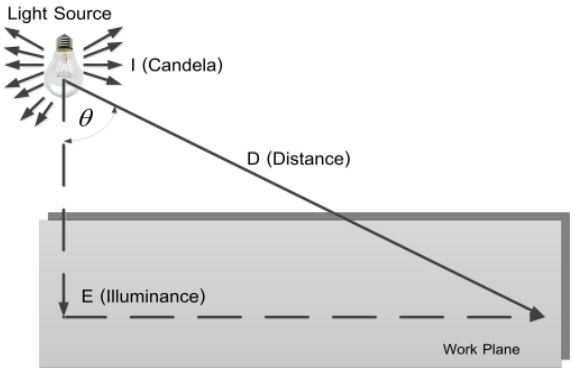


Fig. 1 The fundamental of illuminance computation method in engineering

$$E = \frac{I \times Cos\theta}{D^2} \qquad (1)$$

[1] The illuminance is a measure of the light falling on a working plan. Illuminance can be measured in the unit of either *Lux (lumen/m^2)* or *Foot-candles (lumen/ft^2).* In general engineering design, the illuminance can simply be calculated using Equation (1).

Where I is the amount of visible power per unit solid angle, measured in Candelas (Cd or lm/sr) ,θ is angle between the light axis of the light beam and the vertical axis of the work plan, D is distance between point of the light to work plan in meter (m). Therefore, the illuminance of the lighting for each point can be computed based on the aforementioned figure and equation in studio lighting system. Most measurements assume that the light is directly on vertical axis from the source, the incident illuminance level will then be calculated as $E = I/D^2$. This principle is a general uses for illumination engineering design in many illumination applications.

[2-4] Apart from that, Studio-lighting-designed engineers apply another rule for lighting calculation called *Studio-Lighting-the-Subject* rule. The example shown in Fig.2 clearly elaborates the *Studio-Lighting-the-Subject* idea and concept. It can be seen that the angle of incidence (cosine law) also affects the light level, where T is the distance between the light source to a working plan in meter (m), d is the horizontal distance in meter (m), H is the height of the luminaire above the floor level in meter (m) and Y is the subject height in meter (m) [2]. Equations (2) and (3) represent how to compute the illuminance of the interested area in studio lighting calculation. equation (4) is the final formulation for the studio lighting calculation.

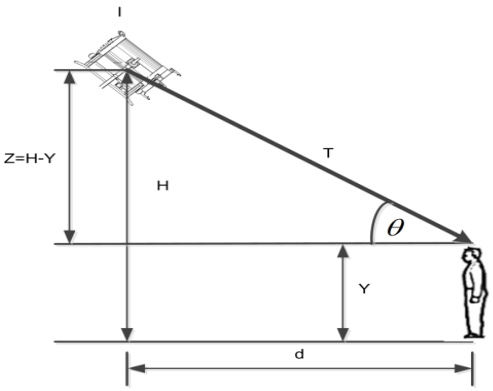


Fig. 2 Studio-Lighting-the-Subject principle

$$Throw\ (T) = \sqrt{\left[d^2 + \left(H - Y \right)^2 \right]}$$

$$Cos\theta = \frac{d}{T} \quad (2)$$

Incident light level is given by

$$\frac{I\ (Candela)}{Throw^2} \times \frac{distance\ (d)}{Throw\ (T)} = \frac{I \cdot d}{T^3} \quad (3)$$

It can then be rewritten as

$$E = \frac{I \times d}{T^3} \quad (4)$$

From the experiments and analysis, we found out that the two methods: equation (1) and equation (4) yield the same results for illuminance computation. But in working area the crew of filmmaking and video production workers used the technical term not a term from Studio-lighting-designed engineers. The professional film maker or television production workers must use the light meter to investigate illuminance that call F-stop (F-number). The F-stop is an index shown on photographic spot meter displays to set an exposure value. Exposure value (EV) design for equating combinations of aperture (f-stop), and shutter speed, we would have a "correct" exposure. The equation is written as:

$$EV = \log^2 (N2/t) \quad (5)$$

A photographic spot meter is a narrow field of view exposure meter used in photography. The spot meter is available from a number of manufacturers appearance to Sekonic Prodigi Color C-500 luminance meter shown in Fig. 4. A photographic spot meter displays exposure value. The exposure value is the degree of exposure of the camera film or sensor it depend on the light falling on all of subjects on screen. In this research, the Sekonic Light L-758 illuminance meter shown in Fig. 3 has been mainly used in the experiments for measuring the Exposure value (EV) or F-stop. For Illuminance measurement, the brightness of continuous light sources is displayed in LUX (lx) or Foot-Candle (FC). Illuminance measurement is especially useful for cinematography, videography, theatrical and other applications. The Sekonic Prodigi Color C-500 shown in Fig. 4

Fig. 3 Sekonic Light L-758[5]

Fig. 4 Sekonic Prodigi Color C-500 [6]

Nowadays, Light-emitting diode of luminaires are the workhorses of stage lighting and the most common luminaire (light) used on stage and in studio. Light-emitting diode (LED) lamps frequently use in studio and outdoor lighting. But some area is narrow or limited than instrument that traditional lighting cannot use to light on scene. Then the flexible of lighting equipment is important.

II. METHODS

This test was set up in the real photographing studio; the dimension of the studio under the tested is 9x8x11 (WxLxH) meters. The nature of interior of this kind of studio is that it has to be decorated with all black materials, walls and textures. There should be zero to none natural light from the Sun penetrating into this studio. In this set up, both luminaires (cool and warm) were hung at the height of 2.6 meter above the tested working plane aiming at the face of the model in this set up, see Fig.5 The distance between the light sources and the model were set up at 1 meter and 2 meters, respectively as exactly in the data specification shown in Fig.6 Illuminance

measurements were manually carried out using Sekonic Light L-758 illuminance meter and Sekonic Prodigi Color C-500 Fig. 5 illustrate show this test configuration was done.

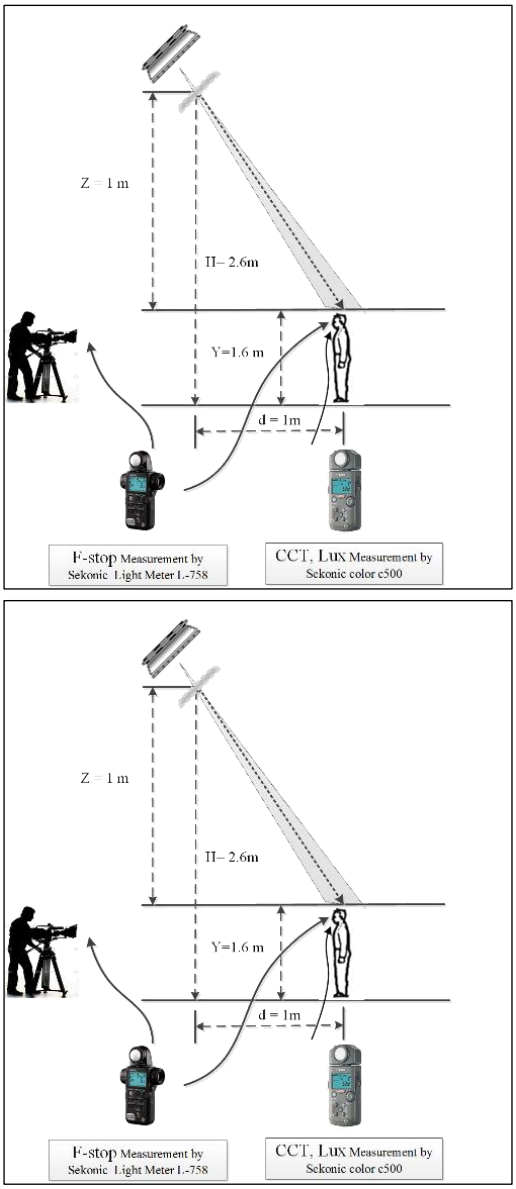


Fig.5 Test configurations for lighting distribution parameters

Experiment

The experimental results of comparisons can be illustrated in Fig.6 the distance of subject and light is 1 meter and set in the same apparatus. Fig. 8 is 2 meters. The result is show in Fig. 7 the distance of subject and light is 1 meter and Fig. 9 is 2 meters. The experiment set up again that luminaires were set to be warm light. The experimental results of comparisons can be illustrated in Fig.10 the distance of subject and light is 1 meter and set in the same apparatus. Fig. 12 is 2 meters. The result is show in Fig.11 the distance of subject and light is 1 meter and Fig. 13 is 2 meters.

Fig. 6 luminaires of Cool lighting in this experimental set ups 1 meter

Fig. 7 Image from luminaires Cool of lighting in this experimental set ups 1 meter

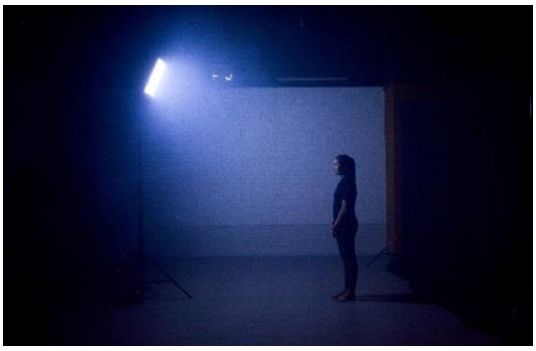


Fig. 8 luminaires of Cool lighting in this experimental set ups 2 meters

Fig. 9 Image from luminaires Cool of lighting in this experimental set ups 2 meters

Fig.10 luminaires of Cool lighting in this experimental set ups 1 meter

Fig. 12 luminaires of Cool lighting in this experimental set ups 2 meters

Fig. 11 Image from luminaires Cool of lighting in this experimental set ups 1 meter

Fig.13 Image from luminaires Cool of lighting in this experimental set ups 2 meters

Table 1 Experimental Comparison Results of specification data Flexible plate Light-emitting diode (LED) versus LED Soft Panel 200 [7]

Information	LED Soft Panel 200	Flexible plate Light-emitting diode (LED)
Identity No.	L002SLSP (M.O.) LP02SLSP (P.O.)	LED Strip Ribbon IP65
Capacity	200W	230W
Voltage	95 - 265V AC 22 - 36V DC	220V AC 12V DC
Frequency	50Hz / 60Hz	50Hz / 60Hz
Current	1A @220V 50Hz AC 2A @110V 60Hz AC 7A @30V DC	5A @220V 50Hz AC 7A @12V DC
Color Temp.	Adjustable 2700K - 6000K	Adjustable 2500K - 8000K
CRI	95	85
TLCI	95	85
Dimming	0 - 100%	0 - 100%
Control Signal	DMX 512	PWM MAX 90W DC
DMX Channel	2	2
LED Life	Approx. 30,000 Hrs	Approx. 100,000 Hrs
M.O. / P.O. Stirrup	Ø28mm (1-1/8 in.) Spigot	-NA-
Max. Surface Temp.	70 ºC	30 ºC
Max. Ambient Temp.	45 ºC	35 ºC

III. RESULTS AND DISCUSSION

The cool light measure color temperature measure by Sekonic Prodigi Color C-500 is 8,080 K. The illuminance measure by Sekonic Light L-758 at 1 meter is 374 lux. and 2 meters is 184 lux. To convert Exposure value (EV) to F-stop at 1 meter is f - 4 (Fig.7) and at 2 meters is f – 2.8 (Fig.8). The warm light measure color temperature measure by Sekonic Prodigi Color C-500 is 2,530 K. The illuminance measure by Sekonic Light L-758 at 1 meter is 550 lux. and 2 meters is 264 lux. To convert Exposure value (EV) to F-stop at 1 meter is f - 4 (Fig.11) and at 2 meters is f - 2.8 (Fig.13)

It can be simply concluded here that the Light-emitting diode (LED) lamp tends to have a bright to the face of subject in the Fig. 7 and 11 because of the distance of subject is a 1 meter closed.

Then it is more clear of the face of subject because of the distance of subject is far than the first one. The shadow under chin is not hard in the Fig. 9 and 13. This paper presented the performance comparisons of flexible plate Light-emitting diode (LED) lamp between Cool and Warm lighting application. It is too comfortable to set lighting because the flexible plate of Light-emitting diode (LED) lamp can shape many shape form for lighting cool light and warm light in narrow areas.

IV. CONCLUSION

The flexible plate Light-emitting diode (LED) lamp to compare with artificial lamp Filmgear model LED Soft Panel 200 the industrial consumer LED light shown that specification data in Table 1. It can be simply concluded here that the more-modern LED tends to have a bright future for studio lighting in the near future to come.

REFERENCES

[1] J. R. Coaton, and A. M. Marsden, *"Lamps and Lighting,"* 4th Edition, New York: Routledge, 2011.

[2] B. Fitt and J. Thornley, *"Lighting Technology a Guide For The Entertainment Industry*," 2nd Edition, Great Britain: Focal Press, 2002.

[3] J. Jackman, *"Lighting For Digital Video and Television,"* 3rd Edition, Chennai, CHN: Focal Press, 2010.

[4] S. Debonnaire and A. Poole, *"TV Low Energy Lighting Guide for TV Productions,"* British Broadcasting Corporation (BBC) Tech. Report, Sept. 2011.

[5] Sekonic Operating Manual: Light L-758, Tokyo, 2006.

[6] Sekonic Operating Manual: Prodigi Color C-500R/C-500, Tokyo, 2007.

[7] Filmgear soft panel 200 [online] http://www.filmgear.net/index.php?route=product/product&path=521_195_224&product_id=309.

TECHNOLOGY AND INNOVATION FOR ENGINEERING

Investigation of Full-Scale Air Flow on HVAC Air Duct of High-Speed Train Using CFD Method

Decha.I[1*], XU.Yugong[1], Wirachai. R[2]
[1]School of Mechanical, Electronic and Control Engineering, Beijing Jiaotong University, Beijing, China.
[2]Engineering Faculty, Rajamangala University of Technology Thanyaburi, Phathumthani, Thailand
[*]E-Mail: 17119009@bjtu.edu.cn

Abstract

The HVAC air duct shape is very importance for air flow distribution into High-Speed Train cabin, the environmental comfort parameters cabin inside include pressure changes, air flow rate, temperature, humidity, air composition, noise, etc. In this paper is investigated the theoretically airflow field and flow characteristics in HVAC air duct of the middle cabin of High-Speed Train CRH380BL model which was simulated by CFD simulation method. The length of HVAC air duct model dimension is about 17 meters and the width is about 1.5 meters. The initial boundary air flow quantities inlet used only one value point from the characteristics fan curve which is 1.2 kg/s. The outlet section of air duct totally 59 sections which located at upper side and beside side of cabin. Airflow distribution contour and airflow outlet mass flow rate quantities showed good design of air duct shape.

Keyword: High-Speed Train cabin, HVAC air duct, CFD simulation Method

I. INTRODUCTION

Ventilation ductwork system is the essential component in modern vehicle to maintain good indoor environment quality. The discontinuities in the air duct will influence the airflow and result in the generation of localized turbulent as the ventilation system begins to operate [1-3]. Also the noise can generate from turbulence airflow and discontinuities of air duct installation [4-5]. The equipment for air environment control of cabin inside provides heating system control and ventilation and air conditioning (HVAC) system control. The ventilation system components and features as follow.

- The filters for water eliminators of fresh air intake from surrounding
- Electrically motorized lower level/upper level supply air diversion dampers
- Electrically motorized fresh air dampers
- Frame type disposable air filters
- Air diffusers and grilles
- Air distribution ducts
- Exhaust ducts
- Exhaust fans
- Emergency fan switches

The air flow in air duct inside use blower generate the mass flow rate of air flow though along air duct length. The fresh air from surrounding intake to cabin obtains high moist that must eliminate vapor. The condensation process is used for eliminate vapor and must drain out from the cabin.

The temperature of surrounding and cabin inside is two main parameters for HVAC system control [6]. The fresh air intake to the cabin depend on the speed of High-Speed Train and the effects of the ventilation working mode on the air quality in a vehicle cabin and surrounding. In somewhere of vehicle is passing can use 100% fresh air intake to the cabin, not use recirculation air [7]. . The total air leakage ventilation rate for a vehicle cabin comprises two components was suggested, namely (1) the car speed induced air leakage rate, and (2) the fan-supplied air speed induced air leakage rate [8].

The air distribution in High-Speed Train cabins may have problems in providing a comfortable and safe cabin environment. Moreover the air distribution may be of unsteady state, low speed, high turbulence with unknown pulse frequency. Therefore, it is essential to study how the air is distributed in cabins.

The thermal comfortable have been studied also the air quality on vehicle and the building. Generally, the experimental have been many studied on mockup, investigate air flow distribution and thermal distribution [9]. However, the measurement not accurate on human body surface. Also full-scale of experimental must use high cost for cabin mockup experiment [10].

Nowadays, the Computational Fluid Dynamics (CFD) method has become the most widely used tool for studying air distributions in cabins. The turbulent model in CFD method base on mostly were use Reynolds-Averaged Navier-Stokes (RANS) equation models[11], and their results presented very significant discrepancies of air velocity magnitude between the measurement data and the CFD results [12]

Re-circulated air flow through a plenum chamber where it mixes with the fresh air, be filtered and pass to the HVAC unit blower. The blower fans will move the mixed air through the cooling and heating coils and force the conditioned air into the upper and lower supply air ducts. The duct sized to minimize noise from air velocity.

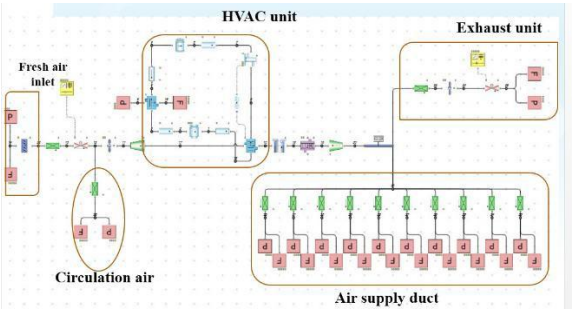


Fig.1 1D Simple model Diagram of HVAC

Fig.1 shows the simple schematics 1Dsimple model of HVAC system. The system include fresh air inlet, circulation air system, and air conditioning unit, exhaust air unit and air duct supply.

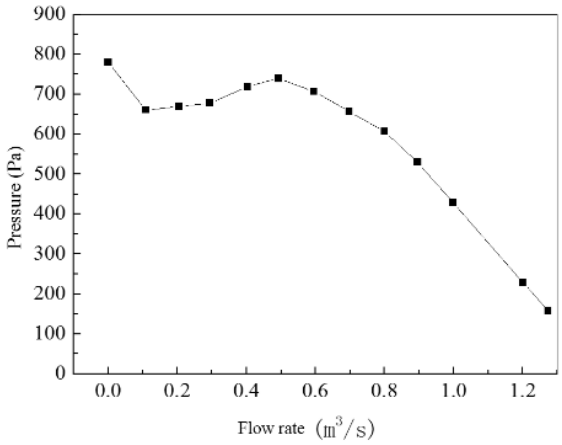


Fig.2 Characteristics Curve of Inlet Duct Fan

Fig.2 shows the Characteristics Curve of Inlet Duct Fan working. When pressure increasing, the flow rate of fan will be decreasing.

This research will focus only on air flow characteristics in middle air duct of High-speed Train. The inlet boundary condition for simulation will use only one point from Characteristics Curve.

II. METHODS

Physical model

The present study considered a High-Speed Train CRH3 model having a cabin with the dimensions shown in Fig. 1. The cabin is fitted with 104 inlets on the upper surface and side surface as shown in Fig. 2 and 4 air outlets on the lower side surface. For evaluation purposes, the present study additionally designed mixing fresh air inlets and circulation air together.

The simulation model was separated two mains parts for CFD simulation that including HVAC air duct system and cabin. Firstly, the HVAC air duct system is simulated then cabin will be simulated by using air flow outlet quantities from HVAC air duct system result to be initial boundary air flow inlet of cabin.

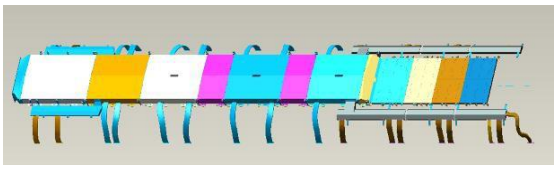


Fig.4 The Assembly model High-speed Train with HVAC and cabin

Fig.3 shows the 3D model HVAC air duct system on middle cabin of High-Speed Train. The length of air duct is 17 meters and the width is 2 meters.

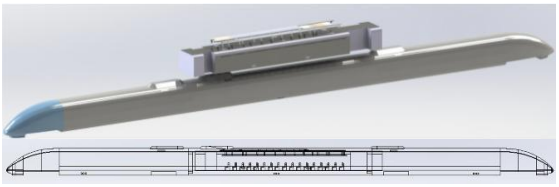


Fig.4 The Assembly model High-speed Train with HVAC and cabin

Fig.4 shows the assembly model of High-speed Train with HVAC and cabin. This research is considered only the middle cabin of high-Speed Train. The model included the simple shape of passenger and seat. This research will simulate focus only the air flow inside the duct not consider the passenger room.

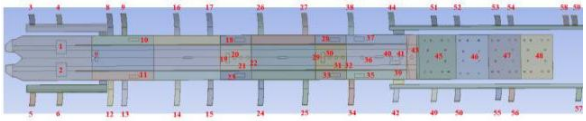


Fig.5 The outlet position of HVAC air duct of High-speed Train

Fig.5 shows the point of air outlet, the outlet of air duct was mainly separated two types that is upper outlet and beside. The upper outlet obtains the point of 1, 2, 7, 10, 11, 18, 19, 20, 21, 22, 23, 28, 29, 30, 31, 32, 35, 36, 37, 39, 40, 41, 43, 45, 46, 47, 48 respectively while the beside side obtains the point of 3, 4, 5, 6, 8, 9, 12, 13, 14, 15, 16, 17, 24, 25, 26, 27, 34, 38, 42, 44, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59 respectively.

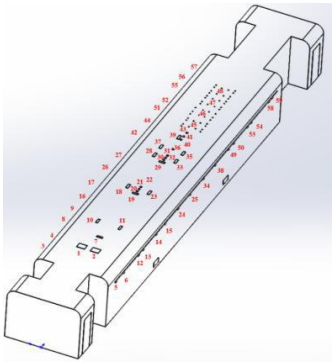


Fig. 6 The inlet position of High-speed Train HVAC Cabin

Fig.6 shows the inlet position of High-speed Train HVAC cabin. This model not simulation in this paper.

Mathematical formulations

CFD Finite Volume Method simulations were performed using for calculation. The simulations considered the air within the cabin to be turbulent, incompressible, Newtonian flow. The related governing equations, boundary conditions and numerical solution procedure are described in the following.

Mass conservation

For a working fluid with constant density ρ (i.e., incompressible flow), the rate of mass change with time t in a control volume is balanced by the net mass flow. That is,

$$\frac{\partial \mathrm{u}}{\partial \mathrm{x}} + \frac{\partial \mathrm{v}}{\partial \mathrm{y}} + \frac{\partial \mathrm{w}}{\partial \mathrm{z}} = 0 \qquad (1)$$

where u, v and w are the x-, y- and z-directional velocity components at a specific position in the control volume, respectively.

Momentum and concentration conservation

The momentum and concentration change rate of a fluid element in the control volume is equal to the sum of the forces acting on the element. For any 3D model, these forces comprise normal force stress and tangential force stress components in the x-, y- and z directions, respectively. In fluid dynamics, the momentum and concentration change rate is expressed using the following Navier-Stokes equations:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\left(\frac{\mu}{\rho}\frac{\partial u}{\partial x} - \acute{u}\acute{u}\right) + \frac{\partial}{\partial y}\left(\frac{\mu}{\rho}\frac{\partial u}{\partial y} - \acute{u}\acute{v}\right) + \frac{\partial}{\partial z}\left(\frac{\mu}{\rho}\frac{\partial u}{\partial z} - \acute{u}\acute{w}\right) \qquad (2)$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + \frac{\partial}{\partial x}\left(\frac{\mu}{\rho}\frac{\partial v}{\partial y} - \acute{v}\acute{u}\right) + \frac{\partial}{\partial y}\left(\frac{\mu}{\rho}\frac{\partial v}{\partial y} - \acute{v}\acute{v}\right) + \frac{\partial}{\partial z}\left(\frac{\mu}{\rho}\frac{\partial v}{\partial z} - \acute{v}\acute{w}\right) \qquad (3)$$

$$\frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + \frac{\partial}{\partial x}\left(\frac{\mu}{\rho}\frac{\partial w}{\partial x} - \acute{w}\acute{u}\right) + \frac{\partial}{\partial y}\left(\frac{\mu}{\rho}\frac{\partial w}{\partial y} - \acute{w}\acute{v}\right) + \frac{\partial}{\partial z}\left(\frac{\mu}{\rho}\frac{\partial w}{\partial z} - \acute{w}\acute{w}\right) \qquad (4)$$

where μ is the dynamic viscosity of air; and $\acute{u}\acute{u}$, $\acute{u}\acute{v}$, $\acute{u}\acute{w}$, $\acute{v}\acute{v}$, $\acute{v}\acute{w}$ and $\acute{w}\acute{w}$ are the Reynolds stresses.

The present simulations employed a standard $k-\omega$ turbulence model and performed finite volume discretization of the governing equations using an implicit, unsteady, first-order difference method. The uncoupled non-linear equations of motion were solved using the SIMPLE method. The simulations were performed using the computational model shown in Fig. 3. The model was discretized using an unstructured polyhedral mesh and allowed for a maximum of five occupants within the cabin.

Boundary conditions

The inlet of air flow in HVAC duct system is mixing air that include fresh air and recirculation air. The mass flow rate of air assume such as eccentric fan machinery working curve as shown in Fig 4. In this research was selected only one working point at 1.2 kg/s of fan machinery working point for investigation of air flow characteristics. The total pressure outlet side selected pressure outlet condition that is 0 Pa. The $k-\omega$ turbulence model was selected for this research.

III. RESULTS AND DISCUSSION

When finished the simulation of air duct, the CFD result showed the various quantities of air flow at the outlet side as shown Table1.

Table 1 Mass flow rate at outlet side.

No.	Mass Flow Rate		No.	Mass Flow Rate		No.	Mass Flow Rate	
	(kg/s)	%		(kg/s)	%		(kg/s)	%
1	-0.033093	2.76	11	-0.036393	3.03	21	-0.020727	1.73
2	-0.021039	1.75	12	-0.003480	0.29	22	-0.022187	1.85
3	-0.002556	0.21	13	-0.002596	0.22	23	-0.031197	2.60
4	-0.002511	0.21	14	-0.003816	0.32	24	-0.004142	0.35
5	-0.004721	0.39	15	-0.003260	0.27	25	-0.003944	0.33
6	-0.004626	0.39	16	-0.003947	0.33	26	-0.003735	0.31

7	-0.015848	1.32	17	-0.003345	0.28	27	-0.002473	0.21
8	-0.003012	0.25	18	-0.037743	3.15	28	-0.061744	5.15
9	-0.002849	0.24	19	-0.063593	5.30	29	-0.075824	6.32
10	-0.033186	2.77	20	-0.020792	1.73	30	-0.023571	1.96
No.	**Mass Flow Rate**		**No.**	**Mass Flow Rate**		**No.**	**Mass Flow Rate**	
	(kg/s)	**%**		**(kg/s)**	**%**		**(kg/s)**	**%**
31	-0.023620	1.97	41	-0.027542	2.30	51	-0.002332	0.19
32	-0.024043	2.00	42	-0.007722	0.64	52	-0.002799	0.23
33	-0.051560	4.30	43	-0.021102	1.76	53	-0.003590	0.30
34	-0.004915	0.41	44	-0.006194	0.52	54	-0.004070	0.34
35	-0.086192	7.18	45	-0.020790	1.73	55	-0.003008	0.25
36	-0.024407	2.03	46	-0.021947	1.83	56	-0.003442	0.29
37	-0.079829	6.65	47	-0.025922	2.16	57	-0.005027	0.42
38	-0.004343	0.36	48	-0.028202	2.35	58	-0.003797	0.32
39	-0.122075	10.17	49	-0.002769	0.23	59	-0.004030	0.34
40	-0.025065	2.09	50	-0.003471	0.29			

Fig.7 shows the curve of mass flow rate quantities at outlet section. The maximum of flow rate is showed at the point of 39 which is located at upper side on the middle of air duct, the quantities is showed about 0.122075 kg/s as 10.17% of whole outlet mass flow rate.

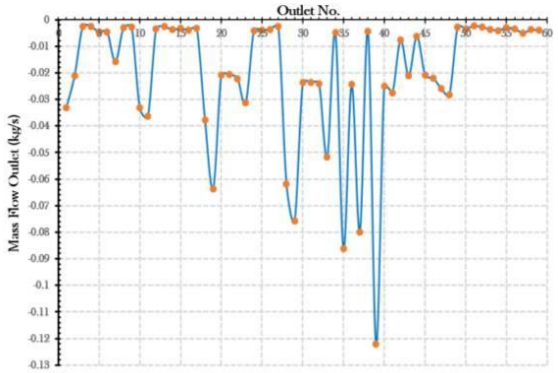


Fig. 7 Curve of mass flow rate outlet at difference point Large Mass flow rate throughout the upper section side of air duct while little mass flow rate throughout the beside section side of air duct.

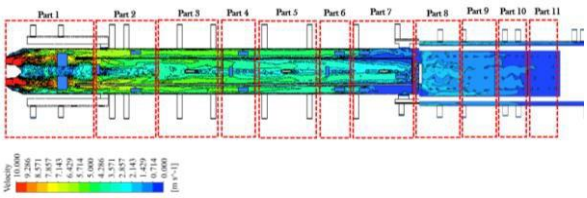


Fig.8 The velocity contour of air duct

Fig.8 shows the velocity contour of air duct, the velocity contour of air flow is good distribution along to the air duct shape. This result indicate good design of air duct shape. The air duct is separated 11 parts for investigate the velocity vector profile as shown in Fig.9

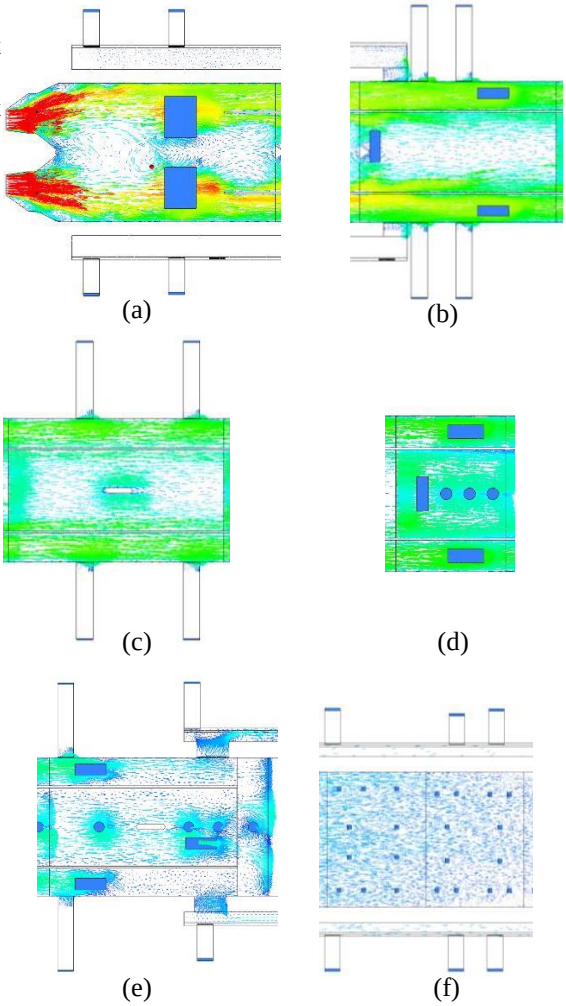


Fig.9 Velocity Vector Profile of HVAC air duct High-Speed Train (a) air duct part 1 (b) air duct part 2 (c) air duct part 3 (d) air duct part 4 (e) air duct part 7 (f) air duct part 9 and 10

At the air duct part 1, the vortex flow is generated as shown in Fig.9 (a), then after air duct part 2 such as Fig.9 (b) until the air duct part 11, the vortex flow not depict again along to the HVAC air duct.

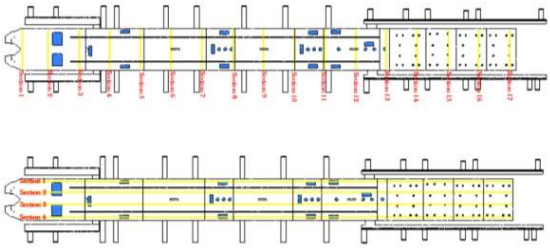


Fig.9 Cross section of air duct (a) Vertical cross section (b) Horizontal cross section

Fig.9 show each cross section of air duct for calculation the velocity profile and turbulence kinetics profile.

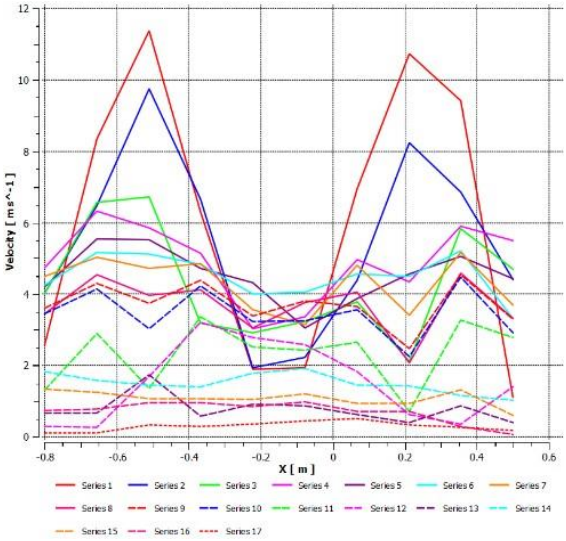


Fig.10 Velocity profile of vertical section of air duct

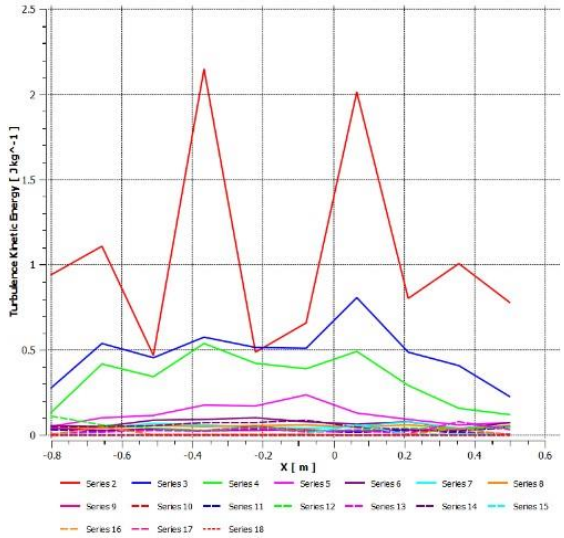


Fig.11 Turbulence kinetics energy of vertical section of air duct

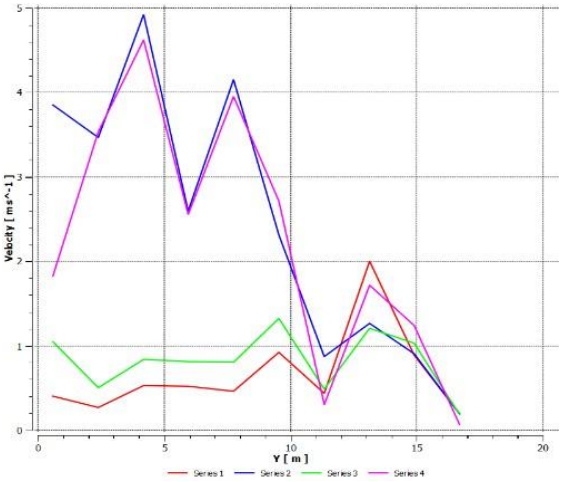


Fig.12 Velocity profile of horizontal section of air duct along with

Fig.10 shows velocity profile of vertical section of air duct. The chart obtains 17 vertical cross sections, each section show that the velocity profile. Series 1 indicates section 1, series 2 indicates section 2, and series 3 indicates section 3, until series 17 indicates section 17 respectively. The curve shows the velocity at the middle of vertical section of air duct quit lower beside side.

Fig.12 shows velocity profile of horizontal section of air duct. The series 1 indicates section 1, series 2 indicates section 4, series 3 indicates section 3 and series 4 indicates section 2 respectively. The section 1,4 located at the beside side of air duct while the section 2,3 located at middle. The velocity profile value show that the length from 0-10 meters at the middle location and beside location quit difference while 10-17 meters length, the velocity showed a little difference.

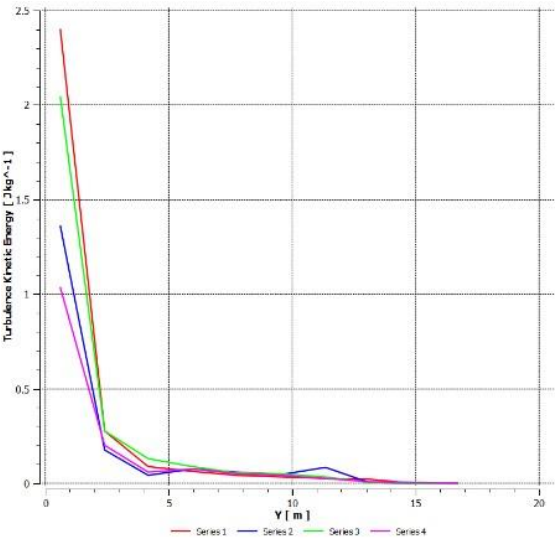


Fig.13 Turbulence kinetics energy profile of horizontal section of air duct

Fig.13 shows the turbulence kinetics energy profile of horizontal section of air duct. The curve

quit decreasing from 0-3 meters of the length from inlet point. After 4 meters the air flow quit laminar flow because turbulence kinetic energy very low which value close to zero.

IV. CONCLUSION

Air flow distribution of HVAC air duct system very important for air flow distribute in High-Speed Train cabin inside. Therefore, the ventilation air duct shape design and air duct network design need compatible with the cabin. In the CFD simulation results showed good design air duct shape and air duct network design because the air flow distribution at beginning section to finishing section of the air duct can distribute along the air duct network and the mass flow rate output not much different at each output section, also the turbulent kinetic energy showed rapid decrease from air inlet section.

ACKNOWLEDGEMENT

The research presented in this paper was partially supported by School of Mechanical, Electronic and Control Engineering, Beijing Jiaotong University, Beijing, China.

REFERENCES

[1] A. Fry, "Noise Control in Building Services," Oxford: Pergamon, 1987.

[2] M. Mori, T. Masumoto, I. Kunihiko, "Study on acoustic, vibration and flow induced noise characteristics of T-shaped pipe with a square cross-section," *Applied Acoustics*, vol. 120, pp. 137–47, May. 2017.

[3] X. Gao, B. Sundén, "PIV measurement of the flow field in rectangular ducts with 60° parallel,crossed and V-shaped ribs," *Experimental Thermal and Fluid Science*, vol. 28, issue. 6, pp. 639–53, 2004.

[4] M. L. Munjal, "Acoustics of Ducts and Mufflers," 2nd ed. New York: *Wiley*, 2014.

[5] C. G. Gordon, "Spoiler-generated flow noise. II: results," J Acoust Soc Am, 45:214–33, 1969.

[6] B. H. Dwiggins, "Automotive Air Conditioning," DELMAR, New York, 2000.

[7] A. T. Chan, M. W. Chung, "Indoor–outdoor air quality relationships in vehicle: effect of driving environment and ventilation modes," *Atmospheric Environment*, vol. 37, pp. 3795–3808, 2003.

[8] A. Wang, Y. Zhang, Y. Sun, and X. Wang, "Experimental study of ventilation effectiveness and air velocity distribution in an aircraft cabin," *Building and Environment*, vol. 43, issue. 3, pp. 337-343, 2008.

[9] C. H. Lin, T. T. Wu, R. H. Horstman, P. A. Lebbin, M. H. Hosni, and B. W. Jones, "Comparison of large eddy simulation predictions with particle image velocimetry data for the airflow in a generic cabin model," *HVAC&R Research*, vol. 12, issue sup.3, pp. 935-951, 2006.

[10] Z. Zhang, X. Chen, S. Mazumdar, T. Zhang, and Q. Chen., "Experimental and numerical investigation of airflow and contaminant transport in an airliner cabin mockup," *Building and Environment*, vol. 44, issue 1, pp. 85-94, January. 2009.

[11] W. Liu, S. Mazumdar, Z. Zhang, B. S. Poussou, J. Liu, and C. Lin., "State-of-the-Art methods for studying air distributions in commercial airliner cabins," *Building and Environment*, vol. 47, issue. 1, pp. 5-12, January. 2012.

[12] Z. Zhang, W. Zhang, Z. Zhai, Q. Chen, "Evaluation of various turbulence models in predicting airflow and turbulence in enclosed environments by CFD. Parte2: comparison with experimental data from literature," *HVAC&R Research*, vol. 13, issue. 6, pp. 871-886, 2007.

Soft Purification of Omega-3 Rich Oil from Sacha Inchi Oil by Membrane Technology

Thirawat Mueansichai*, Parin Kanpaipuean, Mullika Kongpetsak, Paveena Pludplak, and Juraivan Ratanapisit

Chemical and Materials Engineering Department, Rajamangala University of Technology Thanyabuti, Pathumthani, Thailand

*E-Mail: thirawat.m@en.rmutt.ac.th

Abstract

This study investigated soft purification of omega-3 rich oil by using nanofiltration membrane from Sacha Inchi oil. Experiments were consisted of 3 membranes with different molecular weight cut-off (MWCO): NP030, XN45, and TS40. A dead-end nanofiltration was operated for 2 transmembrane pressures (TMP) (15 and 25 bar). The sample of Sacha Inchi Oil was prepared by using oil press machine. The Sacha Inchi seeds were extracted and the oil from the seeds is about 50.51% of the seeds. Before operated with nanofiltration, the sample was filtered by 0.45 micron membrane to remove some solid particles from the sample. The composition, color, turbidity, flux, fouling, and rejection were analyzed after the experiments. Results show that the permeate flux was significantly related to transmembrane pressure. The composition of extracted oil was 38.24% of Linolenic acid (omega-3), 33.49% of Linoleic acid (omega-6), 7.87% of Oleic acid, and 6.18% of others. The turbidity was 1451 NTU. After soft purification by using 0.45 micron membrane, the composition of oil was 42.62% of Linolenic acid (omega-3), 37.32% of Linoleic acid (omega-6), 8.77% of Oleic acid, and 6.89% of others. The turbidity was 0 NTU. The best condition for nanofiltration was NP030 membrane with 25 bar of TMP. The composition of permeate was 47.65% of Linolenic acid (omega-3), 38.19% of Linoleic acid (omega-6), 7.18% of Oleic acid, and 6.98% of others.

Keyword: Omeka-3, Sacha Inchi, Membrane, Purification

I. INTRODUCTION

Sacha inchi (Plukenetia volubilis L.) grows in the tropical Peruvian jungles at altitudes between 200 and 1,500 m. It is an oleaginous plant of the Euphorbiaceae family. There are about 54% of oil contain in the seeds [1]. Sacha inchi oil has a high concentration of unsaturated fatty acid, consist of about 50% linolenic acid (omega 3), about 35% linoleic acid (omega 6), and about 10% oleic acid (omega 9) [2-3]. Polyunsaturated fatty acids have been shown to prevent fatal cardiovascular disease, coronary heart disease prevention, diabetes prevention, and others. Therefore, they are important to the food and nutraceutical industries. Omega 3 is one type of polyunsaturated fatty acid and it associated with a number of health benefits [4-5].

The cold pressing is used to produce unrefined Sacha inchi seed oil because this process is the most suitable method to maintain the original composition of polyunsaturated fatty acid content [6]. The other process for producing of unrefined Sacha inchi seed oil is Soxhlet extraction which yield is better than the cold pressing. The drawback of Soxhlet extraction is it uses the high temperature to operate so the quality of polyunsaturated fatty acid in the oil was reduces by oxidation at high temperature exposure [2, 6] A supercritical fluid extraction is another alternative that can be used to extract oils but this process needs high investment cost [7].

There are number of methods to concentrate the polyunsaturated fatty acid such as supercritical fluid extraction, freezing, crystallization, lipase concentration, and molecular distillation [8]. The new method to concentrate polyunsaturated fatty acid is membrane technology. There are a lot of applications of using membrane technology. For example, water desalination, removal or recovery of toxic or valuable components from various industries. Especially, in oil and fat industry has increasingly gained interest of application of membrane separation process [9]. Ghasemain et al., [10] investigated omega 3 polyunsaturated fatty acids concentration by using polymeric membrane. They found that the highest concentration of omega 3 polyunsaturated fatty acid from Lantern fish oil was 35 wt.%. The suitable conditions was found to be the temperature of 36.19 °C, pressure of 4.82 bar and stirring rate of 43.01 rpm with a desirability value of 0.99.

This study aims to soft purify of omega 3 rich oil from Sacha inchi seed oil by using membrane technology which is a good method to maintain the quality of polyunsaturated fatty acid. This process will be increase the concentration of omega 3 in the oil after the cold pressing process. The effect of 2 transmembrane pressures (TMP) and 3 membranes with different molecular weight cut-off (MWCO) was investigated. The composition, color, turbidity,

flux, fouling, and rejection were analyzed after the experiments.

II. METHODS

Materials

Sacha inchi seeds were purchased from Minlada Jumthi Company in north of Thailand. The nanofiltration flat sheet membranes were purchased from Liquid Purification Engineering International Co., Ltd. Thailand. There are three types of membranes: NP030, XN45, and TS40. The properties of membranes are presented in Table 1.

Methods

Preparation of Sacha inchi seed oil

The sample of Sacha inchi seed oil was prepared by using oil press machine. The Sacha inchi seeds were introduced into the oil press machine to extract the oil from the seeds. The oil was filtered by the sieve in the oil press machine to separate the solid and liquid from the oil press machine. The liquid was filtered again by 0.45 micron membrane with vacuum filtration for preparation the sample of nanofiltration process.

Membrane concentration process

A flat sheet membrane test cell was used to conduct experiments under a nitrogen atmosphere. A required pressure was applied by adjusting the pressure regulator of a nitrogen cylinder. A dead-end nanofiltration was operated for 2 transmembrane pressures (TMP) (15 and 25 bar). The cell was placed on a magnetic stirrer and the agitation was provided by magnetic spin bar. The unit was operated in batch mode by charging the cell with 150 mL of oil sample, and the experiments were stopped after collecting the desired quantity of permeate oil. A schematic diagram of experimental set-up is shown in Fig. 1.

Fig. 1 A schematic diagram of experimental set-up.

The measurement of oil flux that permeates through membrane was carried out in a batch mode. The effective area of the membrane in the module was 196.3 cm^2 and oil flux was measured with the following equation [11].

$$J = \frac{V}{A \cdot t} \qquad (1)$$

where J is the oil flux, V is the volume of permeate oil (mL), A is the effective area of the membrane (cm^2), and t is the sampling time (min).

Data analysis

The data analysis of the results was performed as the composition, color, turbidity, flux, fouling, and rejection for all experiments.

Table 1 The properties of membranes

Membranes	NP030	XN45	TS40
Rejection Na_2SO_4 ($MgSO_4$) (%)	80-95	(94-98)	(98.5)
Area (cm^2)	196.3	196.3	196.3
MWCO (Da)	500	500	200
Material	Polyethersulfone	Thin-film piperzine	Thin-film piperzine

III. RESULTS AND DISCUSSION

Sacha inchi seed oil preparation

The seeds of Sacha inchi were extracted by oil press machine. The composition after passed the oil press machine including 50.51% of oil with small particles, 41.33% of dry solid, 4.33% of wet solid, and 3.83% of others. The oil with small particles needs to remove all small particles before operated with nanofiltration by using 0.45 micron membrane. Fig. 2 shows the color and the turbidity of the oil after extracted by oil press machine and filtered by the membrane. The first one (a) shows the color of the oil after extraction. It is the natural color of the Sacha inchi oil. It has turbidity 1,451 NTU. The oil after membrane filtration (b and c), the turbidity is 0 NTU. It was shown that the turbidity of the oil comes from the small particles which greater than 0.45 micron.

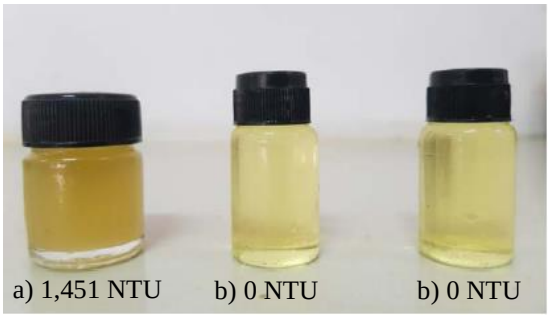


Fig. 2 Color and turbidity of the oil

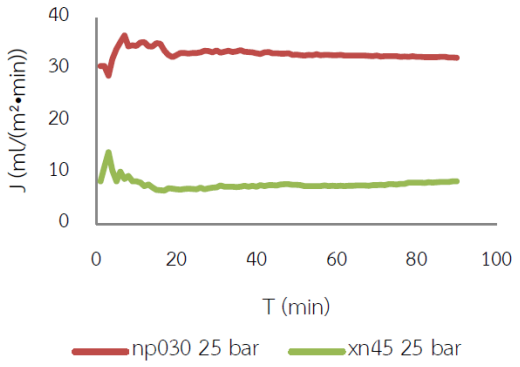


Fig. 3 Permeate flux of the oil for different type of membrane at 25 bar

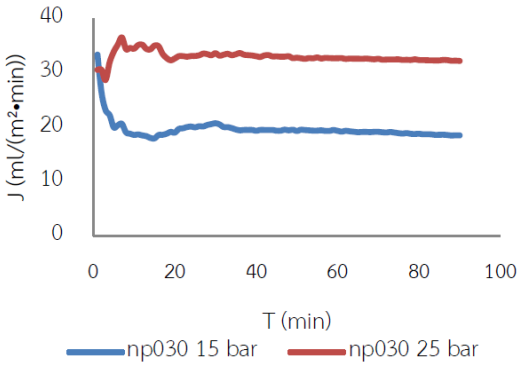


Fig. 4 Permeate flux of the oil for different TMP of NP030 membrane

Permeate flux

From the experiments, there are only three conditions that the oil can pass the membrane. They are NP030 at 15 and 25 bar and XN45 at 25 bar. For XN45 at 15 bar and TN40 at 15 and 25 bar, the oil cannot pass the membrane because the pressures are too low for the MWCO of the membranes. Fig. 3 shows the effect of membrane type on permeate flux. NP030 and XN45 have the same MWCO but produced from different material. It was found that polyethersulfone has the better permeate flux compare to thin-film piperzine. Permeate flux of the Sacha inchi oil at different TMP shows in Fig. 4. As can be seen in the figure, at 25 bar has the higher permeate flux than at 15 bar. This results indicate that the high TMP increases the permeate flux in the system.

Rejection efficiency

There are three parts of membrane process. They are feed, permeate, and retentate. For this study, feed consisted of three main types of polyunsaturated fatty acids including linolenic acid, linoleic acid, and oleic acid. Soft purification by using membrane technology of linolenic acid (omega 3) from other fatty acids should increase the concentration of omega 3 in the permeate or retentate. The result in Table 2 shows that the membrane cannot separate the mixture in the feed.

Table 2 Rejection efficiency and composition of oil for NP030 at 25 bar

Composition				**Rejection**
	Feed	**Permeate**	**Retentate**	
Linolenic acid	42.62	43.62	43.50	0.00
Linoleic acid	37.32	36.98	37.05	0.19
Oleic acid	8.77	8.37	8.37	0.00
Other	6.89	6.63	6.68	0.75

Fouling mechanism

As the same result in the rejection efficiency, because of there is no separation between the mixture in the feed and the most of the feed can passed the membrane so the fouling mechanism was not occurred in the system. From the analysis the most results show that the fouling mechanism are CFM model.

Table 3 R^2 for NP030 at 15 bar

Time (min)	**Filter Volume (ml)**	**R^2 Model of fouling mechanism**		
		SBM	**IBM**	**CFM**
0-15	0.00-0.52	0.6761	0.7112	0.7751
15-30	0.52-1.20	0.9382	0.9347	0.9273
30-90	1.20-3.24	0.8221	0.8257	0.8325
0-90	0.00-3.24	0.1660	0.1753	0.1906

Table 4 R^2 for NP030 at 25 bar

Time (min)	**Filter Volume (ml)**	**R^2 Model of fouling mechanism**		
		SBM	**IBM**	**CFM**
0-7	0.00-0.50	0.8396	0.8285	0.8097
7-26	0.50-1.67	0.5846	0.6075	0.6074
26-90	1.67-5.63	0.8950	0.8962	0.8985
0-90	0.00-5.63	0.1513	0.1437	0.1283

Table 5 R^2 for XN45 at 25 bar

Time (min)	Filter Volume (ml)	R^2 Model of fouling mechanism		
		SBM	IBM	CFM
0-20	0.00-0.26	0.5433	0.5726	0.6173
20-40	0.26-0.60	0.8046	0.8064	0.8096
40-90	0.60-1.45	0.7105	0.7091	0.7059
0-90	0.00-1.45	0.0020	0.0002	0.0023

ACKNOWLEDGEMENT

The authors are grateful to RMUTT annual government statement of expenditure in 2018.

REFERENCES

[1] M. Guillen, A. Ruiz, N. Cabo, R. Chirinos, G. Pascual, "Characterization of Sacha inchi (*Plukenetia volubilis* L.) oil by FTIR spectroscopy and H NMR. Comparison with linseed oil," *Journal of the American Oil Chemists' Society*, vol. 80, issue. 8, pp.755-762, 2003.

[2] L. A. Follegatti-Romero, C. R. Piantino, R. Grimaldi, and F. A. Cabral, "Supercritical CO_2 extraction of omega-3 rich oil from Sacha inchi (Plukenetia volubilis L.) seeds," *Journal of Supercritical Fluids*, vol. 49, issue. 3, pp. 323–329, July. 2009.

[3] R. Chirinos, G. Zuloeta, R. Pedreschi, E. Mignolet, Y. Larondelle, and D. Campos, "Sacha inchi (Plukenetia volubilis): A seed source of polyunsaturated fatty acids, tocopherols, phytosterols, phenolic compounds and antioxidante capacity," *Food Chemistry*, vol. 141, issue. 3, pp. 1732–1739, December. 2013.

[4] E. Arab-Tehrany, M. Jacquot, C. Gaiani, M. Imran, S. Desobry, and M. Linder, "Beneficial effects and oxidative stability of omega-3 long-chain polyunsaturated fatty acids," *Trends in Food Science & Technology*, vol. 25, issue. 1, pp. 24–33, May. 2012.

[5] C. D. Poole, J. P. Halcox, S. Jenkins-Jones, E. S. M. Carr, M. G. Schifflers, K. K. Ray, and C. J. Currie, "Omega-3 fatty acids and mortality outcome in patients with and without type 2 diabetes after myocardial infarction: A retrospective, matched-cohort study," *Clinical Therapeutics*, vol. 35, issue. 1, pp. 40–51, January. 2013.

[6] O'Brien RD, "*Fat and oils: formulating and processing for applications*," 3rd edn. Taylor & Francis, Boca Raton, 2009.

[7] F. Temelli, "Perspectives on supercritical fluid processing of fats and oils," *The Journal of Supercritical Fluids*, vol. 47, issue. 3, pp. 583–590, January. 2009.

[8] N. R. Rodriguez, S. Beltran, I. Jaime, S. M. Diego, M. T. Sanz, and J. R. Carballido, "Production of omega-3 polyunsaturated fatty acid concentrates: a review," *Innovative Food Science and Emerging Technologies*, vol. 11, issue. 1, pp. 1–12, January. 2010.

[9] C. Vaisali, S. Charanyaa, P. D. Belur, and I. Regupathi, "Refining of edible oils: a critical appraisal of current and potential technologies," *International Journal of Food Science & Technology*, vol. 50, issue. 1, pp. 13–23, 2014.

[10] S. Ghasemian, M. A. Sahari, M. Barzegar, and H. A. Gavlighi, "Concentration of Omega-3 polyunsaturated fatty acids by polymeric membrane, *International Journal of Food Science and Technology*, vol. 50, issue. 11, pp. 2411–2418, 2015.

[11] R. S. Juang, H. L. Chen, and Y. S. Chen, "Membrane fouling and resistance analysis in dead-end ultrafiltration of Bacillus subtilis fermentation broths," *Separation and Purification Technology*, vol. 63, issue. 3, pp. 531–538, November. 2008.

MEDICAL SCIENCE AND HERB

Hemostatic Effect of Herbal Extracts on In Vitro Blood Coagulation Activities

Khobjai, W.[1*], Arjsakorn, N.[1], and Sukati, S.[2]
[1]Thai traditional medicine college, Rajamangala University of Technology Thanyaburi, Pathumthani, Thailand
[2]Department of Medical Technology, School of Allied Health Sciences, Walailak University, Nakhon Si Thammarat, Thailand
[*]E-mail: warachate_k@rmutt.ac.th

Abstract

Hemostasis is an important process to prevent the body from blood loss from the circulatory system when there is a blood vessel injury. In the process of hemostasis, it consists of two important mechanisms: blood coagulation and fibrinolysis. This research aims to study the effects of *Zingiber cassumunar* (ZC), *Aloe vera* (AV), *Eupatorium odoratum* (EO), *Centella asiatica* (CA), *Allium cepa* (AC), and *Careya sphaerica* (CS) on blood coagulation. The experiments were studied the effects of the extracts on the process of blood coagulation by PT, APTT, and TT assay. The results showed that the CA extract can completely induce extrinsic pathway PT assay. The AV, EO, CA, and AC extracts can induce intrinsic pathway by APTT assay. The thrombin time result found that the ZC and EOextracts can induce common pathway. This finding indicates that the extract possess anticoagulant activities, thus showing the potential ZC, AV, EO, CA, and AC as a source of bioactive compounds for hemostatic purposes, with particular emphasis on the stop bleeding.

Keyword: Hemostasis, Blood coagulation, Herbs, Stop bleeding

I. INTRODUCTION

Hemostasis is a process to prevent blood loss when there is tissue or blood vessel injury [1]. The coagulation system involves complex reactions involving many proteins. The reactions convert fibrinogen to fibrin, which forms a thrombus with platelets. The initiation of coagulation cascades is divided into two parts, intrinsic and extrinsic coagulation pathways [2]. The extrinsic coagulation pathway is responsible for the initial generation of activated factor X (Factor Xa), which is induced by the factor VIIa/tissue factor complex [3]. The intrinsic pathway composes of coagulation factors XII, XI, IX, and VIII. The activation of the intrinsic pathway leads to amplification of factor Xa, which plays a central role in the coagulation cascade, called thecommon pathway [4]. The PT, APTT and TT tests evaluate the ability to produce a blood clot in a reasonable amount of time and, if any of these factors are inhibited, the test results will be prolonged. The APTT evaluates coagulation factors VIII, IX, XI and XII in the intrinsic coagulation pathway while the PT test is employed to evaluate the extrinsic clotting factors, including coagulation factor VII. Moreover, these two tests also evaluate a common pathway involving factors I, II, V, and X of the clotting cascade [5].

Thai traditional herbal medicines are used for treatment of various symptoms and diseases [6]. As their Thai traditional medicinal properties, including wound healing [7], treat burns and scald wounds, stimulate collagen and elastin production, relieve swelling, and absorb pus, *Zingiber cassumunar* (ZC), *Aloe vera* (AV), *Eupatorium odoratum* (EO), *Centella asiatica* (CA), *Allium cepa* (AC), and *Careya sphaerica* (CS) may affect the coagulation mechanism. Therefore, the present study was carried out aiming to evaluate their blood coagulant activities.

II. METHODS

Preparation and extraction of Plant materials

All plants were collected and purchased from a traditional herb market in Pathum Thani province, Thailand. The plants were cleaned, cut into small pieces, air-dried, and then ground to powder.

The extraction was performed using boiling distilled water decoction technique. The powder plants (10% w/v) were soaked in boiling distilled water for 30 minutes at room temperaturewith occasional stirring.The solution was centrifuged and filtrated through Whatman's filter paper and the filtrate thus obtained was concentrated by lyophilization [8].The crude extracts were stored at -20°C until used.

Blood samples

Peripheral blood samples were collected from 10 healthy human volunteers (aged 19-35 years). Volunteers had no history of oral contraceptive or anticoagulant therapy. The blood placed separately incontainers containing 3.2% sodium citrate. Centrifugation was carried out at 1,000 g for 20 minutes at 4°C, to separate the blood cells from plasma in order to obtain platelet-poor plasma (PPP) [9]. The PPP was employed for prothrombin time (PT), activated thromboplastin tests (APTT) and Thrombin time (TT). The study design and informed consent form for the volunteers were approved by the Committee on Human Rights Related to Human the Experimentation of Walailak

University, Nakhon Si Thammarat, 80160, Thailand (reference number WU-EC-AH-2-0003-61).

Prothrombin time (PT), activated partial thromboplastin time (APTT) and thrombin time (TT) testing

To determine the extrinsic and intrinsic coagulant activity, the PPP was mixed with each extract solution (10 mg/ml) at a ratio of 1:1 v/v [10]. PT, TT, and APTT were determined in the mixtures by thromborel S, and thrombin reagents (SIEMENS, USA), APTT-TCA (Cypress diagnostics, Belgium), respectively, according to manufacturer's instructions by using the URIT-600 Coagulation analyzer (URIT Medical Electronic Co. Ltd, China). Normal saline solution (0.9% w/v NaCl, NSS) was used for the vehicle control. PT, APTT, and TT results are expressed in seconds.

Statistical analysis

All data were expressed as mean±standard deviation. Data were analyzed by the one-way Analysis of Variance (ANOVA) and the statistically significant differences were analyzed using a paired t-test. The value of $p>0.05$ was considered to be statistically significant using GraphPad 6 version 6.01 (GraphPad Software Inc. La Jolla, CA. USA).

III. RESULTS AND DISCUSSION

The percentage of yield extraction and physical appearance of the crude extracts were shown in Table 1.

Table 1. The physical appearances and quantities of herbal extracts obtained after extraction

Crude extracts	Physical appearance	Yields (%w/w)
Z. cassumunar	Dark brown	7.0
A. vera	Brown	1.4
E. odoratum	Brown	13.08
C. asiatica	Brown	31.71
A. cepa	Brown	1.0
C. sphaerica	Dark brown	3.7

Anticoagulant activities

The crude extracts were determined by PT, APTT, and TT assays using pooled human plasma. The crude extract of herbs was evaluated for screening blood coagulant activity at the concentration of 10 mg/ml. The PT, APTT, and TT baseline values of pooled plasma were 14.89±1.45, 40.33±3.46, and 39.42±5.98 seconds, respectively. The PT, APTT, and TT values of NSS vehicle control were 17.50±0.58, 59.60±6.11, and 55.50±3.11 seconds, respectively. The effect of the extracts on the PT, APTT, and TT testing was measured to evaluate the blood coagulant activity against the extrinsic, intrinsic, and common coagulation pathways.

The PT results obtained in the presence of ZC, AV, EO, CA, AC, and CS extracts were 18.67±0.58, 23.67±0.58, 18.00±0.00, 16.33±0.58, and 21.33±0.58, respectively as shown in Figure 1. The all of the extract showed prolonged extrinsic pathway except, the EO extract. The EO extract showed the same activity when compared to NSS control, but it was not significantly different (p=0.72). While, the CA extract showed activated blood coagulant time when compared to the NSS control (p<0.05). The AV and AC showed a highly significant difference compared to the NSS control (p<0.001).While the CS extract showed prolonged blood coagulation with a highly significant difference (p<0.001).

The APTT activities of ZC, AV, EO, CA, AC, and CS extracts were 100±0.00, 0.00, 0.00, 0.00,and >180 seconds, respectively,as shown in Figure 2.The ZC and CS extracts showed prolonged blood clotting time a highly significant difference compared to NSS control (p<0.001). The AC extract showed APTT clotting time lower than the NSS control at p<0.05.While the extracts of AV, EO, and CA found immediately blood clotting after mixing the extract with APTT reagent (p< 0.001). The TT of ZC, AV, EO, CA, AC, and CS extracts were 63.00±3.61, 52.00±1.00, 32.67±6.03, 66.00±2.00,and >180 seconds, respectively, as shown in Figure 3. Then all of the extract showed prolonged thrombin time with significantly different, except, the EO extract.

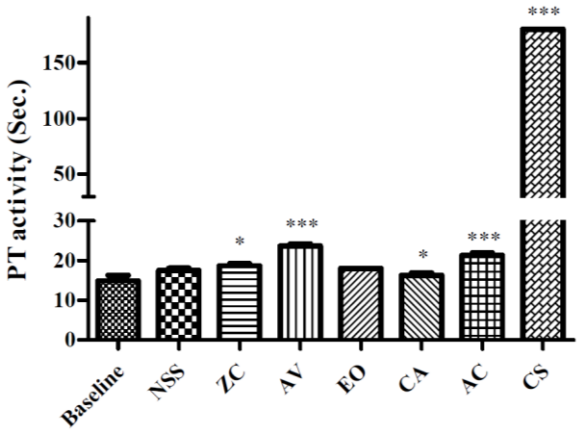


Fig. 1: Effect of herb extracts on PT, *p<0.05, ***p<0.001, compared with NSS, Abbreviations: NSS; Normal saline solution, ZC; *Z. cassumunar*, AV; *Aloe vera*, EO; *Eupatorium odoratum*, CA; *Centella asiatica*, AC; *Allium cepa*, and CS; *Careya sphaerica*

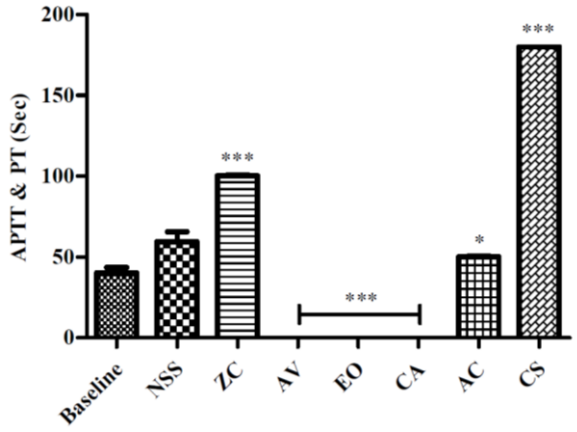


Fig. 2: Effect of herb extracts on APTT,*p<0.05, ***p<0.001, compared with NSS

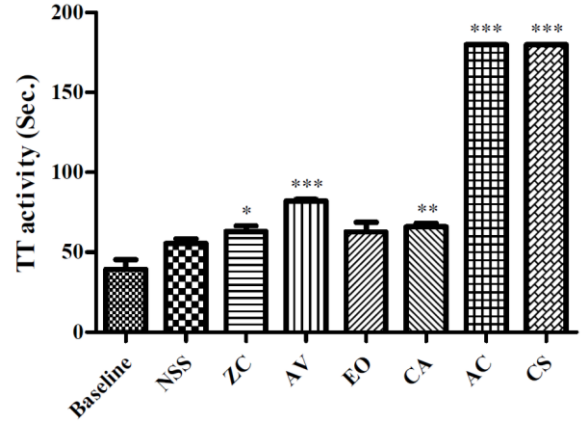


Fig. 3: Effect of herb extracts on TT,*p<0.05, *p<0.01, ***p<0.001, compared with NSS

From our study, allextracts were able to prolong PT except, *E. odoratum*, *C. asiatica* and prolong APTT were *Z. cassumunar* and *C. sphaerica*, demonstrating its anticoagulant activity. In the TT test, all of the extract could prolong TT.

In the PT and APTT prolongation of the clotting time was observed. The prolongation of the PT and APTT indicate the inhibition of coagulation factor both in the intrinsic and extrinsic coagulation pathway [11]. In the other hand, the coagulation of PT and APTT exhibited coagulant activity through activation of coagulation factor in the intrinsic and extrinsic coagulation pathway.

Hemostasis is divided into two consecutive stages: platelet aggregation and coagulation cascade. Therefore, both platelet and coagulation factors play roles in blood hemostasis [12]. The coagulant activities of extracts were measured by APTT, PT, and TT. APTT is used to evaluate the coagulation factors such as VIII, IX, XI, XII, and prekallikreinin intrinsic coagulation pathway while PT is used to evaluate the coagulation factors V, VII, and X in extrinsic coagulation pathway [13]. TT reflects the blood coagulation status that transforms fibrinogen into fibrin, which is directly induced by the addition of thrombin. The test only detects disturbances in the final stages of coagulation, especially dysfibrinogenemia or the presence of thrombin inhibitors [14].

IV. CONCLUSION

We have described the in vitro blood coagulant activity of aqueous extracts from herb extracts, which are beneficial in Thai traditional medicine. The extracts coagulated the PT and APTT, suggesting that the extracts exhibit coagulant activity correlating with the intrinsic and extrinsic coagulation pathway. Since compounds with blood clotting time could be used for stop bleeding or wound healing, we suggest that based in our results, the aqueous extract of the extracts show promising potential as a future therapeutic agent. Further work has to been done for platelet activity, Platelet aggregation, and mechanism of action of the active phytochemical constituents from the herb, to establish an effective hemostatic drug resource for stop bleeding and wound healing.

ACKNOWLEDGEMENT

The authors would like to thank the financial support granted (Grant no. IRF62A1206.1) from Thai traditional medicine college, Rajamangala University of Technology Thanyaburi, Thailand.

REFERENCES

[1] J. G. Andrew, "Current understanding of hemostasis," *Toxicol Pathol*, vol. 39, no. 1, pp. 273-280, 2011.

[2] S. Palta, R. Saroa, A. Palta, "Overview of the coagulation system," *Indian Journal of Anaesthesia.* vol. 58, issue. 5, pp. 515-523, 2014.

[3] N. Mackman, "The role of tissue factor and factor VIIa in hemostasis," *Anesthesia & Analgesia*, vol. 108, no. 5, pp. 1447-1452, May. 2009.

[4] S. Palta, R. Saroa, A. Palta, "Overview of the coagulation system," *Indian Journal Anaesthesia*, vol. 58, no. 5, pp. 515-523, September. 2014.

[5] N. Mackman, R. E. Tilley, N. S. Key, "Role of the extrinsic pathway of blood coagulation in hemostasis and thrombosis," *Arteriosclerosis, Thrombosis, and Vascular Biology*, vol. 27, issue. 8, pp. 1687-1693, August. 2007.

[6] P. Subcharoen, "Thai traditional medicine in the new millennium," *Journal of the Medical Association of Thailand*, vol. 87, pp 52-57, October. 2004.

[7] A. Chuangsuwanich, K. Jongjamfa, "The efficacy of combined herbal extracts gel

preparation in the prevention of postsurgical hypertrophic scar formation," *Dermatology and Therapy*, vol. 4, pp. 187-195, December. 2014.

[8] W. Khobjai, S. Sukati, K. Jarmkom, P. Eakwaropas, and S. Techaoei, "Evaluation of Thrombolytic Activity of *Zingiber cassumunar* and Thai Herbal Prasaplai Formula," *International Journal of Medical, Health, Biomedical, Bioengineering and Pharmaceutical Engineering*, vol. 11, no.5, pp. 268-271, 2017.

[9] P. Dey, T. Bhakta, "Evaluation of in-vitro anticoagulant activity of *Molineria recurpata* leaf extract," *Journal of Natural Product and Plant Resources*, vol. 2, no.6, pp. 685-688, 2012.

[10] H. Khan, M. A. Khan, T. Mahmood, M. I. Choudhary, "Antimicrobial activities of *Gloriosa superba* Linn (Colchicaceae) extracts," *Journal of Enzyme Inhibition and Medicinal Chemistry*, vol. 23, issue. 6, pp. 855-859, 2008.

[11] W. Mao, H. Li, Y. Li, H. Zhang, X. Qi, H. Sun, et al., "Chemical characteristic and anticoagulant activity of the sulfated polysaccharide isolated from *Monostroma latissimum* (Chlorophyta)," *International Journal of Biological Macromolecules*. vol. 44, issue. 1, pp 70-74, January. 2009.

[12] H. Chen, M. Jin, Y. Wang, Y. Wang, L. Meng, R. Li, et al, "Effect of *Too namicrocarpa* Harms leaf extract on the coagulation system," *BioMed Research International*, vol. 2014, pp. 1-7, 2014.

[13] A. P. S. Azevedo, J. C. Farias, G. C. Costa, et al., "Anti-thrombotic effect of chronic oral treatment with *Orbignya phalerata* Mart," *Journal of Ethnopharmacol*, vol. 111, issue. 1, pp. 155-159, April. 2007.

[14] E. Koch, and A. Biber, "Treatment of rats with the *Pelargonium sidoides* extract EPs 7630 has no effect on blood coagulation parameters or on the pharmacokinetics of warfarin", *Phytomedicine*, vol.14, no.1, pp. 40-45, March. 2007.

Effect of Soapberry Aqueous Solution as a Washing Reagent for the Reduction of Parasitic Contamination on Vegetables

Nattapong Wongchum[1*], and Ananya Dechakhamphu[2]
[1*]Program of Biology, Faculty of Science, Ubon Ratchathani Rajabhat University, Ubonratchathani, Thailand
[2]Program of Thai Traditional Medicine, Faculty of Thai Traditional and Alternative Medicine, Ubon Ratchathani Rajabhat University, Ubonratchathani, Thailand
[*]E-Mail: nattapong.w@ubru.ac.th (Phone: +668 9584 9589)

Abstract

Consumption of raw vegetables has been proved to be the vehicle for transmission of parasites. This study aims to examine the effect of soapberry aqueous solution on the reduction of parasitic contamination on vegetables. A total of 120 raw vegetables, including napa cabbage, lettuce, kitchen mint and green shallot were randomly collected from 4 local markets in Ubonratchathani, Thailand in order to investigate their contamination level as well as parasitic contamination after washing with soapberry aqueous solution. The eggs of *Strongyloides* sp., *Teania* sp., *Ascaris lumbricoides* and hookworm were found contamination in vegetables. *Strongyloides* sp. are the highest contamination in all of the vegetables (34/120 28.3%) and the lowest contamination is *Teania* sp. Among varied concentrations (0.3, 0.6 and 1.2%), washing vegetables with 1.2 % soapberry aqueous solution showed the most effective to remove parasitic contamination when compared to standard washing methods, including washing with running tap water and with 0.05 % sodium bicarbonate solution. Washing vegetables with 1.2% soapberry aqueous solution showed to remove all kinds of parasites from all kinds of studied vegetables. The result from this study indicates that soapberry aqueous solution may be used as alternative washing reagent for disinfection of parasitic eggs on vegetables.

Keyword: Parasitic contamination, vegetables; Prevalence, washing solution, soapberry, disinfection

I. INTRODUCTION

Fresh vegetables are a significant component of a healthy nourishment. Many people eat fresh vegetables paired with the main dish, moreover, salads are a popular food for who want to control weight. Therefore, the raw vegetable is a popular public health food widely consumed. However, WHO indicates that fresh vegetables if consumed without passing through the proper wash to reduce parasites may be causing parasitic infection. The vegetables may be parasitic contamination during harvesting, transportation as well as distribution [1]. If contaminated vegetables were consumed by not clearing represent a major risk factor of parasite infection and there is a chance that someone will bring the infection to spread further. There are numerous studies in different parts of the world indicate that the vegetables can be infested with helminthes eggs and protozoa cysts [2-4].

Since fresh vegetables are often consumed raw, without decontamination processing, the effective method for reduction of parasitic contamination is necessary. Vegetables can be washed in several ways, such as rinse with tap water and with vegetable the washing chemical reagent like sodium bicarbonate and potassium permanganate, which may not clear all of the parasites or may have a residue. There are currently developing products used to wash vegetables and fruits directly, thus reduce pesticides and parasitic eggs by using a substance that reduces the surface tension.

Soapberry (*Sapindus rarak* DC.) (Sapindaceae) is a tree which initiated in South East Asia and is now broadly dispersed in Asia. Traditionally, its pericarp was used for skin disorders. The fruit pericarps have a frothing property in water and can be utilized as a regular cleanser for washing [5]. The main bioactive compound of its pericarp has been identified as saponins. Nowadays, there is a present attention on saponins due to the growing amount of studies displaying their bioactive properties. Previously presented data indicated that saponins were linked to immunostimulatory, hypocholesterolemic, anti-tumor, anti-inflammatory, antibacterial, antiviral, antifungal, and antiparasitic activities [6-8]. In the recent research, saponins have been related to promoting gastrointestinal function due to their "prebiotic-like" compounds properties [9]. Additionally, the study of saponins from soapberry fruit in the animal model showed no negative effect [10]. In the view of the fact that solution containing saponins not only benefit for washing but also contain other advantage biological properties. We aimed to employ soapberry aqueous solution as a washing reagent for reduction of parasitic contamination on vegetables. In addition, we also reported the prevalence of parasitic contamination on commonly consumed fresh vegetables which collected from 4 local markets in Ubonratchathani, Thailand.

II. METHODS

Sample collection

The total of 30 samples of each vegetable, including napa cabbage (*Brassica rapa pekinensis*), lettuce (*Lactuca sativa*), kitchen mint (*Mentha piperita* L.) and green shallot (*Alliumcepa* var. *aggregatum*) were randomly collected between November 2016 to February 2017 from 4 local markets in Ubonratchathani, Thailand. Sterile nylon plastic bags were used to transport the samples to analysis in the laboratory.

Preparation of soapberry aqueous solution

Fruit seeds of soapberry were removed to obtain only pericarp and dried in hot air oven at 60 ^{0}C for 24 hrs. Different amounts of dried pericarps, 3, 6 and 12 g were boiled in 1 L of water for 15 min. The boiled solution was filtrated by using Whatman filter paper no.40 to remove marc. The solution was kept in ambient temperature until use.

Parasitological procedures

200 g of each vegetable was washed by vigorous shaking with 1 L of physiological normal saline (0.95% NaCl) by using electric fruit blender (Phillip HR3752). The washing solution was then left for around 12 h for sedimentation to happen. The top layer was disposed and the residual washing water was centrifuged at 2000 rpm for 15 min according to the former report with adjustment [11]. The supernatant was disposed. The residue was carefully collected and transferred into microscope slide for parasitological examination under a light microscope (100-400 magnification). All experiments were done in triplicate.

Washing procedures

Each vegetable samples (6 kg) were randomly divided into 6 groups: 1) unwashed; 2) washing with tap water; 3) washing with 0.05% sodium bicarbonate; 4-6) washing with 0.3%, 6% and 1.2% soapberry aqueous solution, respectively. For each washing group, the vegetable was washed with standard washing processes according to Ministry of Public Health of Thailand. Briefly, leaves were separated and submerged in washing solution for 10 min and were then rinsed with clean water for 3 min. Parasitological examination were measured as previously described in section 2.3. All experiments were done in triplicate. The data were expressed as the number of parasite eggs.

Analysis of data

Statistical analyses were investigated using a Chi-square test of the SPSS software version 22 for Windows (SPSS Inc., Chicago, IL, USA) to compare the differences in the rate of contamination among different washing conditions. A *P*-value <0.05 was considered statistically significant.

III. RESULTS AND DISCUSSION

There are numerous reports have revealed that consumption of fresh vegetables without suitable washing signifies the great risk of parasitic infection [12]. In various studies, the various amounts of helminthic contamination were related with fruits and vegetables in different countries [13]. In the present study, we have revealed the occurrence of helminth eggs on vegetable sold for municipal consumption in Ubonratchathani. These samples were from 4 local markets that have no prewashed their products before the sale to the public. As shown in Table 1, the eggs of *Strongyloides* sp., *Teania* sp., *Ascaris lumbricoides* and hookworm were found contamination in vegetables. *Strongyloides* sp. is the highest contamination in all of the vegetables (34/120, 28.3%) and the lowest contamination is *Teania* sp. that was found only in napa cabbage (8/120, 6.7%). The most of *Strongyloides* sp. contamination was found in kitchen mint (14/30, 46.7%). *A. lumbricoides* is highly contamination in napa cabbage (7/30, 23.3%) and hookworm are highly contamination in green shallot (8/30, 26.7%). The prevalence of *Strongyloides* sp. eggs in this study was similar to the studies in Shahrekord, Iran [14]. Ingestion of this parasite eggs is not the cause of the infection whereas interaction the human skin with the soil contaminated with filariform larvae is the way of infection, that can penetrate the skin and migrate through the body [15]. As the results showed the contamination of *A. lumbricoides* eggs, this may because of the external surface of *A. lumbricoides* eggs has an rough mucopolysaccharide coat allowing them to have solid bond to different surfaces; consequently, are not totally detached by inappropriate washing [16]. Parallel studies done in other countries such as Libya [17], Nigeria [18-19], and India [20] reported *A. lumbricoides* as the main parasite in vegetables. Similar to the reports of Ulukanligil *et al*. [21] in Sanliurfa (south-east Anatolian region) in Turkey, *A. lumbricoides* and *Taenia* spp. were detected, in 11.0% and 1.0%, respectively of unwashed vegetables. Whereas Choi and Lee (1972) reported egg and larvae of hookworm can be found in unwashed vegetables [22]. Moreover, hookworm is common throughout much of sub-Saharan Africa, in addition to South China and Southeast Asia [23].

Vegetables like napa cabbage and lettuce were the high rate of contamination. This could be because of the point that the degree of contamination fluctuates according to the form and surface of vegetables. Vegetable leaves as napa cabbage and lettuce have rough surfaces, wide and large surface areas, leading to more interaction with the sewage-contaminated soil surface [24], both in the farm or when washed with unclean water. While contamination of vegetables may arise in a diversity of methods, it is mostly linked with the water used for irrigation. The use of sewage-contaminated water for

irrigation of vegetables is a common preparation in developing countries [25]. Moreover, vegetables for sale in Ubonratchathani, some vegetables like cabbage were imported from neighboring countries such as Lao PDR and Viet Nam [26], which have been reported an outbreak of many types of parasites [27-30]. Similar to our study, lettuce were the vegetables contaminated most generally in Mazandaran province, northern Iran [31], Burdur, Turkey [32], Ankara, Turkey [12], Benha, Egypt [33], Maiduguri, northeast Nigeria [24], Saudi Arabia [34], and in Kaduna State, Nigeria [35].

Most of the reported papers on this topic have mainly focused on the prevalence of parasitic contamination in the diverse regions of various countries. However, the study on the development of the most potential washing solution for the reduction of parasitic contamination on vegetables is also especially necessary. Nowadays, the global trends have been paid attention to natural sources for the application in human health due to their low toxicity.

In this study, we have investigated the effect of soapberry aqueous solution on the removal of parasites from vegetables (Table 2).

Table 1 Contamination of vegetables with *Strongyloides* sp, *Teania* sp., *Ascaris lumbricoides* and hookworm eggs

Parasites	Number and prevalence of parasites in fresh vegetables (%)				
	Napa cabbage (n=30)	Lettuce (n=30)	Kitchen mint (n=30)	Green shallot (n=30)	Total (n=120)
Strongyloides sp.	9 (30.0)	6 (20.0)	14 (46.7)	5 (16.7)	34 (28.3)
Teania sp.	8 (26.7)	0 (0)	0 (0)	0 (0)	8 (6.7)
A. lumbricoides	7 (23.3)	4 (13.3)	0 (0)	3 (10.0)	14 (11.6)
Hookworm	0 (0)	2 (6.7)	1 (3.33)	8 (26.7)	11 (9.2)

Table 2 Effect of washing solution on the contamination of vegetables, including napa cabbage, lettuce, kitchen mint and green shallot with *Strongyloides* sp., *Teania* sp., *Ascaris lumbricoides* and hookworm eggs

Vegetables	Parasites	Number of parasitic eggs					
		Unwashed	Tap water	0.05% Na_2CO_3	0.3% Sb	0.6% Sb	1.2% Sb
Napa cabbage	*Strongyloides* sp.	0.67 ± 0.33^{b}	0.33 ± 0.33^{ab}	ND	ND	ND	ND
	Teania sp.	1.67 ± 0.33^{b}	1.00 ± 0.57^{b}	ND	ND	ND	ND
	A. lumbricoides	2.33 ± 0.33^{b}	2.00 ± 0.57^{b}	0.33 ± 0.33^{a}	ND	ND	ND
	Total	4.67 ± 0.84^{b}	3.33 ± 1.57^{ab}	0.33 ± 0.19^{a}	ND	ND	ND
Lettuce	*Strongyloides* sp.	13.67 ± 2.90^{b}	0.67 ± 0.33^{a}	0.00 ± 0.00^{a}	0.33 ± 0.33^{a}	ND	ND
	A. lumbricoides	1.00 ± 0.00^{b}	ND	0.33 ± 0.33^{a}	0.00 ± 0.00^{a}	ND	ND
	Hookworm	5.67 ± 0.88^{b}	ND	ND	0.00 ± 0.00^{a}	ND	ND
	Total	20.34 ± 6.41^{b}	0.67 ± 0.39	0.33 ± 0.19^{a}	0.33 ± 0.19^{a}	ND	ND
Kitchen mint	*Strongyloides* sp.	61.33 ± 24.25^{b}	2.67 ± 0.33^{a}	2.33 ± 0.67^{a}	2.00 ± 0.58^{a}	1.33 ± 0.33^{a}	ND
Green shallot	*Strongyloides* sp.	33.00 ± 5.57^{b}	1.00 ± 0.00^{a}	0.67 ± 0.33^{a}	0.67 ± 0.33^{a}	1.00 ± 0.00^{a}	ND
	Hookworm	7.00 ± 3.51^{b}	ND	ND	ND	0.67 ± 0.33^{a}	ND
	Total	40.00 ± 18.38^{b}	1.00 ± 0.71^{a}	0.67 ± 0.47^{a}	0.67 ± 0.47^{a}	1.67 ± 0.23^{a}	ND

Results are mean ± S.D. of triplicate values. Sb indicates soapberry aqueous solution and ND is stand for not detected. Values with different superscript letters indicate statistically significant differences between groups.

As the results shown in Table 2, the number of total parasites that found in unwashed napa cabbage, lettuce, kitchen mint and green shallot were 4.67, 20.34, 61.33 and 40.00, respectively. Remarkably, we found the absence of parasitic contamination on vegetables after washing with 1.2% soapberry aqueous solution. Out of 1.2% soapberry aqueous solution, washing vegetables with tap water, 0.05% sodium bicarbonate, 0.3 and 0.6% soapberry aqueous solution showed to reduce the parasitic contamination by 93.93, 97.10, 97.63 and 98.16 %, respectively. Washing vegetables with 0.3% soapberry aqueous solution showed the most effective on the elimination of parasitic contamination in napa cabbage, whereas, washing vegetables with 0.6% soapberry aqueous solution showed the most effective in lettuce.

In this study, we found that washing vegetables with tap water cannot remove all off *Strongyloides* sp. from all kinds of studied vegetable. We also found the presence of *Strongyloides* sp. and hookworm in kitchen mint and green shallot after washing with tap water or 0.05% sodium bicarbonate solution. In the present context, 1.2% soapberry aqueous solution exhibited the most effective reagent on the reduction of parasitic contamination from napa cabbage, lettuce, kitchen mint and green shallot. This is maybe because of surfactant properties of soapberry pericarp that contain saponins. Previously presented data has reported that four triterpene

saponins were found in *S. rarak* pericarp, including rarasaponins (I, II, and III), raraoside, along with 13 other known saponins and four known acyclic sesquiterpene glycosides [36]. Out of washing properties, the soapberry aqueous solution may act as other biological activities. Oleanane-type triterpene oligoglycosides from pericarps of soapberry showed to inhibit pancreatic lipase activity and reduce lipid digestion *in vitro* which is implied to use as anti-obesity agent [37]. Even there is limited data on the properties of isolated saponins from pericarp of *S. rarak*, however, there are tremendous researches from other kinds of plants. In common, saponins have been associated with immune stimulatory, hypocholesterolemic, anti-tumor, anti-inflammatory, antibacterial, antiviral, antifungal, and antiparasitic activities [6-8]. The data from literature reviews revealed that plant-based saponins show to promote anti-cancer and anti-inflammatory effects by regulating and balancing the gut microbiota, as well as a healthy epithelial microenvironment in the gut [9]. Interestingly, the recent research has pointed to saponins as "prebiotic-like" compounds, which are the benefit to human health [38-40]. In addition, saponins showed against fungi and protozoa, including protozoa in the rumen [41]. Taken together the data from previous studies and this study, aqueous solution from pericarps of soapberry may be used as an alternative method for washing raw vegetables with not only for the reduction of parasitic contamination but also for other useful biological activities. Future studies need to have a focus on other properties of washing potentiation like chemical, microbial and protozoan decontaminations for the great benefit of application.

IV. CONCLUSION

In conclusion, our results demonstrate the significance of vegetables in the transmission of intestinal parasites to human. The potential washing procedure is necessary to increase the sanitary manifestation of consumed fresh vegetables. In the respect to results of this study, soapberry aqueous solution may be used as the proper washing reagent and disinfecting of vegetable before consumption.

ACKNOWLEDGEMENT

This work was supported by Research and Development Institute, Ubon Ratchathani Rajabhat University (Grant Number 2560/08).

REFERENCES

[1] M. A. S. Van Duyn, and E. Pivonka, "Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature," *Journal of the American Dietetic Association*, vol. 100, issue. 12, pp. 1511-1521, 2000.

[2] O. Erdogˇrul, and H. Şener, "The contamination of various fruit and vegetable with *Enterobius vermicularis*, *Ascaris* eggs, *Entamoeba histolyca* cysts and *Giardia* cysts," *Food Control*, vol. 16, pp. 559-562. 2005.

[3] B. Ezatpour, A. S. Chegeni, F. Abdollahpour, M. Aazami, and M. Alirezaei, "Prevalence of parasitic contamination of raw vegetables in Khorramabad, Iran," *Food Control*, vol. 34, issue. 1, pp. 92-95, 2013.

[4] B. V. Maikai, E. B. T. Baba-Onoja, and I. A. Elisha, "Contamination of raw vegetables with *Cryptosporidium* oocysts in markets within Zaria metropolis, Kaduna State, Nigeria," *Food Control*, vol. 31, issue. 1, pp. 45-48, 2013.

[5] E. Wina, S. Muetzel, and K. Becker, "Effects of daily and interval feeding of *Sapindus rarak* saponins on protozoa, rumen fermentation parameters and digestibility in sheep," *Asian-Australasian Journal of Animal Sciences*, vol. 19(11), pp. 1580-1587. 2006.

[6] G. Francis, Z. Kerem, H. P. S. Makkar, and K. Becker, "The biological action of saponins in animal systems: A review," *British Journal of Nutrition*, vol. 88, issue. 6, pp. 587-605. 2002.

[7] A. V. Rao, and D. M. Gurfinkel, "The bioactivity of saponins: triterpenoid and steroidal glycosides," *Drug Metabolism and Personalized Therapy*, vol. 17, pp. 211-236. 2000.

[8] S. G. Sparg, M. E. Light, and J. V. Staden, "Biological activities and distribution of plant saponins," *Journal of Ethnopharmacology*, vol. 94, issue. 2-3, pp. 219-243. 2004.

[9] J. N. D. Hierro, T. Herrera, T. Fornari, G. Reglero, and D. Martin, "The gastrointestinal behavior of saponins and its significance for their bioavailability and bioactivities," *Journal of Functional Foods*, vol. 40, pp. 484-497, 2018.

[10] A. Thalib, Y. Widiawati, H. Hamid, D. Suherman, and M. Sabrani, "The effects of saponin from *Sapindus rarak* fruit on rumen microbes and performance of sheep," *Jurnal Ilmu Ternak dan Veteriner*, vol. 2, no. 1, pp. 17-21, 1996.

[11] S. Uga, N. Hoa, S. Noda, K. Moji, L. Cong, Y. Aoki, *et al.*, "Parasite egg contamination of vegetables from a suburban market in Hanoi, Vietnam," *Nepal Medical College journal*, vol. 11, issue. 2, pp. 75-78, 2009.

[12] E. Kozan, B. Gonenc, O. Sarimehmetoglu, H. Aycicek, "Prevalence of helminth eggs on raw

vegetables used for salads," *Food Control*, vol. 16, issue. 3, pp. 239-242. 2005.

[13] L. J. Robertson, and B. Gjerde, "Occurrence of parasites on fruits and vegetables in Norway," *Journal of Food Protection*, vol. 64, no. 11, pp. 1793-1798. 2001.

[14] A. A. Fallah, K. Pirali-Kheirabadi, F. Shirvani, and S. S. Saei-Dehkordi, "Prevalence of parasitic contamination in vegetables used for raw consumption in Shahrekord, Iran: influence of season and washing procedure," *Food Control*, vol. 25, issue. 2, pp. 617-620, 2012.

[15] L. S. Roberts, and J. Janovy, *"Foundations of parasitology*," 8th ed. Dubuque, Iowa, McGraw-Hill, pp. 414-418, 2009.

[16] D. W. T. Crompton, "*Biology of Ascaris lumbricoides"*, In: Crompton D.W.T., Neshem M.C. and Pawlowski Z.S. (ed.s). Ascariasis and its prevention and control, London, Taylor & Francis, pp. 9-44, 1989.

[17] A. K. Abougrain, M. H. Nahaisi, N. S. Madi, M. M. Saied, and K. S. Ghenghesh, "Parasitological contamination in salad vegetables in Tripoli-Libya," *Food Control*, vol. 21, issue. 5, pp. 760-762, 2010.

[18] A. A. Adenusi, W. A. Abimbola, and T. O. S. Adewoga, "Human intestinal helminth contamination in pre-washed, fresh vegetables for sale in major markets in Ogun state, southwest Nigeria," *Food Control*, vol. 50, pp. 843-849, 2015.

[19] C. J. Uneke, "Potential for geohelminth parasite transmission by raw fruits and vegetables in Nigeria: implication for a risk profile", *Journal of Nutritional & Environmental Medicine*, vol. 16, issue. 1, pp. 59-68, 2007.

[20] N. Gupta, D. K. Khan, and S. C. Santra, "Prevalence of intestinal helminth eggs on vegetables grown in wastewater-irrigated areas of Titagarh, West Bengal, India," *Food Control*, vol. 20, issue. 10, pp. 942-945, 2009.

[21] M. Ulukanligil, A. Seyrek, G. Aslan, H. Ozbilge, and S. Atay, "Environmental pollution with soil-transmitted helminths in Sanliurfa, Turkey," *Memorias do Instituto Oswaldo Cruz*, vol. 96, issue. 7, pp. 903-909, 2001.

[22] D. W. Choi, and S. Lee, "Incidence of parasites found on vegetables collected from markets and vegetable gardens in Taegu area," *The Korean Journal of Parasitology*, vol. 10, issue. 1, pp. 44-51, 1972.

[23] N. R. De Silva, S. Brooker, P. J. Hotez, A. Montresor, D. Engels, and L. Savioli, "Soil-transmitted helminth infections: updating the global picture," *Trends in Parasitol*ogy, vol. 19, issue. 12, pp. 547-551, 2003.

[24] N. B. Adamu, J. Y. Adamu, and D. Mohammed, "Prevalence of helminth parasites found on vegetables sold in Maiduguri, Northeastern Nigeria," *Food Control*, vol. 25, issue. 1, pp. 23-26, 2012.

[25] D. E. S. Said, "Detection of parasites in commonly consumed raw vegetables," *Alexandria Journal of Medicine*, vol. 48, no. 4, pp. 345-352, 2012.

[26] N. Nanthasamroeng, "Forecasting border mobility: A case study on an imported agricultural products from Laos to Thailand via Chong-Mek border," *Proceeding of the 4th International Conference on Urban Studies: Border and Mobility; 2017*, December. 8-9, Surabaya, Indonesia.

[27] H. Hohmann, S. Panzer, C. Phimpachan, C. Southivong, and F. P. Schelp, "Relationship of intestinal parasites to the environment and to behavioral factors in children in Bolikhamxay province of LAO PDR," *The Southeast Asian journal of tropical medicine and public health*, vol. 32, no. 1, pp. 4-13, 2001.

[28] K. Sengchanh, V. Manithong, H. Keonakhone, O. Peter, and B. Boungnong, "Soil-transmitted helminth infections and risk factors in preschool children in southern rural Lao People's Democratic Republic", *Transactions of The Royal Society of Tropical Medicine and Hygiene*, vol. 105, no. 3, pp. 160-166, March. 2011.

[29] W. Maipanich, K. Chaisiri, T. Yoonuan, M. Sato, M. O. Sato, and T. Pongvongsa, *et al*., "Zoonotic helminth contamination of the environment in rural villages of southern Lao PDR," *The Journal of Tropical Medicine and Parasitology*, vol. 34, no. 2, pp. 54-61, 2011.

[30] K. Phongluxa, V. Xayaseng, Y. Vonghachack, K. Akkhavong, P. V. Eeuwijk, and P. Odermatt, "Helminth infection in southern Laos: high prevalence and low awareness," *Parasites & Vectors*, vol. 6, pp. 1-15, 2013.

[31] A. Rostami, M. Ebrahimi, S. Mehravar, A. F. Omrani, S. Fallahi, and H. Behniafar, "Contamination of commonly consumed raw vegetables with soil transmitted helminth eggs in Mazandaran province, northern Iran", *International Journal of Food Microbiology*, vol. 225, pp. 54-58, 2016.

[32] R. Adanir, and F. Tasci, "Prevalence of helminth eggs in raw vegetables consumed in Burdur, Turkey," *Food Control*, vol. 31, issue. 2, pp. 482-484, 2013.

[33] M. A. Eraky, S. M. Rashed, M. E. Nasr, M. S. El-Hamshary, and A. S. El-Ghannam, "Parasitic contamination of commonly consumed fresh leafy vegetables in Benha, Egypt", *Journal of Parasitology Research*, vol.2014, pp. 1-7, 2014.

[34] W. A. I. Al-Megrm, "Prevalence of intestinal parasites in leafy vegetables in Riyadh, Saudi Arabia," *International Journal of Tropical Medicine,* vol. 5, pp. 20-23, 2010.

[35] B. V. Maikai, I. A. Elisha, and E. B. T. Baba-Onoja, "Contamination of vegetables sold in markets with helminth eggs in Zaria metropolis, Kaduna State, Nigeria," *Food Control*, vol. 28, issue. 2, pp. 345-348, 2012.

[36] A. A. Karim, and A. Azlan, "Fruit pod extracts as a source of neutraceuticals and pharmaceuticals," *Molecules*, vol. 17, pp. 11931-11946, 2012.

[37] T. Morikawa, Y. Xie, Y. Asao, M. Okamoto, C. Yamashita, and O. Muraoka, *et al*., "Oleanane-type triterpene oligoglycosides with pancreatic lipase inhibitory activity from the pericarps of *Sapindus rarak," Phytochemistry*, vol. 70, issue. 9, pp. 1166-1172, 2009.

[38] L. Chen, M. S. Brar, F. C. C. Leung, and W. L. W. Hsiao, "Triterpenoid herbal saponins enhance beneficial bacteria, decrease sulfate-reducing bacteria, modulate inflammatory intestinal microenvironment and exert cancer preventive effects in $Apc^{Min/+}$ mice," *Oncotarget*, vol. 7, issue. 21, pp. 31226-31242, 2016.

[39] L. Chen, W. C. S. Tai, and W. L. W. Hsiao, "Dietary saponins from four popular herbal tea exert prebiotic-like effects on gut microbiota in C57BL/6 mice", *Journal of Functional Foods*, vol. 17, pp. 892-902, 2015.

[40] G. Huang, I. Khan, X. Li, L. Chen, W. Leong, and L. T. Ho, *et al*., "Ginsenosides Rb_3 and Rd reduce polyps formation while reinstate the dysbiotic gut microbiota and the intestinal microenvironment in $Apc^{Min/+}$ mic", *Scientific Reports*, vol. 7, no. 12552, pp. 1-14, 2017.

[41] P. R. Cheeke, "Actual and potential applications of *Yucca schidigera* and *Quillaja saponaria* saponins in human and animal nutrition," *Journal of Animal Science*, vol. 77, pp. 1-10, 2000.

NANOTECHNOLOGY AND APPLIED MATERIALS

Analysis of the deformation of powder body having increased aspect ratio at dry pressing by the collector mold of spiral type

Edgar S. Dvilis[1], Oleg L. Khasanov[1*], and Chartpuk Prakorb[2]
[1]National Research Tomsk Polytechnic University, TPU Nano-Centre, Tomsk, Russia
[2]Rajamangala University of Technology Phra Nakhon, RMUTP Research and Development Institute, Bangkok, Thailand
[*]E-Mail: khasanov@tpu.ru; (Phone and Fax: +7 3822 427242)

Abstract

The finite element modeling was used for qualitative and quantitative analysis of the deformation of a powder body at its densification by spiral, linear types of a collector method and by conventional uniaxial single action pressing (CUSAP). Effects of deformation anisotropy of the powder body arising during the compacting dry ceramic powders under the action of wall friction forces have been studied. The deformation of the layers of the powder compacted by linear type (LT) and spiral type (ST) of collector mold (CM) has been described as compared to an article of a similar shape which was compacted by an CUSAP. Shape forming elements of collector molds consist of two plungers and six alternating oppositely-moving sliders of the passive shaping surface. The sliders for the STCM are additionally twisted at an angle of 80^o around the pressing axis. The FEM showed that the statistical variance of local deformation values in the volume of the powder bodies at using the STCM was reduced by 21% in comparison to CUSAP, and by 5.4% compared to the LTCM. As a result of optimizing the geometric parameters of the model, it was determined that at application of STCM, the uniformity of the density distribution can be improved by increasing the values of the twisting angle of the sliders and the number of the sliders. The proposed design of the STCM is promising for the molding the articles with complex spiral-shaped, curved surfaces, with an increased aspect ratio.

Keyword: dry powder, collector pressing, densification, density distribution, layer deformation

I. INTRODUCTION

Despite long history of the development of powder technologies for manufacturing various materials, establishing relationship between the applied compacting pressure and the compacting characteristics of the powder body remains one of the most important tasks for improving the technology and the theory of pressing, especially in relation to nanopowders [1-4]. The actual problem is the establishment of relationship between the magnitude of applied loads to the powder being pressed, the scheme of their application, kinematics of the movement of the press elements and the average density in a volume of green powder body, and its distribution throughout the green body volume.

To sinter articles from the green powder body having required shape, sizes and dimensional tolerances, it is important to provide uniform distribution of density inside the shaped green body. To ensure this condition the methods of pressing dry powders under powerful ultrasonic assistance (PUA) and collector method [5-11] are promising because their application makes it possible to redistribute or reduce the friction forces in the dry powder being pressed even during forming the articles of complex shape.

The friction forces between the passive shaping surface of the molds and the dry powder body are the main cause of the uneven density distribution within the volume of the powder body. This disadvantage can be almost completely eliminated by using the collector pressing method developed and patented at Tomsk Polytechnic University [6]. The method is based on the redistribution of action directions of wall friction forces.

This work describes an improved version of the collector pressing with displacement of its shaping elements along the spiral line. To assess the effectiveness of such a pressing scheme, a comparative study of deformation of the powder body in molds of various types was carried out. This task was fulfilled by numerical simulation of the deformation processes of the powder body with a diameter of 14 mm and a height of 20 mm in molds of various designs using solid modeling and finite-element analysis SolidWorks and Cosmos Works.

II. METHODS

Kinematic schemes of the studied methods of pressing

In contrary to pressing under the PUA, the collector method shows better uniformity of density distribution in the volume of the powder body which is achieved not by reducing the magnitude of wall friction forces but by their redistribution on the green compact surface [5-10].

The kinematic scheme of this method in comparison with the uniaxial single action pressing method is presented in Fig.1a - conventional uniaxial single action pressing (CUSAP), Fig.1b –

linear type of the collector mold (LTCM) with six alternating straight sliders, Fig.1c - spiral type of the collector mold (STCM) with six alternating sliders twisted at an angle of 80o. For clarity, a part of mold shaping elements of the same type are not shown, or are shown as transparent.

Fig. 1d shows the layout of the cross sections of the green powder body, inside which the simulated distributions of the local deformation lines were compared. One of the cross sections (A'C') passes through the areas of minimum and maximum degree of deformation of opposite directed sliders, and the second one (B'D') passes through the areas of movable conjunction of the sliders along their sliding surface.

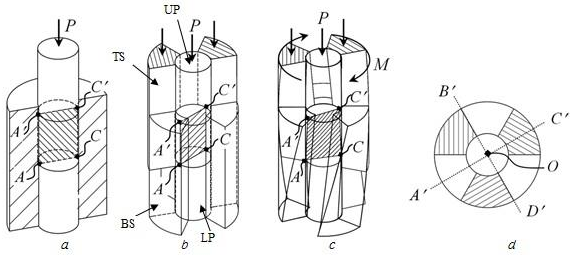


Fig. 1 Methods of pressing dry powders in closed molds: *a* - conventional uniaxial single action pressing (CUSAP), *b* – linear type of the collector mold (LTCM), *c* - spiral type of the collector mold (STCM) with sliders twisted at an angle of 80 degrees, *d* - layout of the cross sections of the green powder body. *P* is pressing force

In the case of CUSAP (Fig. 1*a*), the maximum value of friction forces of a powder body and the corresponding maximum value of the degree of deformation are observed in the conjunction area of the movable upper punch and the passive shape forming surface of the mold matrix (*A'C'* in Fig. 1*a*). Due to the loss of the pressing force to overcome the forces of wall friction in the areas which are most distant from the movable punch, there is a minimal degree of densification (*AC* in Fig. 1*a*). As a result, the density distribution along the axis of pressing dry powder body is axisymmetric and sharply uneven.

In the case of LTCM (Fig. 1*b*), the lower plunger LP synchronously with three bottom sliders BS moves relative to the upper plunger UP and three top sliders TS. At such a pressing scheme the distribution of friction forces and the density of the powder body is centrally symmetric and the average density in any horizontal cross section along the height of the green compact remains constant. However, the density distribution in the horizontal cross section of the powder compact remains uneven.

The uniformity of the density distribution in horizontal cross sections of the green compact made by the collector pressing can be improved by a higher number of alternating oppositely-moving sliders. But such a solution leads to a decrease in the area of their cross sections and to a decrease in the tensile strength of such sliders.

Another solution is the displacement of the areas of increased and reduced density in each layer of a green compact by some angle without reducing the cross-sectional area of sliders. In this case, the mutual influence of the adjacent layers of the green compact compensates for the density difference along these layers. The degree of such compensation is determined by the magnitude of the displacement angle. Sliders should be made in the form of a spiral and they will slide along each other along the helicoid surface in the process of powder densification. For STCM (Fig. 1*c*), the section line *[A′C′]* passes into *[AC]* line, forming the surface of the helicoid *[A′B′C′D′]* (Fig. 1*d*) twisted at an angle $\theta = 80$ degrees.

For LTCM and STCM at any point on *[A′A]* and *[C′C]* lines the deformation of powder, wall friction forces and densification degree will be equal to the average value on opposite sides of the conjugation line. Consequently, the densification degrees of the powders along *[A′A]* and *[C′C]* conjugation lines of the passive shaping surface will be the same.

III. RESULTS AND DISCUSSION

Simulation results

The simulation of the deformation processes of a powder compact pressed by different methods at the same conditions was carried out using the finite element method (FEM). The simulation results are presented in Fig.2 and Fig.3 as isolines of deformation of the layers in a long-length cylindrical green compact having high aspect ratio, on *[ACC′A′]* and *[BDD′B′]* surfaces.

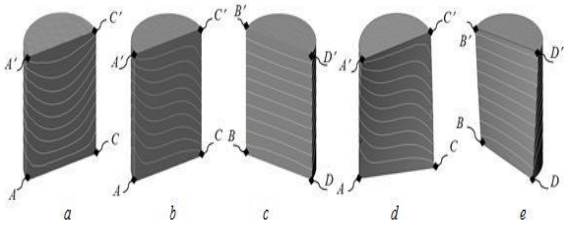


Fig. 2 Isolines of deformation of the green compacts layers during compaction by various methods: *a* - CUSAP; *b, c* – LTCM; *d, e* – STCM

In the case of CUSAP, a significant deformation of the layers towards the immovable (bottom) punch is observed in any vertical section of the green compact (Fig. 2*a*, 3*a*, 3*b*). The deformation distribution is axisymmetric and results in uneven density distribution in the volume of the green compact.

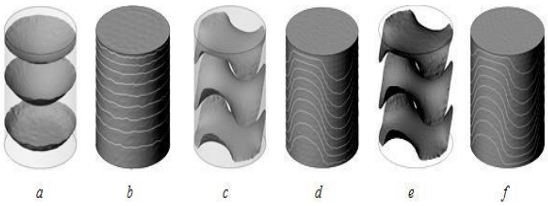


Fig. 3 The bending shapes of the layers (*a*, *c*, *e*) and the contours of their lines on the lateral surfaces of the green compacts (*b*, *d*, *f*) at compaction by various methods: *a*, *b* – CUSAP; *c*, *d* – LTCM; *e*, *f* – STCM

In the cases of the collector pressing (Fig. 2*b*,2*c*, 2*d*, 2*e*, 3*c*, 3*d*, 3*e*, 3*f*), wavy lines of the layers deformation are observed on the lateral surfaces of the green compacts. However, when considering the shapes of these layers located at different heights, it is found that even at a short distance from the lateral surface, the degree of bending is minimized, and the nature and degree of deformation of the layers weakly depend on the height of their location in the green compact.

At STCM (Fig. 3*e*, 3*f*), the nature and degree of bending of the layers in a green compact are almost the same as at LTCM (Fig. 3*c*, 3*d*), but for STCM there is a displacement of alternate deformation zones by an angle corresponding to the twist angle of the sliders.

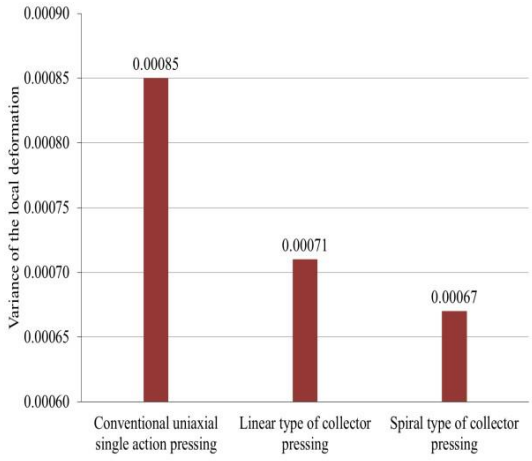


Fig. 4 Variance of local deformation values of the powder body compacted by various methods

A quantitative assessment of the improvement in the uniformity of density distribution in the volume of a green compact as a result of such displacement of the deformation zones was carried out by analyzing the local deformation magnitudes using their statistical variance values in cross sections of the green compacts. The results of such a comparison are presented in Fig. 4. The values of variance of the local deformations in the powder body compacted in the STCM was reduced by 21% as compared with the CUSAP, and by 5.4% in comparison with the LTCM.

Prospects for practical application of the collector pressing of spiral type

The method of collector pressing can be used to manufacture uniformly dense articles of various shapes [10]. The collector pressing of spiral type, as compared with the linear type, makes it possible to improve the uniformity of density distribution throughout the volume of green compacts of complex shape and with an increased aspect ratio. Spiral collector pressing allows manufacturing articles with a cylindrical lateral surface, as well as articles on the lateral surface of which there is a screw relief with a constant twist angle. It can be, for example, helical gears (Fig. 5*c*), the pressing of which by other methods, including linear collector pressing, is not possible. Articles that can be manufactured by spiral collector pressing are shown in Fig. 5.

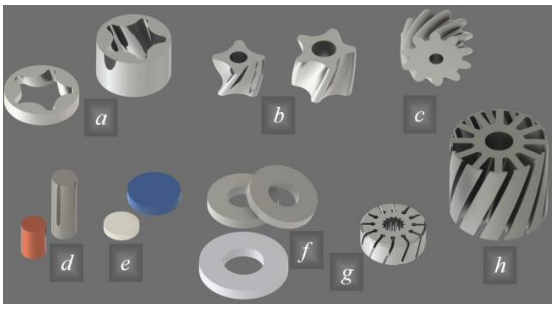


Fig. 5 Articles that can be efficiently manufactured by collector pressing of spiral type: *a* - external screw of the oil pump; *b* - internal screw of the oil pump; *c* - helical gear; *d* - stocks; *e* - lenses; *f* - piezoceramic rings; *g* - impeller of the fuel pump; *h* - engine rotor

IV. CONCLUSION

Qualitative and quantitative analysis of the deformation of a powder body during its densification carried out by the finite element method has shown the possibility of improvement of density distribution uniformity in the green compact using the spiral and linear types of the collector pressing method as compared to the conventional uniaxial single action pressing. Collector schemes of pressing allow reducing density differences in the volume of articles up to 20%. The spiral version of the collector method can be used for further improvement of the density uniformity of long- length articles with an increased aspect ratio or for the manufacturing the articles of complex spiral shape, like helical gears, screws, impellers, rotors, articles having increased aspect ratio, etc.

ACKNOWLEDGEMENT

The work has been supported by the grant of the Russian Science Foundation #17-13-01233.

REFERENCES

[1] R. Oberacker, "Powder Compaction by Dry Pressing," in *Ceramics Science and Technology*: *V.3*: *Synthesis and Processing*, R. Riedel, and I-W. Chen, Ed. Wiley-VCH, 2013, pp. 3-37.

[2] S. J. Glass and K. G. Ewsuk, "Ceramic Powder Compaction," *MRS Bulletin*, vol. 22, pp. 24-28, 1997.

[3] J. R. Groza, "Sintering of Nanocrystalline Powders," *Int. J. Powder Metall.*, vol. 35, pp. 59-66, 1999.

[4] D. Bortzmeyer, "Dry pressing of ceramic powders," in *Ceramic Processing*, R.A. Terpstra, P.P.A.C. Pex and A.H. de Vries, Ed. London: Chapman & Hall, 1995, pp. 102-146

[5] O. L. Khasanov and E. S. Dvilis, "Net–shaping nanopowders with powerful ultrasonic action and methods of the density distribution control," *Adv.Appl.Ceram*, vol. 107, pp. 135–141, 2008.

[6] E. S. Dvilis, O. L. Khasanov, V. M. Sokolov and Yu. P. Pokholkov, "Method for compacting powder materials into articles and a mold for implementing the method," *US patent No. 6919041*, 2005.

[7] O. L. Khasanov, E. S. Dvilis, V. M. Sokolov and Yu. P. Pokholkov, "Compaction method to make uniformly dense ceramic bodies of complex shape," *Key Eng. Mat.*, vol. 264–268, pp. 241–244, 2004.

[8] O. Khasanov, E. Dvilis, V. Sokolov and P. Chartpuk, "The comparison of model compaction method to make uniformly dense ceramic bodies," *Proc.7th Int. Forum on Strategic Technology*, *IFOST 2012*, Tomsk Polytechnic University, September 18-21, 2012, pp. 489-493. DOI: 10.1109/IFOST.2012.6357599.

[9] E. Dvilis, O. Khasanov, P. Chartpuk, V. Sokolov, "Optimal design of the spiral type of collector die for dry powder compaction," *Proc.8th Int. Forum on Strategic Technology*, *IFOST 2013*, Mongolian University of Science and Technology, Ulaanbaatar, June 28- July 1, 2013, pp. 25-28. DOI: 10.1109/IFOST.2013.6616979.

[10] O. Khasanov, E. Dvilis, V. Sokolov and Yu. Pokholkov, "Mechanisms of dry powder net-shaping under ultrasonic vibration and by the collector method," in *Global Roadmap for Ceramics, Proc. 2nd Int. Congress on Ceramics ICC2*, J. N. Babini and A. Bellosi Ed. CNR, Verona: European Ceramic Society, 2008, pp. 359-368.

[11] M.-H. Hwang, H.-S. Lee, J.-H. Han, D.-H. Kim and H.-R. Cha, "Densification mechanism of soft magnetic composites using ultrasonic compaction for motors in EV platforms," *Materials*, vol.12, pp. 824-838, 2019. DOI: 10.3390/ma12050824.

Properties of transparent $MgAl_2O_4$ nanoceramics doped with ceria

Vladimir D. Paygin, Oleg L. Khasanov*, Edgar S. Dvilis, and Damir T. Valiev
National Research Tomsk Polytechnic University, TPU Nano-Centre, Tomsk, Russia, vpaygin@mail.ru
*E-Mail: khasanov@tpu.ru; (Phone and Fax: +7 3822 427242)

Abstract

Transparent magnesium aluminate spinel ($MgAl_2O_4$, MAS) ceramics doped with different concentrations of Ce^{3+} ions from 0.005 to 0.1 wt. % were fabricated by spark plasma sintering (SPS) technique from commercial nanopowders. The optimal combination of the mechanical, optical and luminescent properties has been obtained when SPS was carried out at temperature 1400°C under progressive uniaxial loading at 72 MPa. The in-line transmittance for pure MAS ceramic samples in the visible spectral range reaches 52% (at λ = 600 nm), and in the near infrared range reaches 69% (at λ = 1100 nm). In depend of Ce^{3+} ions concentration the microhardness varies from 15.96 to 17.4 GPa, critical stress intensity factor reached the value of 3.92 MPa*m1/2. The effect of cerium oxide dopant on the optical, photoluminescent and mechanical properties of $MgAl_2O_4$-based transparent ceramics is discussed. The redshift of the photluminescent spectra for MAS ceramics doped with different Ce^{3+} concentration has been observed.

Keyword: $MgAl_2O_4$ transparent ceramics, cerium oxide, spark plasma sintering, optical-luminescent properties, mechanical properties

I. INTRODUCTION

Transparent ceramics based on magnesium aluminate spinel (MAS) is one of the most promising optical materials [1]. Studies of transparent MAS ceramics have been conducted since the 60s of the twentieth century [2]. Most of the investigations are aimed at transparent materials obtaining for possible applications in aerospace and optoelectronics, laser industries (infrared fairings, transparent armor, etc.) [3, 4]. In recent years, the ceramics of such components have been used to make optical elements of the space telescopes, outlet windows of UV and IR laser devices, elements of passive optics operating under extreme conditions [5].

$MgAl_2O_4$-based transparent ceramics with high transparency in a wide spectral range from 200 nm to 5500 nm and light transmission without optical distortions can be used as scintillators and converters of ionizing radiation [6, 7]. The mechanical properties of MAS ceramics are comparable to the mechanical properties of polycrystalline corundum due to it is chemically inert to the action of corrosive media and has high thermal stability. Spinel doped with rare earth (RE) ions due to its high thermo-optical characteristics is a promising material for use as active elements of solid-state lasers [8 - 11].

Previously, RE oxides were used as sintering additives in the manufacture of MAS ceramics [1, 12]. Currently, $MgAl_2O_4$ nanopowders doped with oxides of rare-earth elements are being actively studied [13 - 17]. The possibility of obtaining transparent luminescent MAS ceramics doped with Yb_2O_3 or CeO_2 was demonstrated in [7, 11]. It is known that to obtain ceramics with high optical properties, it is necessary to keep the initial phase composition, nanostructured perfect grain interfaces, chemical and phase purity of the material in the compaction process of ceramics consolidation. It is cannot be fully achieved by traditional methods of consolidating powder materials such as low-temperature sintering, hot isostatic pressing techniques, etc. This problem can be solved by the spark plasma sintering method (SPS), which is increasingly used to produce transparent nanostructured ceramic materials.

The duration of the sintering process in this way does not exceed tens of minutes, as a result of which the growth of grains is minimal, and their sizes inherit the sizes of sintered powders particles. A uniform density distribution in the volume of sintered ceramics occurs and perfect grain boundaries are formed during the SPS process [18 – 21].

According to this, the problem of the low solubility of rare earth oxides in the aluminum-magnesium spinel host, which leads to the impurity formation (secondary phases) and the degradation of optical properties, becomes significant. One of the ways to solve this problem is the use of high-quality nanopowders as starting materials in combination with effective mixing methods and powder mixtures consolidation [11].

The purpose of this study is to obtain Ce^{3+}-doped MAS transparent luminescent ceramics prepared by the SPS technique and to carry out characterization of their physical-mechanical, opticalproperties.

II. METHODS

$MgAl_2O_4$ ceramics processing

Commercially available powder of $MgAl_2O_4$ magnesium aluminate spinel (S30CR, Baikowski Malakoff Inc. USA, purity 99.999%, average particle size is 200 nm) and CeO_2 powders (Nevatorg,

Russia, purity 99.999%, the average particle size 50 – 100 nm) was used for ceramics preparation. Before sintering process, the mechanical mixture of MAS and RE oxides powders has being mixed with the ethanol using the high power ultrasonic treatment (~1.2 kW) during 20 minutes. As a result, powder mixtures of the composition $MgAl_2O_4$: *x* wt. % CeO_2 (*x* = 0.005; 0.01; 0.5; 0.1) were obtained.

The MAS nanopowder both pure and doped with Ce^{3+}, which was mixed homogeneous, has been consolidated by spark plasma sintering installation SPS 515S (Syntex Inc., Japan) to obtain dense nanostructured ceramics. The desired quantity of powder (2.8 g) was placed in graphite dies having a 20 mm inner diameter. SPS conditions were as follows: sintering temperature T=1400°C, the pressure of 72 MPa, and the heating rate of 5 °C/min. The duration of heating was 10 minutes. The processing modes of ceramics manufacturing were chosen based on our previous studies [22].

The sintered ceramic samples were cylindrical disks with a thickness of 2.5 mm and 20 mm in diameter. Before being characterized, the samples were polished using by polishing machine (300 Pro Buehler, Germany) with MetaDi (Buehler, Germany) diamond suspension. The density of ceramics was determined by measuring the mass and linear dimensions. Further studies of ceramics samples were performed on their polished side surfaces.

Experimental techniques

X-ray diffraction phase analysis (XRD) was performed by an XRD-7000S diffractometer (Shimadzu, Japan). The XRD results were interpreted using "PowderCell" software and "PDF 4" international crystallographic database. The study of the optical properties of the sintered ceramic samples was carried out using an SF-256 UVI two-beam scanning spectrophotometer in the spectral range λ from 200 to 1100 nm. The photoluminescence (PL) spectra were measured by a Cary Eclipse (Agilent, USA) fluorescence spectrophotometer with 150 W xenon lamp as the excitation source.

The microhardness of ceramics was determined by the Vickers diamond pyramid indentation method using a standard DUH-211S dynamic ultra-microhardness tester (Shimadzu, Japan) with a load of 1.96 N' as well as using the microhardness tester PMT-3M (LOMO, Russia). The critical stress intensity factor K_{1c} was calculated based on the measurement of radial crack lengths formed during indentation, performed by Niihara equation [23].

III. RESULTS AND DISCUSSION

XRD analysis confirmed that MAS ceramic samples doped with low Ce^{3+} concentration consist of stoichiometric magnesium aluminate spinel of cubic modification. All observed XRD reflexes are characteristic for this spinel phase. The presence of other phases in the sintered ceramics was not detected.

Based on XRD analysis the lattice parameters *a*, mean size of coherent scattering regions (crystallite size *D*), and relative microstrains *ε* were determined (Table 1).

It was shown a 10-fold increase in crystallite size after SPS sintering. The undoped MAS ceramics are characterized by the degree of relative microstrains of the crystal lattice equal to 0.000092 and the crystallite size is 364.5 nm. The MAS ceramics doped with 0.01 wt. % cerium ions have the maximum crystallite size *D* = 465.8 nm and the minimal lattice microstrains *ε* = 0.000079.

Table 1 Unit cell parameters, crystallite sizes, and relative microstrains of the studied MAS ceramics

Ceramics	*a, Å*	*D, nm*	*ε, arb. u.*
Initial powder $MgAl_2O_4$	8.0860	36.2	0.000442
$MgAl_2O_4$	8.0844	364.5	0.000092
$MgAl_2O_4$: 0.005Ce	8.0842	394.6	0.000100
$MgAl_2O_4$: 0.01Ce	8.0839	465.8	0.000079
$MgAl_2O_4$: 0.05Ce	8.0840	403.1	0.000098
$MgAl_2O_4$: 0.1Ce	8.0859	412.9	0.000086

The optical transmission spectra of the samples are shown in Fig. 1. The sintered MAS ceramics were transparent in the visible and infrared spectral region from λ = 200 nm to λ = 1100 nm. The transmission edge of the sintered ceramics lies in the spectral region of 250 nm.

An integral increase of in-line transmission from the visible to the infrared range is observed. The in-line transmission of the pure MAS ceramics reaches 52% in the visible range (λ = 600 nm) and 69% in the near infrared range (λ = 1100 nm). Among Ce^{3+}-doped samples the MAS:0.01Ce ceramics has maximum of the optical transmission coefficient: 39% at λ = 600 nm (Fig. 2).

The minimum value of the optical transmission coefficient is 0.16% at λ = 600 nm was observed for the MAS:0.1Ce ceramics. There is a tendency to decreasing the in-line transmittance

(from 52.03% to 0.16 %) of MAS ceramics with an increase of the ceria concentration.

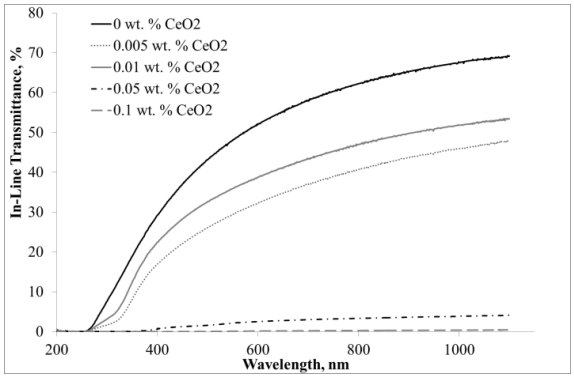


Fig. 1 Transmittance spectra of MAS ceramics manufactured by SPS

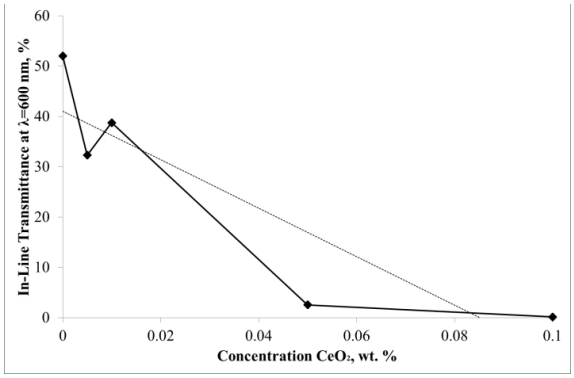


Fig. 2 Optical transmission coefficient vs CeO_2 concentration in MAS ceramics

Fig. 3 shows the photoluminescence spectra of the MAS ceramics samples exited by short-wave radiation at $\lambda_{exc.}$ = 317 nm. The broad emission band in 350 – 650 nm spectral region is observed. As can be seen from the results the PL spectra differ significantly for MAS ceramics doped with different Ce^{3+} concentration. There is a redshift of the PL spectra with increasing Ce^{3+} concentration from 375 nm (MAS:0.005Ce; MAS:0.01Ce) to 475 nm (MAS:0.1Ce). The maximum intensity of the emitted photoluminescence has MAS:0.05Ce ceramics: I = 815 at λ_{em} =~425 nm.

Based on this fact it is advisable to carry out the following optimization of the SPS modes for sintering the MAS ceramics doped with cerium oxide.

The measured physical-mechanical properties for sintered MAS ceramics (pure and Ce^{3+} doped) are presented in Table 2. It can be seen that the increase of the ceria concentration from 0 to 0.1 wt.% leads to increasing the microhardness from 15.76 ± 0.41 to 17.42 ± 0.23 GPa, but the critical stress intensity factor K_{1c} was decreased from 3.72 ±0.07 MPa*$m^{1/2}$ to 3.26 ± 0.06 MPa*$m^{1/2}$. The maximum value of the microhardness was observed for MAS:0.01Ce ceramics. The maximum value K_{1c} = 3.92 has MAS:0.005Ce ceramics. However the observed change in microhardness does not significantly exceed the confidence interval for determining this value.

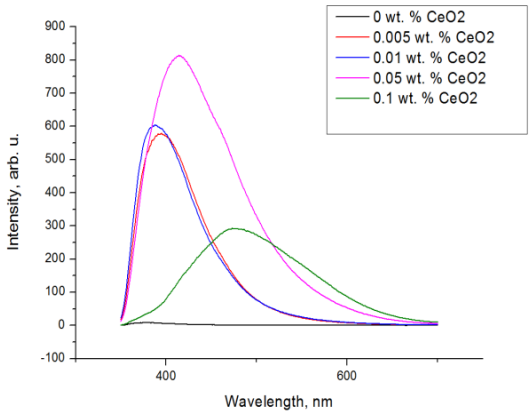


Fig. 3 Photoluminescence spectra of pure MAS ceramics and ceramics doped with different concentration of Ce^{3+} ions ($\lambda_{exc.}$= 317 nm)

Table 2 Physical-mechanical properties of ceramics based on aluminum-magnesium spinel doped with different cerium concentration

Ceramic samples	*ρ, %*	*Hv, GPa*	K_{1C}, MPa*$m^{1/2}$
$MgAl_2O_4$	98.14	16.21±0.36	3.72±0.07
$MgAl_2O_4$: 0.005Ce	98.29	15.76±0.41	3.92±0.08
$MgAl_2O_4$: 0.01Ce	98.32	17.42±0.23	3.82±0.08
$MgAl_2O_4$: 0.05Ce	98.78	15.96±0.20	3.51±0.07
$MgAl_2O_4$: 0.1Ce	98.35	16.38±0.70	3.26±0.06

IV. CONCLUSION

Transparent magnesium aluminate spinel ceramics both pure and doped with different concentrations of Ce^{3+} ions from 0.005 to 0.1 wt. % were manufactured by spark plasma sintering. The effect of cerium oxide on the optical, luminescent, and mechanical properties of MAS ceramics has been studied.

An integral increase of in-line transmission from the visible to the infrared range is observed. The in-line transmission of the pure MAS ceramics reaches 52% in the visible range (λ = 600 nm) and 69% in the near infrared range (λ = 1100 nm). Among Ce^{3+}-doped samples the MAS:0.01Ce ceramics has maximum of the optical transmission coefficient: 39% at λ = 600 nm.

The minimum value of the optical transmission coefficient is 0.16% at λ = 600 nm was observed for the MAS:0.1Ce ceramics. There is a tendency to a decrease in the in-line transmittance (from 52.03% to 0.16 %) of MAS ceramics with an increase of the cerium oxide concentration from 0 to 0.1 wt. %.

The redshift of the photoluminescent spectra with increasing Ce^{3+} concentration from 375 nm (MAS:0.005Ce; MAS:0.01Ce) to 475 nm (MAS:0.1Ce) has been observed.

Increase of the ceria concentration from 0 to 0.1 wt.% leads to increasing the microhardness from 15.76 ± 0.41 to 17.42 ± 0.23 GPa, but the critical stress intensity factor K1c was decreased from 3.72 ±0.07 MPa*m1/2 to 3.26 ± 0.06 MPa*m1/2. The maximum value of the microhardness was observed for MAS:0.01Ce ceramics. The maximum value K1c = 3.92 has MAS:0.005Ce ceramics.

Based on the practical purpose in our opinion the MAS:0.01Ce ceramics has the optimal combination of the properties such as in-line transmission 38.75%, microhardness 17.42 ± 0.23 GPa, critical stress intensity factor 3.82 ± 0.08 MPa·m1/2.

ACKNOWLEDGEMENT

The work is supported by a project of the Russian Science Foundation #17-13-01233. The authors are grateful to Dr. E. Polisadova, PhD S. Stepanov for analysis of the PL spectra and useful discussions.

REFERENCES

[1] I. Ganesh, "A review on magnesium aluminate ($MgAl_2O_4$) spinel: synthesis, processing and applications," *International Materials Reviews*, vol. 58, pp. 63 – 112, 2013.

[2] G.A. Vidrik, T.V. Solovieva and F. Ya. Haritonov, "Transparent Ceramic," Moskva: Energiya, 1980, pp. 96.

[3] M. Ramisetty, S. Sastri, U. Kashalikar, L. M. Goldman and N. Nag, "Transparent polycrystalline cubic spinels protect and defend," *American Ceramic Society Bulletin*, vol. 92, pp. 20 – 25, 2013.

[4] A. Goldstein, "Correlation between $MgAl_2O_4$ - spinel structure, processing factors and functional properties of transparent parts (progress review)," *European Ceramic Society*, vol. 32, pp. 2869 – 2886, 2013.

[5] M. K. Alekseev, G. I. Kulikova, M. Yu. Rusin, N. N. Savanina, S. S. Balabanov, A. V. Belyaev, E. M. Gavrishchuk, A. V. Ivanov, R. N. Rizakhanov, "Transparent ceramics prepared from ultrapure magnesium aluminate spinel nanopowders by spark plasma sintering," *Inorganic Materials*, vol. 52, pp. 324 – 330, 2016.

[6] M. C. L. Patterson, J. E. Caiazza and D. W. Roy, "Transparent spinel development," *Inorganic Optical Materials II: SPIE*, Proceedings vol. 4102, pp. 59 – 68, 2000.

[7] C.F. Chen, F.P. Doty, J.T.H. Houk, R.O. Loutfy, H.M. Volz and P. Yang, "Characterizations of a hot-pressed polycrystalline Spinel:Ce scintillator," *American Ceramic Society*, vol. 93, pp. 2399 – 2402, 2010.

[8] K. Lemanski, P.J. Deren, W. Walerczyk, W. Strek, R. Boulesteix and R. Epherre, et al., "Spectroscopic and structural properties of $MgAl_2O_4$:Nd_3 nanopowders and ceramics," *Rare Earths*, vol. 32, pp. 265 – 268, 2014.

[9] J. Sanghera, S. Bayya, G. Villalobos, W. Kim, J. Frantz and B. Shaw, et al., "Transparent ceramics for high-energy laser systems," *Optical Materials*, vol. 33, pp. 511 – 518, 2011.

Mechanical Properties of Carbon Fiber Prepreg Insert Injection Moldings

B. Pinpathomrat[1], K. Nishitani[1], N. O-charoen[2] and H. Hamada[1,*]
[1]Department of Advanced Fibro-Science, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan
[2]Department of Materials and Metallurgical Engineering, Rajamangala University of Technology Thanyaburi, Klong 6, Thanyaburi, Pathumthani 12110, Thailand
[*]E-Mail: hhamada@kit.ac.jp (Phone: +81 75 724 7844)

Abstract

Thermoplastic composites are found in various applications such as automotive, aerospace and construction, which was due to their advantages in high specific strength and lightweight. Injection molding is used for the advantages of shortening the molding time and high molding accuracy. Automotive parts are mostly bolted joining and using an adhesive. An insert-injection molding is a process that can be applied reinforcing or decorative material to produce complex injection molding parts. The insert-injection molding is the process that is injected melted polymer around the inserted material placed in the molded cavity. Hence, inserted injection molding is introduced for adhering automotive parts without using bolts or the adhesive. In this study, two types of thermoplastic prepregs inserted were glass fiber/polypropylene (GF/PP) prepreg and carbon fiber/polyamide 6 (CF/PA6) prepreg. GF/PP resin is injected to GF/PP prepreg while GF/PA6 resin is injected to CF/PA6 prepreg. The role of adhesion between the inserted part and injected resin on the mechanical property is measured by tensile and bending testing. The unidirectional of prepreg improved the flexural strength of the insert-injection molding composites. Mechanical properties and microscope observation indicated that the main failure mode of the insert-injection molding was the structure failure mode.

Keyword: Insert-injection molding, Prepreg, woven, adhesion

I. INTRODUCTION

Thermoplastic composites are found in various applications such as automotive, aerospace and construction, which was due to their advantages in high specific strength and lightweight. Injection molding is used for the advantages of shortening the molding time and high molding accuracy [1]. The industry parts are mostly bolted joining using an adhesive. An insert-injection molding process is an advanced injection molding technology that uses dissimilar material to produce complex part [2-3]. This unique manufacturing process can process metal and plastic, ceramics, or multiple combinations of materials, components, and plastic into a single unit. The insert injection molding process is molded specimen by injected melted polymer to the inserted part that placed in the injection molded cavity and an adhesive single bonding between the inserted part and the injected polymer [4-6]. Hence, the insert-injection molding is introduced for adhering automotive parts without using bolts or the adhesive. On the other hand, the insert-injection molded, also called two stages sequential insert molding, is the injection molding process using a rigid substrate or the flexible material. The insert can either be incorporated at the time of the molding process or can be inserted as post-molding operation.

In this paper, we focused on the prepreg insert composites as inserted in the molding process. GF/PA6 resin was injected to CF/PA6 prepreg. The role of adhesion between inserted part and injected resin on the mechanical property and morphology was measured by 3-point bending testing, optical microscope. The effects of prepreg orientation and the number of the inserted parts on mechanical properties of the inserted-injection molding system were investigated.

II. EXPERIMENTAL

Materials and Preparation

Thermoplastic unidirectional and woven prepreg CF/PA6 prepreg (Grade MCP 1223) was provided by Maruhachi Corporation, Japan. Prepregs were cut to dimension of 150 mm long x 10 mm wide x 0.3 mm thick as the inserted parts. The prepreg-inserted part was put in the mold cavity by double-side adhesive tape before injected with polymer resin. Glass fiber pre-compounded polyamide 6 (GF/PA6, Grade A1030BRL) was provided by Unitika Limited, Japan. GF/PA6 was injected to mold cavity, which had dimensions of 150x10x3.5 mm according to ASTM standard D638 by injection molding (TOYO MACHINERY & METAL CO., Ltd, TI-30F6, Japan). Table 1 tabulates a code of specimen of insert-injection molding. Figure 1 shows photographs of the insert-injection molded with various inserted parts.

Table 1 Specimen code and detail

No.	Code	Prepreg directions	Inserted part position
1	PA-U-1	Unidirectional	One side
2	PA-U-2	Unidirectional	Both side
3	PA-W-1	Woven	One side
4	PA-W-2	Woven	Both side

Testing methods

Three-point bending test was done with testing speed of 1 mm/min at span length of 48 mm. Morphology of fractured surface of the insert injection molded specimens was observed by optical microscope (KEYENCE, Japan).

III. RESULTS AND DISCUSSION

Mechanical properties of insert-injection molding

Flexural strength is presented in Fig.1. Flexural strength of the insert-injection moldings was greater improved when using double side of the unidirectional prepreg. he flexural strength was improved about 27% in PP-U-2 and 50% in PA-U-2 as compared to the neat GF/PP and the neat GF/PA, respectively. It was considered that the prepreg was under a compression load, which processed on buckling and kinking of the prepreg [7]. Hence, the flexural strength of PA-U-1 was lower than the neat polymers.

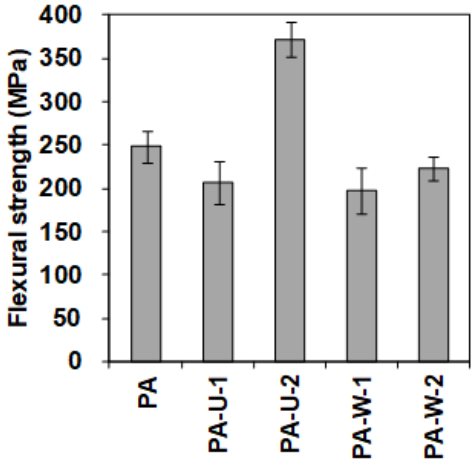


Fig. 1 Flexural strength of insert moldings

Morphology and fracture behavior

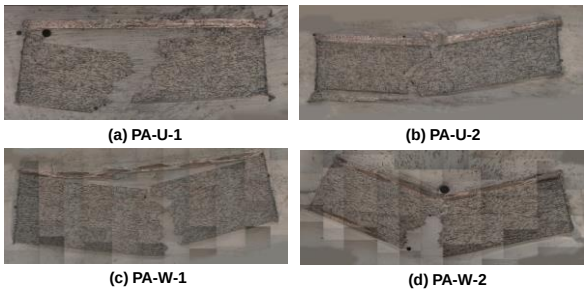


Fig.2 Flexural strength of insert moldings

Fig.2 shows optical photographs of the specimens after bending test. From the results, it would indicate that the main failure mode of the insert-injection molding was the structural failure. It can be seen that the fracture of the specimens more occurred with one side of the unidirectional prepreg insertion specimens. In addition, the specimen with the woven fabric prepreg insertion was less adhesion and easily broken after compression load as presented in Figure 2 (c) and (d).

IV. CONCLUSION

The effect of fiber direction in the prepreg inserted on the adhesive property of the insert-injection molded was presented. The prepreg inserted had bonded with the injection part by injection molded process and promotes the adhesion between the inserted and the injected parts. Tensile strength and flexural strength of the insert-injection molding were better improved with the double side insertion of the unidirectional prepreg. However, the woven structure was not promoted tensile and bending properties of CF/PA-GF/PA insert-injection molding. The failure mode of the specimens was the structural failure, which the fracture was occurred both in the prepreg-inserted part and the polymer-injected part. It can be noted that the insert-injection molding composites were required higher stress than neat reinforced polymers before the initial crack occurred. The insert-injection molding process presented a benefit for the fabrication of joint materials and reinforced composites.

REFERENCES

[1] "Handbook of Semiconductor Manufacturing Technology," N. Yoshio and D. Robert, Ed. New York: Marcel Dekker, 2000.

[2] M. Ryosuke, S. Motoko and T. Akira, "Improving performance of GFRP/aluminum single lap joints using bolted/co-cured hybrid method," *Composites Part A: Applied Science and Manufacturing*, vol. 39, no. 2, pp. 154-163, 2008.

[3] N. S. Mohan, S. M. Kulkarni, and A. Ramachandra, "Delamination analysis in drilling process of glass fiber reinforced plastic (GFRP) composite materials," *Journal of Materials Processing Technology*, vol. 186, no. 1-3, pp. 265–271, 2007.

[4] J.P. Davim, P. Reis and C.C. Antonio, "Experimental study of drilling glass fiber reinforced plastics (GFRP) manufactured by hand lay-up," *Composites Science and Technololy*, vol. 64, no. 2, pp. 289-297, 2004.

[5] R.M. O'Higgins, M.A. McCarthy and C.T. McCarthy, "Experimental and Numerical Study of the Open-Hole Tensile Strength of Carbon/Epoxy Composites," *Mechanics of Composite Materials*, vol. 40, no. 4, pp. 269-278, 2004.

[6] J. Bohse, "Acoustic Emission Examination of Polymer-Matrix Composites," *Journal of Acoustic Emission*, Vol. 22, pp. 208-223, 2004.

[7] B. Budiansky and N.A. Fleck, "Compressive Kinking of Fiber Composites: A Topical Review," *Applied Mechanics Reviews*, vol. 47, no. 6s, pp. S246-S250, 1994.

[8] A. Nakai, T. Osada, H. Hamada and N. Takeda, "Role of surface treatment in textile composites," *Composites Part A: Applied Science and Manufacturing*, vol. 32, no. 3-4, pp. 487-498, 2001.

Magnetic Properties in Ba_2FeMoO_6 (BFMO) Double Perovskits

Vanussanun Aitviriyaphan[1], Prasert Wirotcheewan[1], Prakorb Chartpuk[1] and Naphat Albutt[2*]
[1]Department of Mechanical Engineering, Faculty of Engineering, Rajamangala University of Technology Phra Nakhon, Wongsawang Sub-district, Bang Sue District, Bangkok 10800, Thailand
[2]Division of Science, Faculty of Science and Technology, Rajamangala University of Technology Phra Nakhon, Wongsawang Sub-district, Bang Sue District, Bangkok 10800, Thailand
[*]E-mail: naphat.cha@rmutp.ac.th

Abstract

The magnetic properties of Ba2FeMoO6 (BFMO) double perovskite are investigated. BFMO samples were prepared by solid state reaction method through compression. Magnetic properties are influenced by electron environments of the Fe3+ and Mo5+ ions within the perovskite structure. BFMO calcined at 800 ºC exhibited the largest hysteresis loop at 50 K. In addition, the values of Ms and Mr indicate ferromagnetic behaviour in BFMO ceramics calcined from 600 ºC to 800 ºC. Finally, the value of magnetization was reduced by using a lower calcining temperature.

Keyword: Composite, double perovskite, BFMO

I. INTRODUCTION

The double perovskite of Ba_2FeMoO_6 ceramics have magnetic properties with behaviour similar to Sr_2FeMoO_6, the most representative of the ferromagnetic double perovskites which have the general formula (AA')(BB')O_6 [1-5]. In this formula, A and A' are alkaline rare earth cations such as Ba^{2+}, Ca^{2+} and Sr^{2+}, while B and B' represent transition metal cations such as Fe^{3+} and Mo^{5+}, possessing high Curie temperature (Tc) and spin polarization [6]. Properties of the ceramic can be modified with processing. Annealing and sintering effects the crystal structure and magnetic behaviour of double perovskite [7]. The temperature dependence of the magnetization results indicates ferromagnetic metallic and antiferromagnetic (or paramagnetic) insulating domains, which is believed to induce a metal–insulator transition at the Curie temperature [6, 8]. Double perovskites have been prepared by sol-gel with characterization of ferromagnetism [9-11], cation order and magnetic property [12].

Following on from previous research on the calcined material and powder samples [13-16]. A vibrating sample magnetometer (VSM instrument) is used to study the magnetic properties or magnetic behaviour of Ba_2FeMoO_6 samples. This instrument can find the samples magnetization using an applied magnetic field (H). Resulting in a characteristic M-H curve, which is used to classify the kind of magnetic behaviour as revealed in all the conditions.

II. EXPERIMENTAL

The powder Ba_2FeMoO_6 samples were synthesized using a 2:1:1 ratio of $BaCO_3$ (Barium carbonate, 99.9%), $Fe(NO_3)_3.9H_2O$ (Iron(III) nitrate, 99.0%) and MoO_3 (Molybdenum trioxide, 99.0%). A slurry was prepared by mixing the powders with deionized (DI) water at a ratio of 1:7.5. The mixture was stirred up to 700 rpm for 48 hours to achieve homogeneity. A calcined sample was prepared by heating the solution at several temperatures 600 ºC, 700 ºC and 800 ºC (three conditions), each maintained for 2 hours. Finally, the dried material was crushed to a fine powder.

To reveal the magnetic behaviour, the Ba_2FeMoO_6 samples were measured by a vibrating sample magnetometer (VSM). In this case we measured at temperature from 50K to 350K, whereas the applied magnetic fields (H) were from -30000 to 30000 Oe.

III. RESULTS AND DISCUSSION

Figure 1 presents plots of magnetization hysteresis loops for the Ba_2FeMoO_6 samples produced from the three temperature conditions of 600 ºC, 700 ºC and 800 ºC, measurements were made at a temperature of 50 K. It is clearly seen in the figure that all of the conditions exhibit ferromagnetism at 50 K. The 600 ºC_2hr condition produced the weakest response, with small ferromagnetism and paramagnetism due to the low saturated magnetization. Generally, increasing the temperature of the calcining step results in a larger hysteresis loop of the BFMO ceramic at 50 K, which can be seen in figure 1 up to 800 ºC. This indicates that the ferromagnetic properties of BFMO ceramics can be adjusted with calcining temperature alone. From figure 1 (a-c), an increase of the saturation magnetization (Ms) is seen to 0.13, 0.76 and 2.52 emu/g by increasing the calcining temperature, which is due to the presence of stronger magnetic material. Similarly, the remanence magnetization (Mr) also increased, with values of 0.011, 0.059 and 1.040 emu/g and a coercive field (Hc) of 1.3 k, 0.75 k and 2.73 k for 600 ºC, 700 ºC and 800 ºC, respectively. These hysteresis loops show the BFMO ceramics have high ferromagnetism and near hard magnetic material when calcined at the higher temperatures, as shown in Figure 1(d)

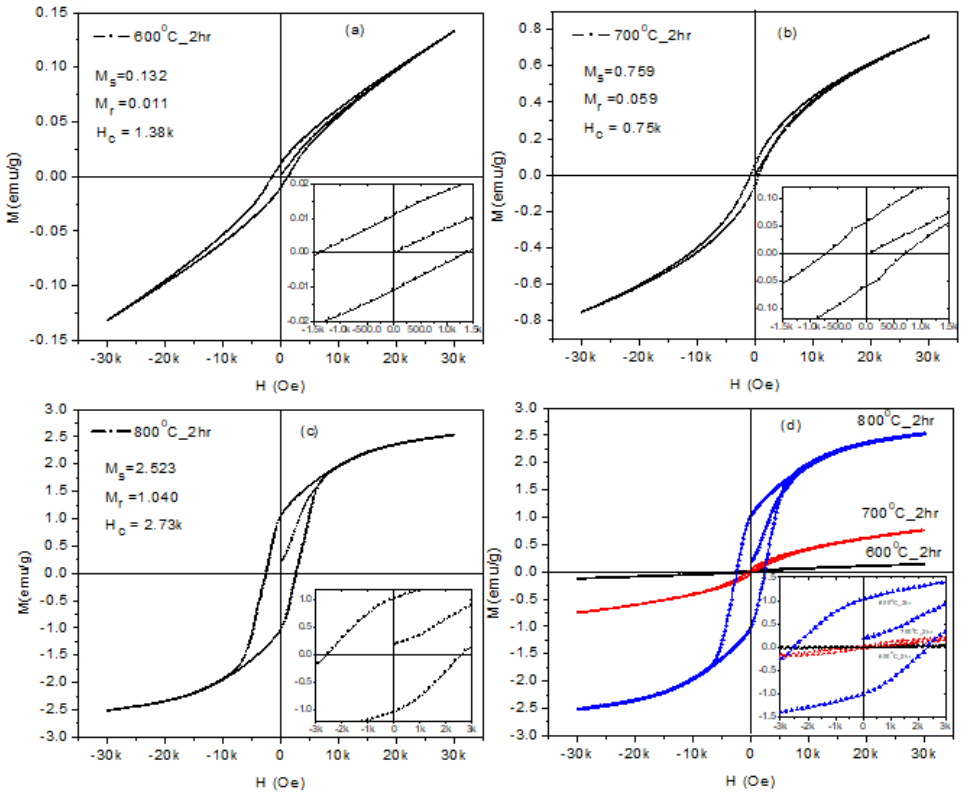


Fig. 1 M–H curves of Ba_2FeMoO_6 ceramics measured at a temperature of 50 K. Ba_2FeMoO_6 calcined at (a) 600 ºC, (b) 700 ºC, (c) 800 ºC and (d) overlay. The insets show H_c and M_r.

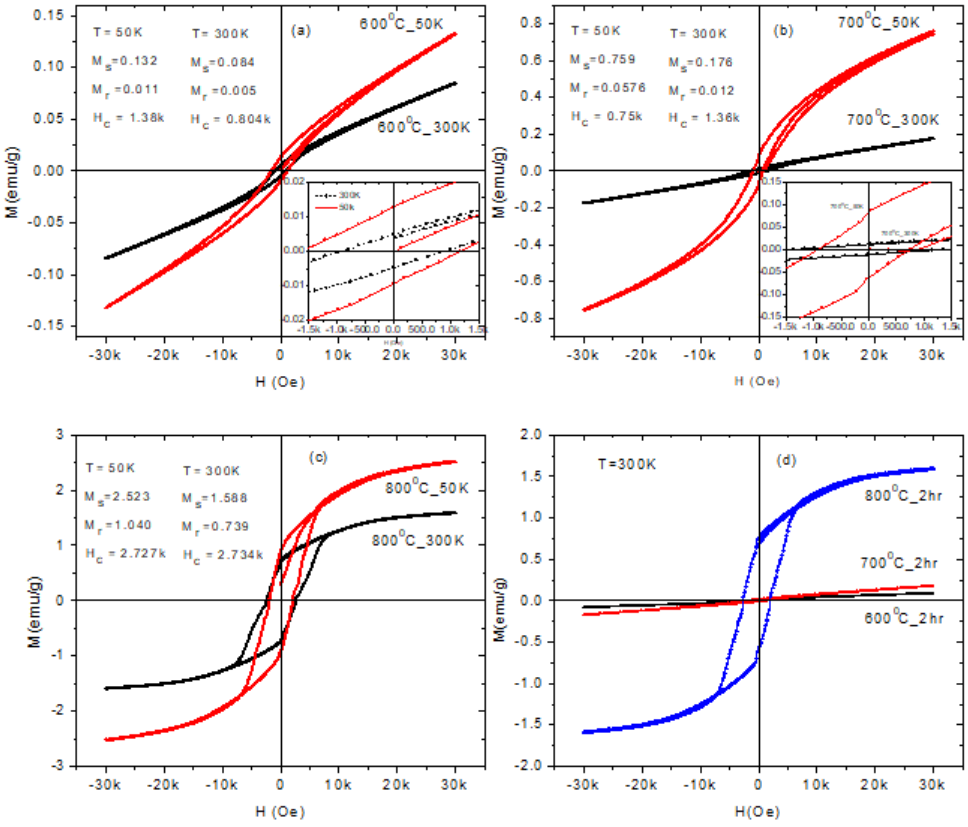


Fig. 2 Magnetic-field dependence of magnetization at temperatures of 50 K and 300 K. Ba_2FeMoO_6 calcined at (a) 600 ºC, (b) 700 ºC, (c) 800 ºC and (d) overlay. The insets show H_c and M_r.

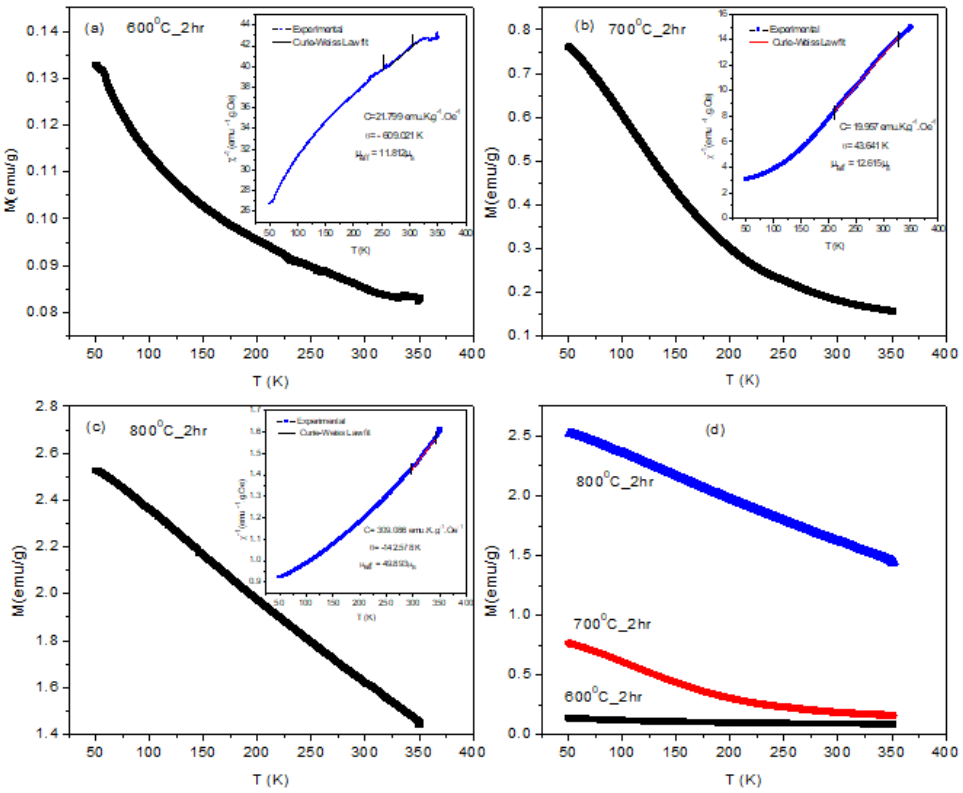


Fig. 3 (M-T) curves of Ba_2FeMoO_6 double perovskites for H= 30 kOe. Thermal magnetization with temperatures (K) for samples calcined at (a) 600 ºC, (b) 700 ºC, (c) 800 ºC and (d) overlay. Insets show the inverse magnetic susceptibility (χ^{-1}) and magnetic field (H=30 kOe)

Magnetization magnetic measurements (M) versus applied magnetic field (H) were also performed on the BFMO samples at 300 K for comparison, as shown in Figure 2 (a-c). Comparing the magnetic behaviour of BFMO ceramics at 50 K and 300 K provides insight into the stability and structure of the samples. Generally, a reduction of ferromagnetism is observed at the higher analysis temperature of 300 K in comparison to 50 K for each sample condition. The largest reduction was seen for samples calcined at 800 ºC, with Ms decreasing by 0.935 emu/g and Mr decreasing by 0.301 emu/g from 50 K to 300 K. However, Hc remained constant for the 800 ºC condition at both 50 K and 300 K, whereas Hc was reduced at 300 K for the 600 ºC and 700 ºC conditions. Despite the reduction in ferromagnetism with applied temperature increase, the samples calcined at 800 ºC retained a large proportion of their magnetic response.

Figure 3(a-d) shows the temperature dependence of magnetization of BFMO ceramic calcined at temperature 600 ºC, 700 ºC and 800 ºC, respectively. The Curie-Weiss law was used to determine magnetic susceptibility by linear fit to the data between 200 K and 350 K at 30 kOe, which is shown in figure 3 insets. BFMO calcined at 600 ºC, 700 ºC and 800 ºC have the Curie-Weiss temperature at θ= -609.021 K, θ= 43.641 K and θ= -142.578 K, respectively. A positive Curie temperature indicates a ferromagnetic characteristic of the calcined sample. On the other hand, the negative values of θ shows the antiferromagnetic characteristic of materials due to opposite spin of electron, whereas a value of zero indicates paramagnetic material. Therefore, the 700 ºC condition shows ferromagnetic characteristic of calcined BFMO sample, but the 600 ºC and 800 ºC conditions demonstrated the antiferromagnetic characteristic. The magnetic susceptibility (χ) and magnetic field (H=30 kOe) was measured over 50 K to 350 K. Conditions which exhibited the ferromagnetic behaviour show magnetic susceptibility values over 10^{-6}, which is determined from a calculated formula M/H. However, χ can be shown versus magnetic field or temperature, but in this case it can be inhibited to apply 50 K to 350 K. In theory, the calculated magnetic moment of high spin Fe^{3+} and low spin Fe^{3+} are 5.92 μ_B and 1.73 μ_B respectively. As a result, the effective magnetic moment was μ_{eff}~11.812 μ_B, μ_{eff}~12.615 μ_B and μ_{eff}~49.893 μ_B for 600 ºC, 700 ºC and 800 ºC calcine temperature, respectively. The different values of the theoretical and the experimental effective magnetic moment (μ_{eff}) indicate that all the magnetic ions are in the high spin configuration and increase with elevated calcine temperature. Figure 3(d) presents the temperature dependent of magnetization (M-T) curves of the calcine at temperature 600 ºC, 700 ºC and 800 ºC, respectively. The higher 800 ºC calcine temperature shows the magnetization at 2.523 emu/g more than the lower calcine temperature at 0.125 emu/g at 50 K. As

the applied temperature increased towards 350 K, M decreased for all conditions. However, the magnitude of the fall increased with calcine temperature.

IV. CONCLUSION

Magnetic properties of powder Ba_2FeMoO_6 ceramics are influenced by the calcining temperature. BFMO calcined at the highest temperature of 800 ºC for 2 hours exhibited the largest hysteresis loop at 50 K. However, for all conditions, if the applied temperature increased, the hysteresis loop and also magnetic susceptibility decreases. In addition, the values of Ms and Mr indicate ferromagnetic behaviour in the calcined BFMO ceramic. Finally, the value of magnetization was reduced by using a lower calcining temperature.

ACKNOWLEDGEMENT

The authors thank the Advanced Materials Physics Laboratory (Amp.), School of Physics, Institute of Science, Suranaree University of Technology, Nakhon Ratchasima and the division of Science, Faculty of Science and Technology, Rajamangala University of Technology Phra Nakhon (RMUTP).

REFERENCES

[1] C. L. Yuan, S. G. Wang, W. H. Song, T. Yu, J. M. Dai, S. L. Ye, and Y. P. Sun, "Enhanced intergrain tunnelling magnetoresistance in double perovskite Sr_2FeMoO_6 polycrystals with nanometer-scale particles," *Appl.Phys.Lett*, vol. 75, no. 24, pp. 3853–3855, 1999.

[2] Y. Tomioka, T. Okuda, Y. Okimoto, R. Kumai and K. Kobayashi, "Magnetic and electronic properties of a single crystal of ordered double perovskite Sr_2FeMoO_6," *Phys. Rev. B*, vol. 61, pp. 422–427, 2000.

[3] C.Yang and T. Fang, "Structures and development mechanism of the anti-phase boundaries in Sr_2FeMoO_6," *J. Electrochem.Soc*, vol. 159, no. 3, pp. 35–39, 2012.

[4] Ll. Balcells, J. Navarro, M. Bibes, A. Roig, B. Martínez, and J. Fontcuberta, "Cationic ordering control of magnetization in Sr_2FeMoO_6 double perovskite," *Appl. Phys. Lett*, vol. 78, pp. 781–783, 2001.

[5] P. Zhao, R. Yu, F. Li, Z. Liu, M. Jin and C. Jin, "Structural stability and electrical properties of Sr_2FeMoO_6 under high pressure," *J.Appl. Phys*, vol. 92, pp. 1942–1944, 2002.

[6] X. Lia, Y. Suna, W. Lua, R. Anga, S. Zhanga, X. Zhua, W. Songa and J. Daia, "Size dependence of electronic and magnetic properties of double perovskite Sr_2FeMoO_6," *Solid State Communications*, vol. 145, pp. 98–102, 2008.

[7] D. Yang, T. Yang, Q. Sun, Y. Chen and G. Lampronti, "The annealing effects on the crystal structure, magnetism and microstructure of the ferromagnetic double perovskite Sr_2FeMoO_6 synthesized via spark plasma sintering," *Journal of Alloys and Compound*, vol. 728, pp. 1-11, 2017.

[8] K. Kobayashi, T. Kimura, H. Sawada, K. Terakura and Y. Tokura, "Room-temperature magnetoresistance in an oxide material with an ordered double-perovskite structure," *Nature*, vol. 395, pp. 677–680, 1998.

[9] H. Wu, Y. Qian, E. Kan, R. Lu, Y. Liu, W. Tan, C. Xiao, and K. Deng, "The effect of biaxial mechanical strain on the physical properties of double perovskite Sr_2FeMoO_6: A theoretical study," *Solid State Communications*, vol. 191, pp. 70-75, 2014.

[10] M. Cernean, F. Vasiliu, C. Bartha, C. Plapcianu and I. Mercioniu, "Characterization of ferromagnetic double perovskite Sr_2FeMoO_6 prepared by various methods," *Ceramics International*, vol. 40, no. A8, pp. 11601-11609, 2014.

[11] M. Cernea, F. Vasiliu, C. Plapcianu, C. Bartha, I. Mercioniu, I. Pasuk, R. Lowndes, R. Trusca, G.V. Aldica, L. Pintilie, "Preparation by sol–gel and solid state reaction methods and properties investigation of double perovskite Sr_2FeMoO_6," *Journal of the European ceramics society*, vol. 33, pp. 2483-2490, 2013.

[12] H. Sakuma, T. Taniyama, Y. Kitamoto and Y. Yamazaki, "Cation order and magnetic properties of double perovskite Sr_2FeMoO_6," *Journal of applied physics*, vol. 93, pp. 2816-2819, 2003.

[13] S. Theeranum, N. Chathirat, M. Chivalrat and Y. Teerapon, "Synthesis, characterization, and dielectric properties of Y_2NiMnO_6 ceramics prepared by a simple thermal decomposition route," *J Mater Sci: Mater Electron*, vol. 25, pp. 1361-1368, 2014.

[14] P. Deeyai, T. Sareein, B. Putasaeng, N. Chathirat, "Dielectric properties of Y_2NiMnO_6 ceramics at various sintering times and temperatures," *AMM*, vol. 804, pp. 16-20, 2015.

[15] T. Sareein, P. Deeyai, B. Putasaeng, N. Chathirat, "The Dielectric property of Y_2NiMnO_6 ceramics sintered at high temperature," *AMM*, vol. 804, pp. 108-112, 2015.

[16] T. Sareein, P. Deeyai, B. Putasaeng, N. Chathirat, "Electrical properties of Y_2NiMnO_6 ceramics sintered at high temperature," *AMM*, vol. 804, pp. 55-58, 2015.

Properties of transparent YSZ ceramics manufactured from nanopowders by spark plasma sintering

Oleg L. Khasanov*, Edgar S. Dvilis, Vladimir D. Paygin, Damir T. Valiev
National Research Tomsk Polytechnic University, TPU Nano-Centre, Tomsk, Russia, dvilis@tpu.ru
*E-Mail: khasanov@tpu.ru, (Phone and Fax: +7 3822 427242)

Abstract

Optically transparent ceramics with submicron grain sizes based on cubic yttrium-stabilized ZrO_2 has been sintered by the SPS technique in the temperature range of 1200–1400ºC with relatively low compacting pressure 100 MPa. The optimal processing modes have been determined to sinter ceramics having in-line transmittance up to 50% in the visible range and 70% in the IR range at the sample thickness about 1 mm, the submicron grain size and combination of the high elastoplastic properties: microhardness *HV of* 17 GPa; fracture toughness K_{1c} of 3 MPa.m$^{1/2}$; elastic modulus *E* of 170 GPa; creep strain at indentation C_{it} of 1,4%. An increase in sintering temperature from 1200ºC to 1300ºC leads to an increase in the average grain size from 307 to 529 nm, light transmission to 50%, and an improvement in the elastoplastic properties by 5–23%. A further increase in temperature reduces light transmission, degrades the elastoplastic properties, and increases the average grain size of YSZ ceramics. The relationship between optical and elastoplastic properties of studied ceramics is discussed using the equation which relates the optical density of sample with light wavelength and the sample thickness.

Keyword: yttrium-stabilized zircona (YSZ), transparent ceramics, spark plasma sintering (SPS), optical properties, elastoplastic properties

I. INTRODUCTION

Zirconium dioxide (ZrO_2) is widely used in various fields of science and technology. ZrO_2 have high mechanical and operational properties, such as increased hardness and toughness, low thermal conductivity, chemical inertness up to 2000°C. The Y_2O_3 as a dopants (from 8 mol.%) makes it possible to stabilize ZrO_2 in the high-temperature cubic modification and leads to the appearance of oxygen vacancies.

This improves ion conductivity and makes it possible to use yttrium-stabilized ZrO_2 as an electrolyte for solid-state fuel cells. The unique optical properties of ceramics based on cubic yttrium-stabilized ZrO_2 (YSZ), it is currently of great interest as a transparent material [1].

YSZ ceramics has a high refractive index (~2.2), which allows to significantly reduce chromatic aberrations. The transparency in a wide spectral range (from the near UV to the near IR region) makes it a promising material for optical applications [2].

The recent studies show that SPS technique is an effective method for producing high-dense transparent ceramics with submicron grain size [1, 3].

It was shown that optically transparent YSZ ceramics could be obtained using the SPS technique in various modes. The authors were succeeded in obtaining a transparent YSZ ceramics with following sintering parameters: a compacting pressure of 400 MPa, a temperature of 1100ºC [4, 5]. The value of the in-line transmission coefficient at a wavelength λ = 600 nm (T_{RIT}) was 42% with a thickness of about 1 mm.

In [6] a translucent YSZ ceramics was SPSed at the compacting pressure of 600 MPa and a temperature of 1000ºC with a transmittance of about 32% at λ = 600 nm and a samples thickness of 1 mm. It is reported in [7, 8] about sintering YSZ ceramics at a temperature of 1200 ºC and a significantly lower compacting pressure of 141 MPa with a light transmission coefficient of about 48% at λ = 600 nm and a thickness of about 0.85 mm. With a temperature of 1300ºC and a pressure of 100 MPa, YSZ ceramics was obtained with in-line transmission coefficient about 23% at λ = 600 nm and a thickness of 0.6 mm [9].

The elastoplastic properties of transparent YSZ ceramics as well as the influence of SPS processing parameters on them are practically not studied. An assessment only of elastoplastic properties of YSZ ceramics is given in literature. According to S. R. Casolco the critical stress intensity factor K_{IC} of transparent cubic ZrO_2stabilized by Y_2O_3 was 3 MPa•m$^{1/2}$.

The microhardness of YSZ ceramics, according to [6] is equal to 13.3 GPa, which is 3% less than the microhardness of the zirconia single-crystal. In [10] a comprehensive assessment of the mechanical and optical properties of YSZ ceramics was carried out, but without any information about processing modes.

Despite the relatively large number of publications devoted to ZrO_2-based transparent ceramics, there has been practically no research on its quantitative relationship between structural, optical, and elastoplastic properties.

In [11] it was proposed to use the approximation equation coefficients of the dependence of the optical density on the wavelength

as criteria for optimizing SPS processing parameters. This approach allows quantitatively characterize the optical transmittance spectra of YSZ ceramics and adequately compare them with elastoplastic characteristics and microstructure. In addition, it can be used for evaluation effect of certain SPS-consolidation parameters on the ceramics properties.

The aim of this study was to examine the relationship between optical and elastoplastic properties of transparent YSZ ceramics, their microstructure, as well as the effect of SPS sintering temperature on the ceramics properties.

II. METHODS

Experimental techniques

Commercially available powder of YSZ (TZ-10YS) from TOSOH Corp., Japan, was used for YSZ ceramics preparation. X-ray diffraction phase analysis (XRD) was performed by an XRD-7000S diffractometer (Shimadzu, Japan). Scanning electron microscopy (SEM) JSM-7500FA (JEOL, Japan) and SALD-7101 (Shimadzu, Japan) laser diffractometer were used for powder characterization.

The results showed that the nanopowder consists of particles with sizes from 50 to 184 nm and their agglomerates with sizes up to several tens of micrometers. The specific surface area of the nanopowder, measured by the BET method was 5.13 m^2/g. This value in the spherical approximation corresponds to an average particle diameter of 196 nm.

The X-ray phase analysis results confirmed that the powder consists entirely of cubic ZrO_2 without any impurities. Analysis of the reflection broadening of the experimental X-ray diffraction allowed to determine the average size of the coherent scattering regions around 172 nm. Impurities detected in the powder by the method of energy dispersive elemental analysis (EDS) are within the purity of the material declared by the manufacturer.

Transparent YSZ ceramic samples were consolidated by the spark plasma sintering installation SPS 515S (Syntex Inc., Japan) in vacuum at a residual pressure of not more than 10^{-3} Pa in the temperature range from 1200°C to 1400°C. SPS conditions were as follows: heating from room temperature to 1000°C was carried out at the heating rate of 10°C/min. The duration of isothermal heating was 10 min.

The compacting pressure of the powder in the graphite die was changed during the sintering process from 20 MPa to 100 MPa when approaching a given sintering temperature and reduced at the end of isothermal heating. The temperature during sintering process was controlled by a high-temperature pyrometer at the bottom of the technological hole located on the side surface of the graphite die.

Transparent cylindrical YSZ ceramic samples with a diameter of 14 mm and a thickness of 1.5 mm were obtained after SPS sintering process. The density of the ceramic samples was determined by hydrostatic weighing. The YSZ ceramics were annealed in air at 900°C for 4 h to restore the quantitative ratio between oxygen and zirconium and reduce the defects concentration associated with oxygen vacancies formed in the SPS process [4, 5].

Further studies of ceramics were carried out after mechanical polishing of its end surfaces on the EcoMet 300 Pro grinding and polishing system (Buehler, Germany) with MetaDi (Buehler, Germany) diamond suspensions. The morphology structure of YSZ ceramics surface cleavage was evaluated by SEM images using the ImageJ free software.

The microhardness HV , elastic modulus E of the YSZ ceramics were determined by the Vickers method according to a standard procedure using a ultramicrohardness tester DUH-211S (Shimadzu, Japan) with a load of 1.96 N. The fracture toughness K_{1c} was determined by the Vickers pyramid indentation using microhardness tester PMT-3M (LOMO, Russia) and it was calculated based on the measurement of radial crack lengths formed during indentation, performed by Niihara equation [12].

Optical absorption spectra of ceramics were measured with the spectrophotometers LOMO-Photonics SF-256 UVI and SF-256 BIK in the spectral range of 200–1100 nm and 1100–2500 nm, respectively.

The search for quantitative criteria for the ceramics optical quality was carried out by the analysis of the obtained light transmission spectra according to the equation (1) [11]. The equation relates the optical density of a sample D with its thickness h, light wavelength λ through constant coefficients:

$$\frac{D}{h} = \frac{1}{k.\ln\left(\frac{\lambda}{\lambda_i}\right) + h_{0.1}} \quad (1)$$

where k is characterized the intensity of D value decrease with increasing wavelength λ. Quantitatively coefficient k is equal to the sample thickness h on which the light flux with wavelength λ is e times more than the flux at UV edge of the transmission spectrum and attenuated by 10 times; $h_{0.1}$ is characterized the sample thickness h, on which light emission with a wavelength λ attenuated by 10 times. In this work λ = 600 nm.

The maximum values of the coefficients k and $h_{0.1}$ are characterized ceramics samples with the best optical properties. The product of both coefficients $k \cdot h_{0.1}$ is a complex parameter of the optical quality and allows us to quantitatively characterize the light transmission spectrum of YSZ ceramics [11].

III. RESULTS AND DISCUSSION

Optical properties

The light transmission spectra in the spectral range from 250 to 1100 nm of the YSZ ceramics are shown in Fig. 1.

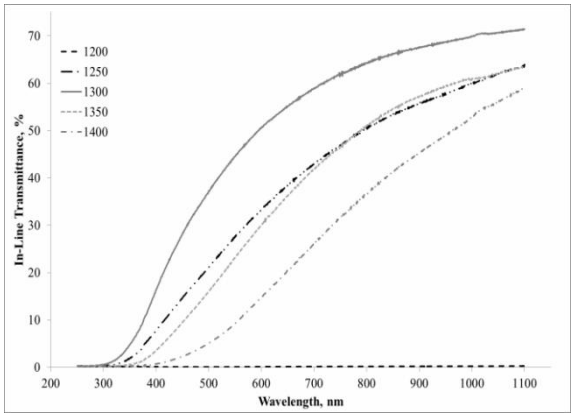


Fig. 1 In-line transmittance spectra of YSZ-ceramic samples sintered at different temperature

The transparency of YSZ ceramics is up to 10% in the UV spectral region. The light transmission coefficient of YSZ ceramics at λ = 600 nm was 50.6%, which is 2% higher than that of similar composition ceramics obtained using SPS technique by other authors [4–9]. The UV transmission edge of YSZ ceramics is 350 nm. On the basis of the transmission spectra the constant coefficients of equation (1) were determined.

The values of coefficients in Eq. (1) are presented in Table 1. It is known that the sintering temperature significantly affects the optical properties of YSZ ceramics [4 – 9]. In our experiments, the maximum transmittance of 50.6% at the highest value of the complex parameter of the optical quality $k \bullet h_{0.1}$ was 3.13 mm^2 is observed at 1300ºC. However a deviation from this optimum in any direction leads to a significant decrease in the transmittance and deterioration optical quality of YSZ ceramics.

The almost complete lack of transparency has been observed for YSZ ceramics sintered at 1200ºC. It can be explained by the high residual porosity ~5.4%, which has a critical effect on the light transmission coefficient [13]. Thus, increasing the transparency of YSZ ceramics is possible by optimizing the processing modes of SPS.

Table 1 Relative density ρ_{rel} and optical quality parameters of ZrO_2-based ceramics SPSed at various temperatures

T, °C	ρ_{rel}, %	T_{RIT}, % (λ = 600 nm)	k, mm	$h_{0,1}$, mm	$k \bullet h_{0,1}$, mm^2
1200	94.62	0.09	0.01	0.15	0.01
1250	98.92	33.36	1.48	1.02	1.51
1300	**99.80**	**50.67**	**2.11**	**1.48**	**3.13**
1350	98.99	30.03	1.70	1.08	1.84
1400	99.24	14.78	0.96	0.57	0.55

Microstructure

The analysis of then YSZ ceramics microstructure according to the SEM results revealed a predominantly transcrystalline character of the ceramics fracture (Fig. 2, *a, b, c, d, e*). This effect indicates a high strength of grain boundaries.

The sintering process does not seem to be fully completed at relatively low for SPS process heating rates and temperature of 1200 ºC (Fig. 2, *a*). Therefore the grain sizes remain at the level of the initial sizes of the powder agglomerates and the ceramics samples have a low density (Table. 1).

The ceramics consolidation occurs more intensively at 1250ºC and 1300ºC. The grain growth is somewhat accelerated, but not going beyond the submicron range (Fig. 2, *b, c*).

The consolidation of YSZ ceramics at 1350ºC (Fig. 2, *d*) is limited by the processes of intensive grain growth and local recrystallization.

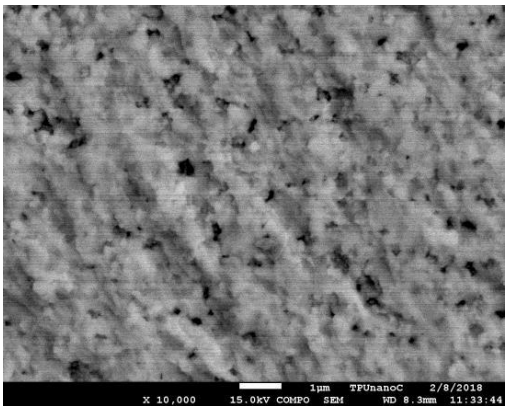
The intensity of recrystallization increases at 1400ºC. The significant grain growth occurs without further densification (Fig. 2, *e*).

Thus, the SPS temperature significantly affects the grain size of YSZ ceramics, which is consistent with previously obtained results [9, 14].

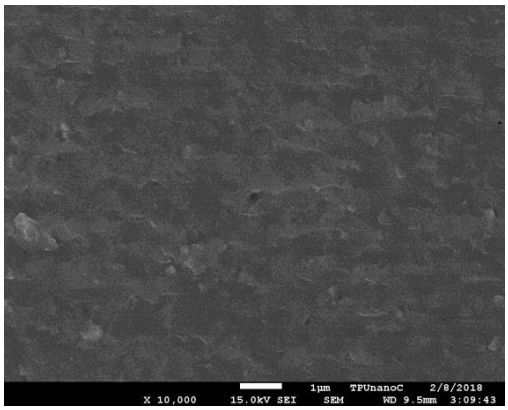
The most complete and uniform consolidation of YSZ ceramics with preservation of submicron average grain size <*D*> = 530 nm was observed at 1300ºC (Fig. 3, *a*).

An increase in the SPS temperature from 1200ºC to 1400ºC leads to an increase in the average grain size <*D*> from 307 nm to 1.766 μm. The growth of grains occurs according to the exponential rule with the approximation accuracy of 96.2% (Fig. 3, *a*). This nature of the <*D*> change can be explained as follows.

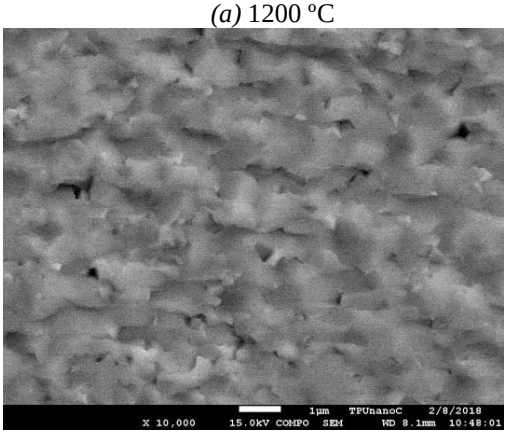
It can be concluded that SPS process at relatively low pressures ~100 MPa and temperature 1300ºC provides transparent ceramics having submicron grains and high optical quality $k \bullet h_{0.1}$ = 3.13 mm^2. The dependence of $k \bullet h_{0.1}$ vs <*D*> *(*Fig. 3,*b)* is extreme in nature with a maximum in the middle of the submicron range of grain sizes in the 530 nm spectral range. The optical quality parameter of ceramics decreases with following increasing <*D*>.



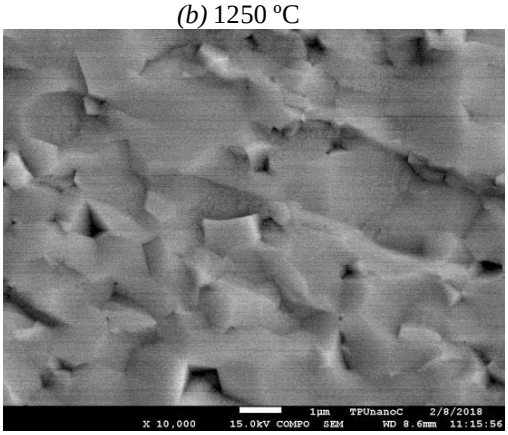
(a) 1200 ºC



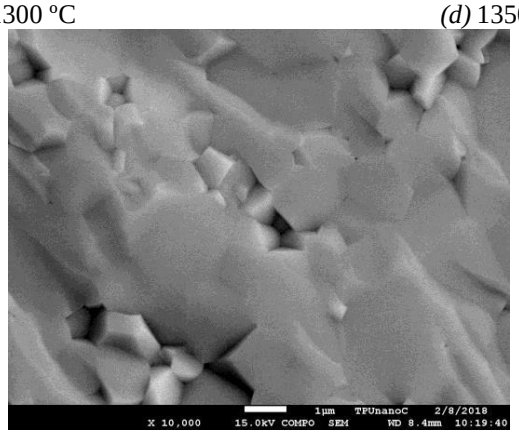
(b) 1250 ºC



(c) 1300 ºC

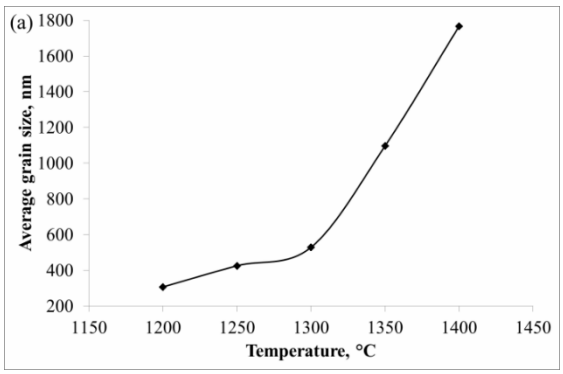


(d) 1350 ºC

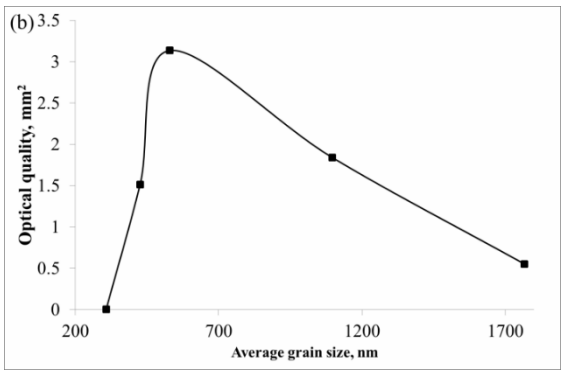


(e) 1400 ºC

Fig. 2 SEM-Images of YSZ-ceramics samples sintered at various temperatures *(a, b, c, d, e)*



(a)

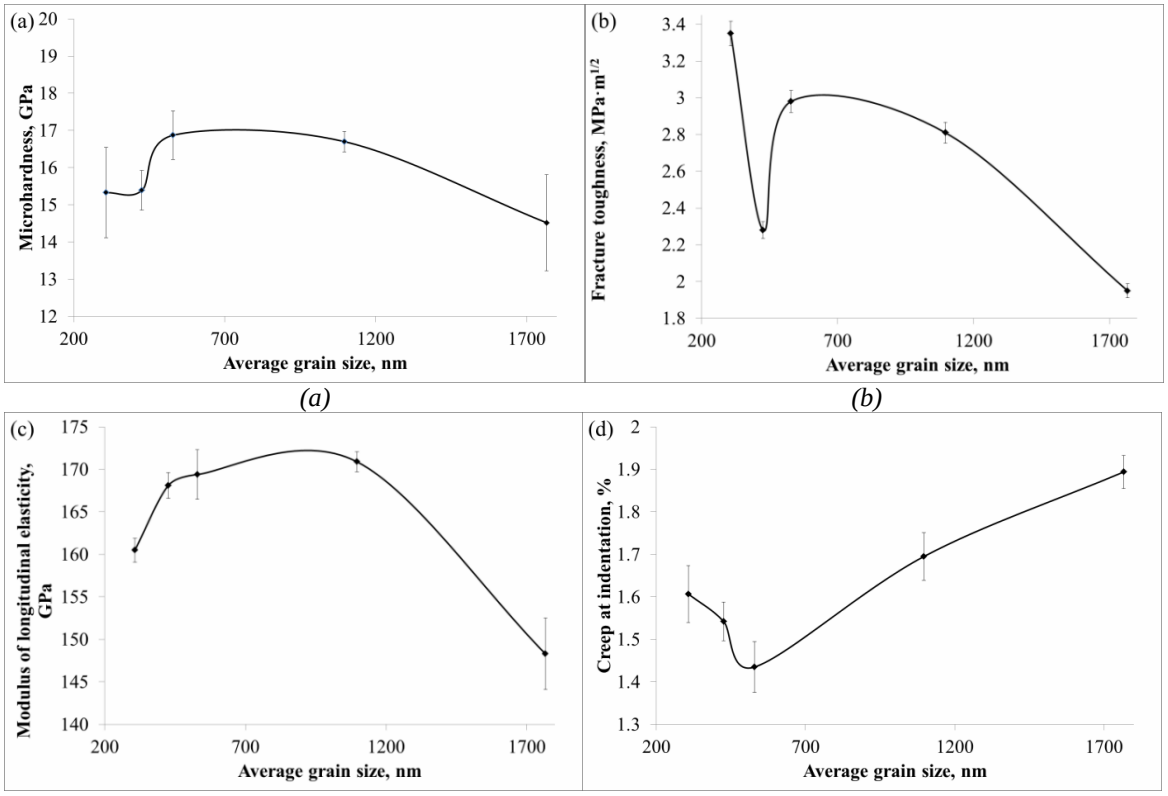


(b)

Fig. 3 Average grain size <*D*> of YSZ ceramics vs SPS temperature *(a)*; the complex parameter of the optical quality $k \cdot h_{0.1}$ of YSZ ceramics vs <*D*> *(b)*

Table 2 Elastoplastic properties of various YSZ ceramics

Reference	*T*, °C	*HV*, GPa	K_{1c}, MPa•m$^{1/2}$	*E*, GPa	C_{it}, %
The present work	1200	15.32±1.21	3.35±0.06	160.5±1.4	1.61±0.1
	1250	15.39±0.53	2.28±0.04	168.1±1.5	1.54±0.16
	1300	**16.87±0.65**	**2.98±0.06**	**169.4±2.9**	**1.43±0.22**
	1350	16.70±0.28	2.81±0.06	170.9±1.2	1.69±0.29
	1400	14.52±1.29	1.95±0.04	148.3±4.2	1.89±0.22
[15]	--	11.8	1.8	200	--
SPS [6]	1000	13.2	--	--	--
SPS [14]	1300	12.6—13.6	1.3—1.5	--	
Single crystal [16]	--	15.6	2.01	--	--
HIP [17]	1300	15.0	1.47	218	--
SPS [8]	1200	--	3	--	--



(a) *(b)* *(c)* *(d)*

Fig. 4 Elastoplastic properties of YSZ ceramics vs <*D*>: microhardness *HV (a)*, fracture toughness K_{1c} *(b)*, modulus of longitudinal elasticity *E (c)*, creep strain at indentation C_{it} *(d)*

The elastoplastic properties

The results of study of the elastoplastic properties of YSZ ceramics according to various literature data are given in Table. 2.

The *HV* and K_{1c} of YSZ ceramics obtained under optimal conditions, turned out to be higher. The value of the elastic modulus *E* when pressed in is somewhat lower than that of a similar material based on YSZ with cubic structure [6, 14, 15]. The microhardness of YSZ ceramics is comparable to the microhardness of a single crystal of cubic ZrO_2 with higher K_{1c} value [16]. The YSZ ceramics creep strain at constant indentation load C_{it} was 1.43– 1.89%.

The dependence of the elastoplastic properties of YSZ ceramics samples on <*D*> is shown in Fig. 4. The curves are non-monotonic, and the better elastoplastic properties were observed at <*D*> around 530 nm.

The elastoplastic properties deteriorate with a further increasing <*D*> from 530 nm to 1.76 μm: *HV* decreases from 17.47 to 14.52 GPa, K_{1c} decreases from 2.98 to 1.95 MPa•m$^{1/2}$, elastic modulus *E* decreases from 169.4 to 148.3 GPa, and C_{it} increases from 1.43 to 1.89%.

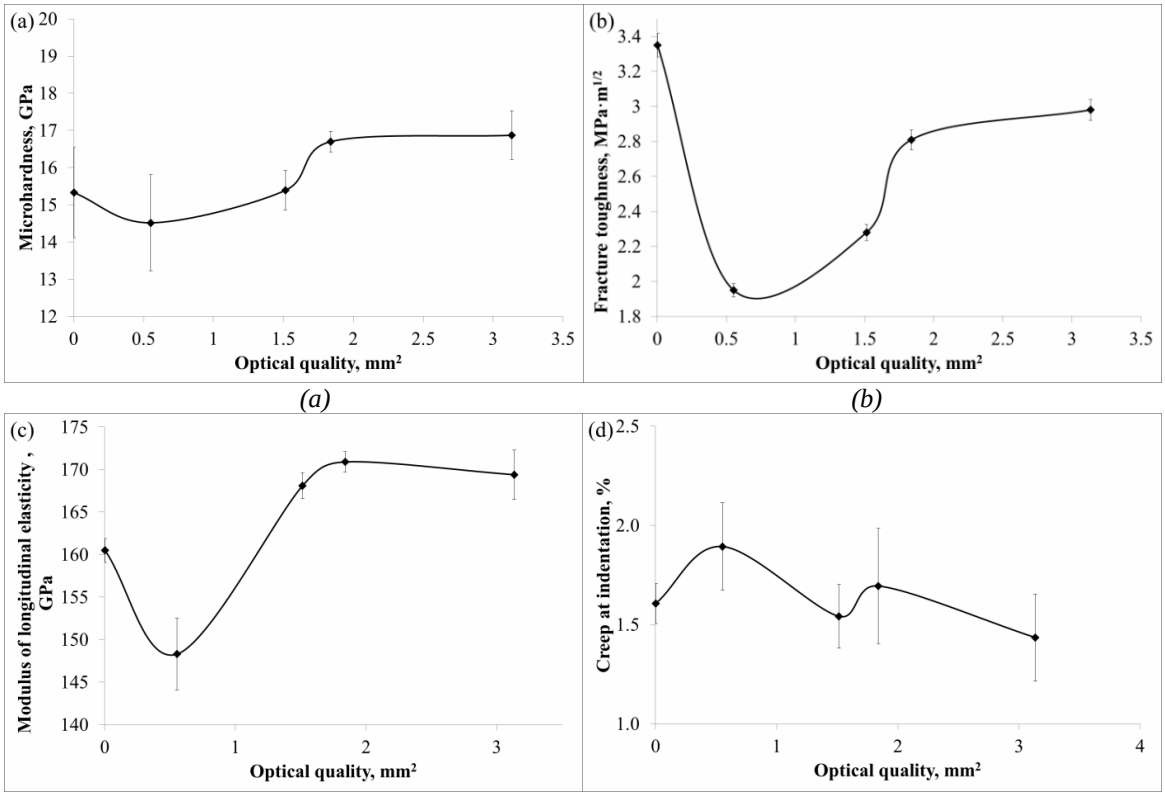
It should be noted that there are no significant differences in the elastoplastic behavior of samples

with <D> from 307 to 1096 nm.

The relationship between optical and elastoplastic properties was investigated using the complex parameter of the optical quality $k \bullet h_{0.1}$ (Fig. 5). There is no significant increase in the *HV* of YSZ ceramics with an increase in the optical quality parameter. The changes do not exceed the limits of the confidence interval for determining these quantities. However, it was shown the tendency to increase in *HV* with increasing the optical quality, i.e. light transmission (Fig. 5, *a*).

The highest value of K_{1c} corresponds to the minimum value of $k \bullet h_{0.1}$ parameter (Fig. 5, *b*). It can be associated with a relatively high content of pores, which stop the growth of cracks, overestimating the K_{1c} parameter values. The general trend is that with an increase in the optical quality of YSZ ceramics, an increase in K_{1c} occurs, as well as an increase in *E* (Fig. 5, *c*)

A change in C_{it} with an increasing the optical quality does not exceed the confidence interval for determining C_{it} value (Fig. 5, *d*).



(a) *(b)* *(c)* *(d)*

Fig. 5 Elastoplastic properties of YSZ ceramics vs the complex parameter of the optical quality $k \bullet h_{0.1}$: microhardness *HV (a)*, fracture toughness K_{1c} *(b)*, elastic modulus *E (c)*, creep strain at indentation C_{it} *(d)*

IV. CONCLUSION

The optimal SPS processing modes have been determined to sinter optically transparent YSZ ceramics having in-line transmittance T_{RIT} up to 50% in the visible range and 70% in the IR range at the thickness $h \sim 1$ mm, the submicron grain size and combination of the high elastoplastic properties (*HV* = 17 GPa; K_{1c} = 3 MPa•m$^{1/2}$; *E* = 170 GPa; C_{it} = 1,4%).

The better ceramic samples were sintered at relatively low compacting pressure (100 MPa), sintering temperature 1300ºC, exposure 10 min, and heating rates of 10 ºC /min. These samples showed a higher in-line transmittance than transparent YSZ ceramics previously obtained using SPS method, but at the higher compacting pressure [4-6].

The effect of SPS temperature at a relatively low compacting pressure on the microstructure, optical and elastoplastic properties of YSZ ceramics was investigated. An increase in sintering temperature from 1200ºC to 1300ºC leads to an increase in the average grain size from 307 to 529 nm, light transmission to 50.67%, and an improvement in the elastoplastic properties by 5–23%. A further increase in temperature reduces light transmission, degrades the elastoplastic properties, and increases the average grain size of YSZ ceramics.

ACKNOWLEDGEMENT

The work is supported by a project of the Russian Science Foundation #17-13-01233. The authors are grateful to Dr. E. Polisadova, PhD S. Stepanov for useful discussions.

The study was performed using equipment of

the Nano-Centre of the National Research Tomsk Polytechnic University.

REFERENCES

[1] S. F. Wang, et al., "Transparent ceramics: processing, materials and applications," *Prog. Solid State Chem.*, vol. 41. pp. 34-39, 2013.

[2] U. Peuchert, Y. Okano, Y. Menke, et al., "Transparent cubic-ZrO_2 ceramics for application as optical lenses," *J. Eur. Ceram. Soc.*, vol. 29, pp. 283-291, 2009.

[3] A. A. Kachaev, D. V. Grashchenkov, Yu. E. Lebedeva, S. St. Solntsev, O. L. Khasanov, "Optically transparent ceramic (review)," *Glass and Ceramics*, vol. 73, pp.117-123, 2016.

[4] H. B. Zhang, B. N. Kim, K. Morita, et al., "Optimization of high-pressure sintering of transparent zirconia with nano-sized grains," *J. Alloys Compd.*, vol. 508, pp. 196-199, 2010.

[5] H. B. Zhang, B. N. Kim, K. Morita, et al., "Effect of sintering temperature on optical properties and microstructure of translucent zirconia prepared by high pressure spark plasma sintering," *Sci. Technol. Adv. Mater.*, vol. 12, pp. 1-6, 2011.

[6] U. Anselmi-Tamburini, J. N. Woolman, Z. A. Munir, "Transparent nanometric cubic and tetragonal zirconia obtained by high-pressure pulsed electric current sintering," *Adv. Funct. Mater.*, vol. 17, pp. 3267-3273, 2007.

[7] J. E. Alaniz, F. G. Perez-Gutierrez, G. Aguilar, J. E. Garay, "Optical properties of transparent nanocrystallineyttria stabilized zirconia," *Optical Mater.*, vol. 32, pp. 62-68, 2009.

[8] S. R. Casolco, J. Xu, J. E. Garay, "Transparent/translucent polycrystalline nanostructured yttria stabilized zirconia with varying colors," *Scripta Mater.*, vol. 58, pp. 516-519, 2008.

[9] L. W. Lei, Z. Y. Fu, H. Wang, et al., "Transparent yttria stabilized zirconia from glycine-nitrate process by spark plasma sintering," *Ceram. Int.*, vol. 38, pp. 23-28, 2012.

[10] H. Nagayama, M. Kudoh, N. Shinozaki, et al., "Development of colored zirconia ceramics," *TOSOH Research & Technology Review*, vol. 53, pp. 53-56, 2009.

[11] O. L. Khasanov, E. S. Dvilis, Z. G. Bikbaeva, V.D. Paygin, A.O. Khasanov, "Relationship of optical properties and elastoplastic characteristics of transparent spark plasma sintered YSZ ceramics," *J. Ceram. Sci. Technol.*, vol. 8, pp. 161-168, 2017.

[12] K. Niihara, R. Morena, D. P. H. Hasselman, "Evaluation of *KIc* of brittle solids by the indentation method with low crack-to-indent ratios," *J. Mater. Sci. Lett.*, vol. 1, pp. 13-16, 1982.

[13] A. Krell, J. Klimke, T. Hutzler, "Transparent compact ceramics: Inherent physical issues," *Opt. Mater.*, vol. 31, pp. 1144-1150, 2009.

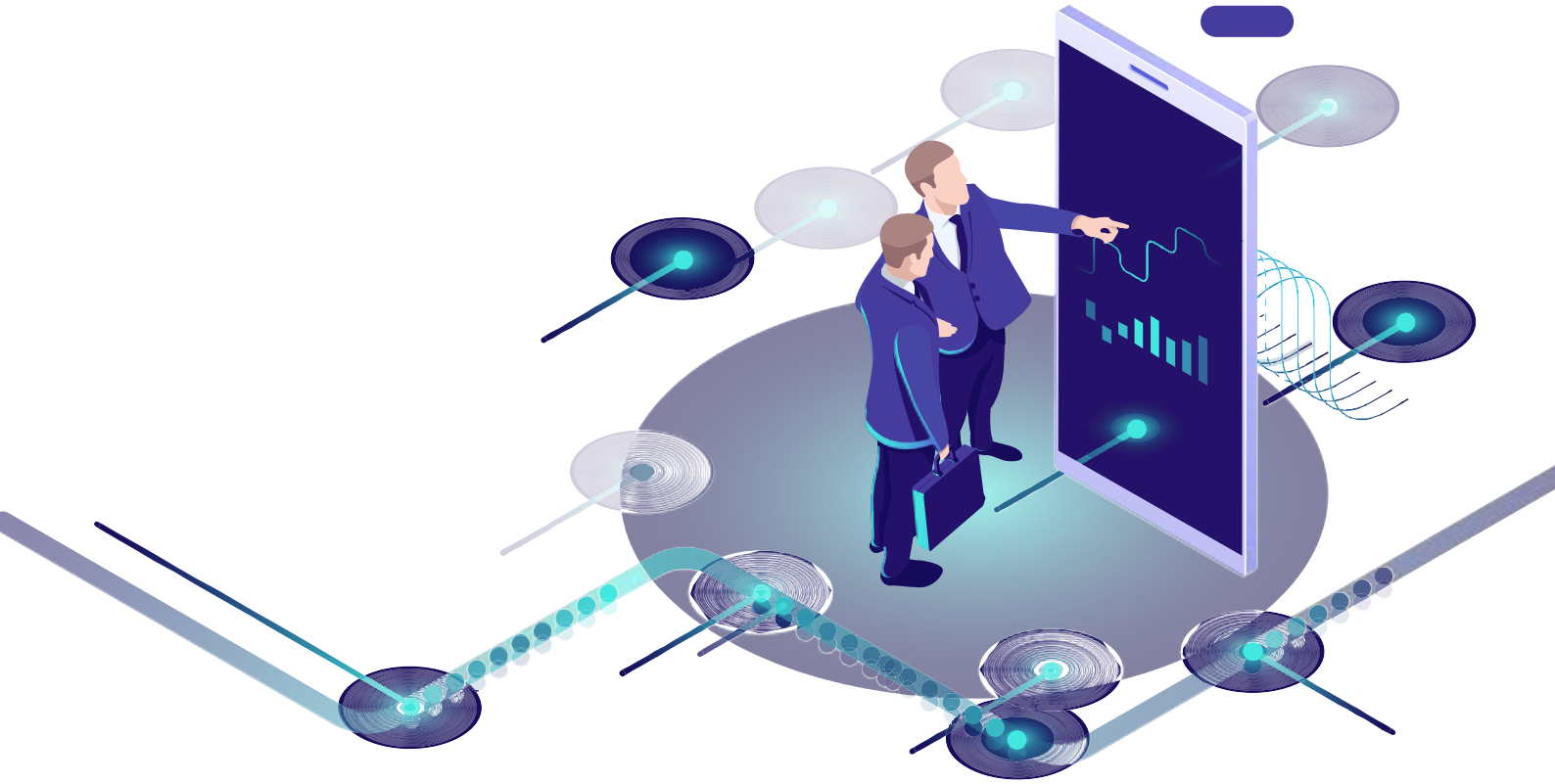
[14] P. Dahl, I. Kaus, M. Johnsson, et al., "Densification and properties of zirconia prepared by three different sintering techniques," *Ceram. Int.*, vol. 33, pp. 1603-1610, 2007.

[15] I. Yamashita, M. Kudo, K. Tsukuma, "Development of highly transparent zirconia ceramics," *TOSOH Research & Technology Review*, vol. 53, pp. 11-16, 2009.

[16] G. A. Gogotsi, S. N. Dub, E. E. Lomonova, B. I. Ozersky, "Vickers and Knoop indentation behavior of cubic and partially stabilized zirconia crystals," *J. Eur. Ceram. Soc.*, vol. 15, pp. 405-413, 1995.

[17] L. Donzel, S. G. Roberts, "Microstructure and mechanical properties of cubic zirconia (8YSZ)/SiC nanocomposites," *J. Eur. Ceram. Soc.*, vol. 20, pp. 2457- 2462, 2000.

HUMANITY AND SOCIAL SCIENCES



Highly Cultural Caring

Tomoko Ota[1], Xiaodan LU[1*], Naoki Sugiyama[2], Hiroyuki Hamada[2] and Noriyuki Kida[2]
[1]Chuo Business Group, 1-6-6 Hunakoshicho, Chuo-ku, Osaka 540-0036, Japan
[2]Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606-8585, Japan
[*]E-Mail: promotl@gold.ocn.ne.jp (Phone: +81 06 6943 4412)

Abstract

High quality nursing teaching material series" is a teaching material that compares the movements of caregivers with high experience from a scientific point of view and movements of low caregivers, and analyzes the difference clearly using animation and numerical data. "High-grade" is a word that indicates "high quality", for example, traditional industrial crafts that are loved by people for a long time can be called "high-grade products". We have developed this teaching material aiming at nursing care that the residents always will be pleased at the nursing care site where training of human resources is always required. Stable nursing care techniques can give residents a sense of security and comfort. At the same time, it aims to solve the problem of separation of caregivers by reducing the burden on the caregiver's body. That is, both the caregiver and the care receiver can feel joy.

"High quality nursing care teaching material series" express skilled caregivers with high experience and expert inferior caregivers as unskilled persons, using videos recorded from the front, top, and side three directions, skillful the "skill of the artist" of the person is explained. In addition to images, it is the first time in the industry to measure motion of a caregiver in the range of 360 degrees, and it expresses the distance between the caregiver and the care receiver, the angle of the body, and so on by numerical values for the first time in the industry. By comparing the motions of experts and non-experts with animation and data, you can clearly understand the characteristics of both movements and lead to improvement in nursing care skills.

Because the lecturer teaching materials have a polite commentary, you can learn more about the features and advantages of movement. The curriculum is structured to allow group discussions, and it is also possible to take advantage of the originality of each care facility.

Keyword: High quality nursing, teaching material series, measurement caregiver motion

I. INTRODUCTION

In recent years, among the countries of the world, Japan has the highest percentage of elderly people [1]. The 2017 edition of Annual Report on the Aging Society explain that the percentage of elderly people in Japan (over 65) is over 21%. The percentage of elderly people is projected to increase to 38.1% in 2060 [2]. Therefore, workers who provide care services (hereinafter called "caregiver") are required. However, according to the survey of nursing care work in 2017, the sense of shortage of workers providing nursing care services is 66.6%, and there is also a problem short of caregiver. Furthermore, nursing care is arbitrary, without a manual.

In this study, we analyzed the behavior of expert caregiver. In addition, "High quality nursing teaching material series" was developed based on the analysis data.

II. TEACHING MATERIAL SERIES

Situations in teaching material series are "Posture change", "Housing/lying behaviors", "Transfer", and "Bed makeup/bedclothes change". Fig. 1, 2 shows the poster of "High quality nursing care teaching material series".

Posture change

Posture change means changing and maintaining the orientation and posture of the body for those whose caregivers can not change their position on their own [3]. Pulmonary complications and pressure ulcers are prevented by proper dealing. Therefore, Posture change is important in home care and facility care. Vol.1 explains four kinds of situation: Horizontal Movement (From the middle of the bed to the edge), Horizontal Movement (toward the Upper Direction), from supine to lateral, and from lateral to supine.

Housing / lying behaviors

When putting a bedridden care receiver out of bed, the caregiver must do care keeping secure. Vol. 2 explains care motion from the bed to standing motion.

Transfer

Transfer assistance in care is important motion that is required in various situations and places a heavy burden on caregivers. Thus, we experimented assuming four situations used for home care and facility care. Among teaching material series, Vol.3 explains care motion from bed to wheelchair, from wheelchair to bed.Vol.4 explains care motion by slide board from bed to wheelchair, from wheelchair to bed. And Vol.5 explains care

motion from bed to portable toilet, from portable toilet to bed.

Bed makeup / bedclothes change

The bed to go to bed is very important for the care receiver. When adjusting bed or changing bedding, appropriate measures should be taken to avoid burdening the care receiver. Bonus video explains the basis adjustment of bed for care receiver.

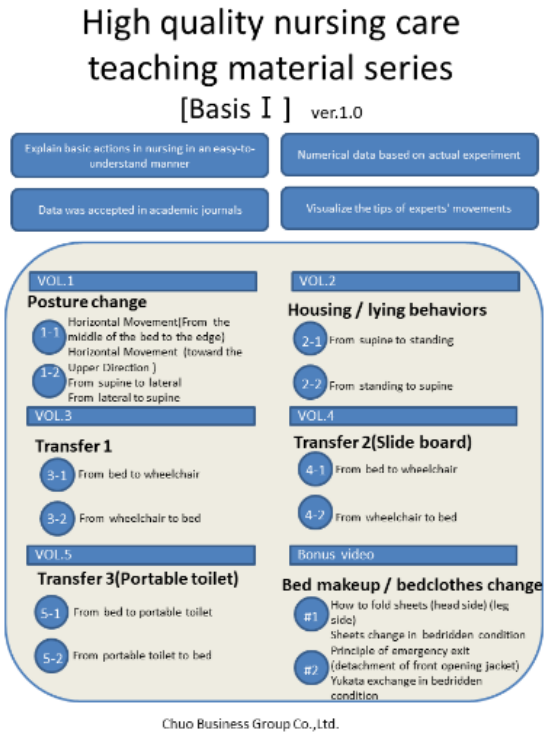


Fig. 1 The poster of "High quality nursing care teaching material series"_1

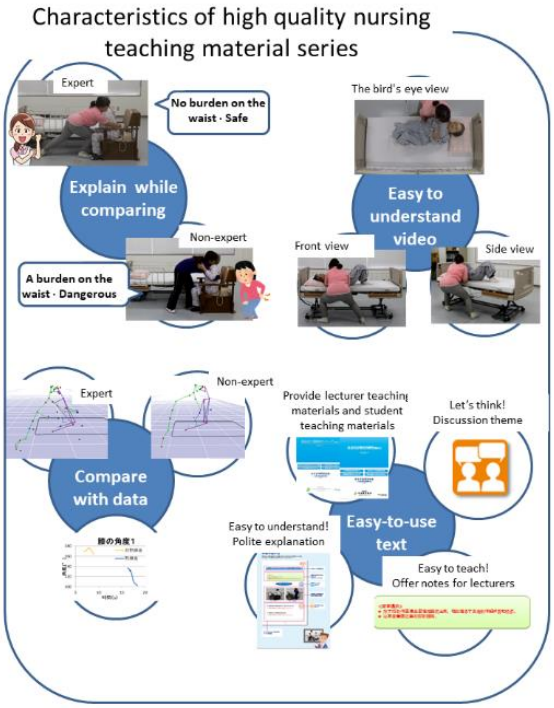


Fig. 2 The poster of "High quality nursing care teaching material series" _2

III. CONCLUSION

In this paper, we have described the contents of "High quality nursing care teaching material series". "High quality nursing care teaching material series" explains the features and benefits of the caregiver in an easy-to-understand manner. In addition, we propose that it is possible to use suitable for each care facility by having a discussion based on the teaching materials.

REFERENCES

[1] The United Nations, (2019, Feb 05). *World Population Prospects* [Online]. Available: https://esa.un.org/unpd/wpp/publications/files/wpp2017_keyfindings.pdf

[2] Government of Japan, (2019, Feb 08). *Annual Report on the Aging Society* [Online], https://www8.cao.go.jp/kourei/whitepaper/w-2017/gaiyou/pdf/1s1s.pdf

[3] Kyoto Institute of Technology Future-Applied Conventional Technology Center, "Takumi no Waza no Kagaku Dousahen," *The Nikkan Kogyo Shimbun*, 2017, pp. 151.

Formulation of Key-factors for the Development Model of Appropriate Technology (AT) in the Context of Environmental Technology based on Literature Reviews

Fritz A. Nuzir[1*], Shiko Hayashi[1], and Koji Takakura[2]
[1]Institute for Global Environmental Strategies, Kitakyushu, Japan, nuzir@iges.or.jp
[2]Takakura Environmental Research Institute, Kitakyushu, Japan, takakura.en.re.in@gmail.com
[*]E-Mail: nuzir@iges.or.jp

Abstract

Introduced by Schumacher back in the 60s and 70s, the term of "Appropriate Technology (AT)" refers to all kind of technologies including environmental technology. It has been since developed into a global discourse on technology advancement and its impacts of implementation on human civilisation as seen from various perspectives. This study aims to formulate a development model for a sustainable implementation of an AT focusing on environmental technologies. This study examined relevant references and extracted the most important socio-economic and cultural key-factors of AT such as: financial mechanisms and cost affordability; technological adaptability and independence; social and cultural acceptability; local needs, demands, and resources; community participation and involvement; commitment from local government; environment consciousness; and continuity and long-term impact. Finally authors concluded that the key-factors provided important measures to capture and assess the development processes of the AT implementation. These key-factors also serve as main components for the basic development model. However in order to actually implement the model, the linkage and hierarchy between the components need to be introduced to set up a structure for the model.

Keyword: environment; Appropriate Technology; key-factors; development model; sustainable

I. INTRODUCTION

In the early stages of global civilisation, technology was highly considered as one of the main contributors of urban-rural development. In the beginning of its introduction, the implementation of technology innovation or advancement was commonly acknowledged as one of the main drivers of any kind of life-changing transformation resulting from development activities whether from a social, cultural, or economical perspective.

However it takes several centuries for humanity to realise that not all technologies could be appropriately implemented to generate or support the development under all conditions. Conversely, not every context whether it is a city or a country could appropriately provide the opportunity to access or to implement the technology itself. Furthermore, not all technology could offer the same positive impact, yet negative impacts instead, for each different condition and context, whether this is, for example in developed or developing countries, or in the context of urban, rural, regional, or national setting.

As a result, a number of multidisciplinary studies has set their primary objectives to define what appropriate technology actually is. Many parameters and criteria have been discussed, however only very few studies have identified and reflected on the most important feature of a technology which is its endless ability to be transformed and developed towards its implementation in contextual and sequential manner within a development process. Based on this feature, we would elaborate on a hypothesis that a technology would ultimately require a development model in order to be implemented in a sustainable way. Therefore the main purpose of this study is to analyse the cross-sectoral concepts and perspectives of the appropriate technology itself and to provide a base for formulation of a development model for the implementation of appropriate technology in the context of environmental technology. Formulation of a comprehensive development model that is able to be replicated and modified on different contexts and conditions would be the novelty of this approach.

II. PREVIOUS STUDIES

Global Discourse on Appropriate Technology

The basic thinking of "Appropriate Technology (AT)" was initially introduced by E.F. Schumacher back in the 60s and 70s, and has been widely discussed since then [1]. The concept of AT was broadly introduced, covering both the hard element and physical appearance of technology as well as the soft element and non-physical factors such as transfer of knowledge, communication skills, capacity building and others [2].

By this understanding, the technology itself could be interpreted as one that is high-tech, futuristic, and involves larger capital investment. However, it could also relate to basic, fundamental yet innovative technology. Currently the term AT is also used to refer to all kind of technologies including environmental technology. Furthermore, the concept of AT was developed in the context of the global discourse on the appropriateness and impact of implementing technological advancement for human civilisation as seen from various perspectives.

Many studies have already discussed the definition, implementation, development, and evaluation of AT from different backgrounds and perspectives as well as within various settings and contexts. For example, based on a case study in Kampong Sodana, Indonesia, Putri and Wardiha (2013) argued that an appropriate technology should be: adaptable, aimed at self-help, energy efficient, locally controlled, and should also leading to: a strong community involvement [3].

Meanwhile a study conducted by Lee, Vaccari, and Tudor (2016) suggested that one could consider 16 factors of the purchasing managers' strategic framework developed by an organization called the National Health Service (NHS) in order to select and determine appropriate technologies. Four out of 16 separate factors are applicable to select appropriate waste treatment technologies such as: legal and compliance; sector specific guidelines; mandatory reporting requirements (environment, sustainability, and carbon reporting); and cost of purchased solution (economics) [4].

Another study by Dunmade (2002) also suggested that the sustainability of technology implementation depends on its adaptability, which is then determined by: technical sustainability, indicated by the accessibility of component parts, the availability of the needed infrastructure, the availability of technical know-how to accomplish such service, and the elapsed time between repairs; economic sustainability, indicated by affordability, reusability, and local availability of required servicing resources; environmental sustainability, indicated by resource consumption, environmental releases, resource conservation, and environmental compliance; and socio-political sustainability, indicated by the level of awareness, acceptability, governmental policy and continuity, and the sociocultural influence [5].

Uddin, Muhandiki and Sakai et al (2014) also suggested that generally in order for a technology to be accepted, it should overcome several main challenges such as: identifying the proper drivers (institutional, socio-cultural, technological, and/or financial); alternative financial mechanisms (such as involvement of micro finance organisations); the involvement of community-based organisations; and the active participation of local governments [6]. Furthermore according to Wicklein (1998) in the context of technology implemetation in developing countries, some criteria should also be considered such as: systems independence; image of modernity; individual technology or collective technology; cost of technology; risk factor; evolutionary capacity of technology; single-purpose and multi-purpose technology [7].

Another study by Murphy, McBean, and Farahbakhsh (2009) concluded that there are important considerations in AT development and implementation such as: meeting the basic needs of users; sound technology; flexible technology; meeting local capabilities by utilising local materials and resources; affordability; sustainability; encourages local participation; culturally/socially appropriate; gender considerations; and appropriate technology transfer mechanisms [2].

After the implementation of a technology by considering the factors above, the next step would be to assess and evaluate whether the technology is appropriate or not. Bauer and Brown (2014) have developed a quantitative Appropriate Technology Assessment Tool (ATAT) which employs Multi-Criteria Decision Analysis (MCDA) to generate an Appropriateness Index with 49 independent indicators. The most prevalent indicators are: community input, affordability, autonomy, transferability, community control, scalability, local availability of raw materials, and adaptability [8].

Having concluded all previous studies above, authors would argue that it would be very beneficial if there was a development model that could cover the comprehensive transformation process of AT from the initial stage (planning, selecting, introducing), then the implementation stage followed by the advancement stage. Ideally this development model would be providing strategies of adaptation by determining the priority of each development stage.

Appropriate Environmental Technology

Environmental technology itself could be understood to cover the techniques, concepts, products, and knowledge-based services for environmental protection, conservation, and improvement on issues such as climate change, air pollution, biodiversity, waste management, and others [9]. In the same publication, it was also stated that although indirectly the global technology advancement has been one of triggers to some of the current environmental issues, the environmental technology in particular has the promising potential to provide the answers and solutions for those issues following the increasing trend of sustainable living style if appropriately implemented. Therefore it is very important to understand what appropriate environmental technology is.

II. METHODOLOGY

The main purpose of this study is to formulate a development model for the implementation of AT. However before formulating a model, the authors needed to have an overview from different perspectives in order to identify the main components or key-factors of AT. This study was designed to perform a qualitative approach by examining relevant references and to extract the most important socio-economic and cultural factors from the references. These key-factors would be utilised to construct the development model for the implementation of AT.

Basically the authors carried out series of literature review on selected scientific publications and academic journals. The authors collected a number of scientific papers published in international journals as important references for this study, and then selected the most relevant ones as described in the section on previous studies. From the selected papers, authors extracted key-factors by categorising the common factors discussed from the content of each paper and introducing group of key-factors. These groups of key-factors would then be referred as the key-factors. The authors then summarised the common factors under eight key factors: (1) financial mechanism and cost affordability; (2) technological adaptability and independence; (3) social and cultural acceptability; (4) local needs, demands, and resources; (5) community participation and involvement; (6) commitment from local government; (7) environmental consciousness; and (8) sustainability and long-term impact. Table 1 shows the categorisation of the key-factors which will be used as the main components to develop the structure to formulate the development model.

Table 1 Categorisation of key-factors of AT implementation and development.

Nr.	Key-factors of AT development	Group of key-factors
1	Affordability (Dunmade, 2002)	Financial mechanism and cost affordability
	financial driver; alternative financial mechanisms (Uddin, Muhandiki & Sakai et al, 2014)	
	cost of technology (Wicklein, 1998)	
	affordability (Bauer & Brown, 2014)	
	affordability (Murphy, Mcbean & Farahbakhsh, 2009)	
	cost of purchased solution (economics) (Lee, Vaccari & Tudor, 2016)	
2	accessibility of component parts; availability of the needed infrastructure; availability of technical know-how to accomplish such service; elapsed time between repairs (Dunmade, 2002) technological	Technological adaptability and independence
	driver (Uddin, Muhandiki & Sakai et al, 2014)	
	systems independence; individual technology or collective technology; evolutionary capacity of technology; single-purpose and multi-purpose technology (Wicklein, 1998)	
	autonomy; adaptability (Bauer & Brown, 2014)	
	sound technology; flexible technology (Murphy, Mcbean & Farahbakhsh, 2009)	
	adaptable (Putri & Wardiha, 2013)	
3	level of awareness; acceptability; the socio-cultural influence (Dunmade, 2002)	Social and cultural acceptability
	socio-cultural driver (Uddin, Muhandiki & Sakai et al, 2014)	
	image of modernity (Wicklein, 1998)	
	culturally/socially appropriate; gender considerations (Murphy, Mcbean & Farahbakhsh, 2009)	
4	local availability of required servicing resources (Dunmade, 2002)	Local needs, demands, and resources
	local availability of raw materials (Bauer & Brown, 2014)	
	meets basic needs of users; meet local capabilities by utilizing local materials and resources (Murphy, Mcbean & Farahbakhsh, 2009)	
	Self-help; locally controlled (Putri & Wardiha, 2013)	

Nr.	Key-factors of AT development	Group of key-factors
5	involvement of community based organizations (Uddin, Muhandiki & Sakai et al, 2014)	Community participation and involvement
	community input; community control (Bauer & Brown, 2014)	
	encourages local participation (Murphy, Mcbean & Farahbakhsh, 2009) strong	
	community involvement (Putri & Wardiha, 2013)	
6	governmental policy and continuity (Dunmade, 2002)	Commitment from local government
	institutional driver; active participation of local governments (Uddin, Muhandiki & Sakai et al, 2014)	
	legal and compliance; sector specific guidelines (guidelines) (Lee, Vaccari & Tudor, 2016)	
7	resource consumption; environmental releases; resource conservation; environmental compliance (Dunmade, 2002) energy	Environmental consciousness
	Efficient (Putri & Wardiha, 2013)	
	mandatory reporting requirements (environment, sustainability & carbon reporting) (Lee, Vaccari & Tudor, 2016)	
8	Reusability (Dunmade, 2002)	Sustainability and long-term impact
	risk factor (Wicklein, 1998)	
	transferability; scalability (Bauer & Brown, 2014)	
	sustainability; appropriate technology transfer mechanisms (Murphy, Mcbean & Farahbakhsh, 2009)	

III. RESULTS AND DISCUSSION

1. Financial mechanism and cost affordability

For the imported technology from foreign or external entity, the cost should be affordable. There should be potential financial drivers and/or alternative financial mechanisms in order to support and sustain its implementation. Also in the case that the technology comes as a solution with operational cost, it should be fully anticipated and affordable as well. The technology should also be economically affordable within the whole implementation process.

2. Technological adaptability and independence

The component parts of the technology should be able to access easily if not locally. The infrastructure needed to implement the technology should be available. In the case of maintenance service is needed, the technical know-how is available and locally preferable. Thus the elapsed time in-between repairs and/or maintenance process should not be lengthy. The technology should be better (safety, comfort, ease, etc.) compared with the existing technology thus this advancement can be the driver (reason) to use the new technology. The technology should also have the ability to become independence from any other systems. However it should be flexible enough to be implemented either as a stand-alone technology in a remote/individual society or as a collective technology in a cultural group society where everyone contributes.

Furthermore it needs to have the evolutionary capacity of a technology so it can be expanded and reconfigured to higher and more sophisticated production when the demand increases. The technology should have multi-purpose applications or at least the potential for variety of applications. The autonomy, adaptability, and flexibility of the technology should be also identified during implementation and it should be locally contextual.

3. Social and cultural acceptability

The level of awareness of all stakeholders towards the technology should be appropriate, so does the acceptability. The socio-cultural influence should either encourage, in harmony, or at least not against the implementation of the technology. The technology should have the acceptance of cultural

leaders, religious leaders, school teachers, and/or other community leaders as the socio-cultural driver for its implementation. The image of modernity should also be represented by the technology which means that the technology should be seen as something that can elevate the social status or provide a good image for an individual. It should also fit to the local norms and habits which means culturally and/or socially appropriate. The technology should also be able to be equally accessed by both genders.

4. Local needs, demands, and resources

The servicing resources required by the technology for its maintenance such as: technical experts, maintenance facilities, and materials that are specific to the technology needing repair, should be locally available. The technology should also use raw materials that are locally available. The technology should meet the basic needs of its users. It should also meet the local capabilities by utilising local materials and resources. The technology should be self-help during its operation meaning that is directly implemented by local human resources without any external assistances and locally controlled on site.

5. Community participation and involvement

Community-based organisations should be involved in the implementation of the technology. The implementation process of the technology should be open to community inputs. Moreover, it could be controlled by the community. By a strong community involvement, the technology could encourage high level of local participation.

6. Commitment from local government

The implementation of the technology should be supported by the governmental policy and stability. The technology should have at least the potential to be institutional driver. The local governments should be actively participating in the implementation process of the technology. It should also be recognised as a legal matter and compliant to formal regulations at local, regional, and national level. The technology should be equipped by specific guidelines developed by responsible organisations.

7. Environmental consciousness

The technology should include the practice of environment-sound resource consumption. The technology should also be responsible for its environmental releases and resource conservation during its implementation. It should follow the environmental compliances. It should be energy efficient. Lastly, the implementation process should include mandatory reporting requirements on its environmental sustainability.

8. Sustainability and long-term impact

The technology should provide reusability. The technology should limit and/or minimise the risk factors on its operational, financial, long-term development, and other implementation components. The implementation of the technology should be also scalable, preferably to be sequentially scaled-up to achieve optimum impact. The technology implementation should be sustainable and continuously improving. Lastly, it should also be transferable and have appropriate technology transfer mechanisms since the initial and introduction process until the dissemination and replication process to other cities.

IV. CONCLUSION

The key-factors provided important measures to capture and assess the development processes of the AT implementation. These key-factors also serve as main components for the basic development model, as shown in Figure 1. However in order to actually implement the model, the linkage and hierarchy between the components need to be introduced to set up a structure for the model. In order to set up a structure for the model, authors would argue that it is necessary to learn and analyse from the case studies of the AT implementation.

Only after gaining more lessons and experiences from different stages of the implementation (initial, scaling up, replication) at the case studies, authors would argue that the structure of the development model could be better identified and determined. Feedbacks from facilitators, operators, users, and all relevant stakeholders would be the main empirical data to further formulate the development model.

Fig. 1 Basic development model at the AT implementation

ACKNOWLEDGEMENT

This study is initiated by the Institute for Global Environmental Strategies (IGES) Kitakyushu Urban Centre (KUC) in collaboration with the City of Kitakyushu, and Takakura Environment Research Institute, Japan

REFERENCES

[1] S. Trace, "Rethink, Retool, Reboot: Technology as if people and planet mattered," UK: Practical Action Publishing, 2016.

[2] H. M. Murphy, E. A. Mcbean, and K.Farahbakhsh, "Technology in Society Appropriate technology – A comprehensive approach for water and sanitation in the developing world," *Technol. Soc.*, vol. 31, no. 2, pp. 158–167, 2009.

[3] P. S. A. Putri and M. W. Wardiha, "Identification Problems in the Implementation Plan of Appropriate Technology for Water and Sanitation using FGD Approach (Case Study: Kampong Sodana, Sumba Island, East Nusa Tenggara Province)," *Procedia Environ. Sci.*, vol. 17, pp. 984–991, 2013.

[4] S. Lee, M. Vaccari, and T. Tudor, "Considerations for choosing appropriate healthcare waste management treatment technologies: A case study from an East Midlands NHS Trust, in England," *J. Clean. Prod.*, vol. 135, pp. 139–147, 2016.

[5] I. Dunmade, "Indicators of sustainability: assessing the suitability of a foreign technology for a developing economy," *Technol. Soc.*, vol. 24, pp. 461–471, 2002.

[6] S. M. N. Uddin, V. S. Muhandiki, A. Sakai, A. Al Mamun, and S. M. Hridi, "Socio-cultural acceptance of appropriate technology: Identifying and prioritizing barriers for widespread use of the urine diversion toilets in rural Muslim communities of Bangladesh," *Technol. Soc.*, vol. 38, pp. 32–39, 2014.

[7] R. C. Wicklein, "Designing for appropriate technology in developing countries," *Technol. Soc.*, 1998.

[8] A. M. Bauer and A. Brown, "Quantitative assessment of appropriate technology," *Procedia Eng.*, vol. 78, pp. 345–358, 2014.

[9] N. Weinberger, J. Jörissen, and J. Schippl, "Foresight on environmental technologies: Options for the prioritisation of future research funding - Lessons learned from the project 'Roadmap Environmental Technologies 2020+,'" *J. Clean. Prod.*, vol. 27, pp. 32–41, 2012.

The Important of Interaction in Community Planning

Poomchalit Walanrak[1*] and Suzuki Katsuhiko[2]
[1*]Department of Architectural Technology, Faculty of Architecture, Rajamangala University of Technology Thanyaburi, Patumthani, Thailand
[2]Department of Science and Technology, Kyoto Institute of Technology, Kyoto, Japan
*E-Mail: walanrak_p@rmutt.ac.th (Phone and Fax: +668 1864 2276, +66 2549 4775)

Abstract

Since Thailand has operated new paradigms of country developments, the decentralization and the sustainability seem as key concerning in country development policies and frameworks. Cooperation and collaboration in developments in the level of local authorities have been prioritized. Participation is a method to generate a mutual understanding. Many tools of participation have been used and operated before the operation of public projects. Through this article that is a part of the *Social Approach in Community Development and Applicable Conservation Methods in Thailand* aims to understand the interaction between community people and the method that they use to generate a mutual understanding in a thing that is happening or will happen in their community. It is a survey-based study that questionnaires, observation and interview are used as tools of data collection. The studying results are presenting in the easy format of numbering percentage and they have shown that only formal meeting in community cannot generate the mutual understanding as well. However, there are another method of interaction that are useful for a local community. They are the neighborhood discussion and several community activities based on specific relationship and culture.

Keyword: Interaction, Participation, Empowerment, Community, Development

I. INTRODUCTION

When Thailand confronts the economic augmented threat of the 1997 Asian Financial crisis, government at that time had an effort to recover the unstable economy by equivalent development based on sustainability. Decentralization with participatory procedure has been established as a bottom-up systematic motivating tool. Until now, these concepts have become country developing frameworks and policies to achieve the goal of sustainable prosperity (NESDB, 2017).

Even though economic is one concerning factor of sustainability, in spatial development according to sustainable theory or sustainable community creation, social factor is well acceptable as key succession of sustainable goal achievement (Armstrong, 2000). Feeling of being a part of community is important to make people participate in living effective activities. Consequently, characters of sustainable community; planning, private open spaces, public open spaces, vehicle ways, pathways, housing frontage arrangement and housing characters especially solid and voids are considered to encourage interaction of residents. As the sustainable community creation, Sizes and positions of those elements must be suited decent proportions that generating interaction (Essex Planning Officer Association, 1997). It is the reason of relationship between interaction and civil society performing as social characters.

From the *Social Approach in Community Development and Applicable Conservation Methods in Thailand* that framed this study has proved that there are many participatory methods to motivate interaction motivation ((Poomchalit & Suzuki, 2018), (Poomchalit, 2019)). Simple method matching people behaviors and their nature is the easiest way to make people interact each other (Poomchalit, 2019). The power of interaction results mutual understanding. That is a basic factor of planning successfulness which is concerned in the term of "*Zukuri*" in Japanese urban development method called "*Machizukuri*" (Watanabe, 2009).

II. METHODS

General concept of study

As consideration on the Machizukuri, the term "Zukuri" that is a civil society motivation and participatory methods are consistent (Poomchalit, 2019). However, the Zukuri; Japanese participatory methods adapted matching their nature is more flexible appliance. Methods such as street activities and festivals has promoted community interaction. It brought specific area finally reach the highest goal of participation; the people empowerment in enforcement of urban development and conservation restriction (Poomchalit & Suzuki, 2018). Consequently, this research is not only based on participatory theory but also additionally concerning on flexible facilitation of the "Zukuri" depending on social characters in based area of development.

Objective and framework

According to the successfulness of the Zukuri in Japan, both planning approach of top-down and bottom-up processes are met through collaboration between local authority and community members. The bottom-up processes encourage the successful

operation of top-down planning by community. That is the general framework of this study.

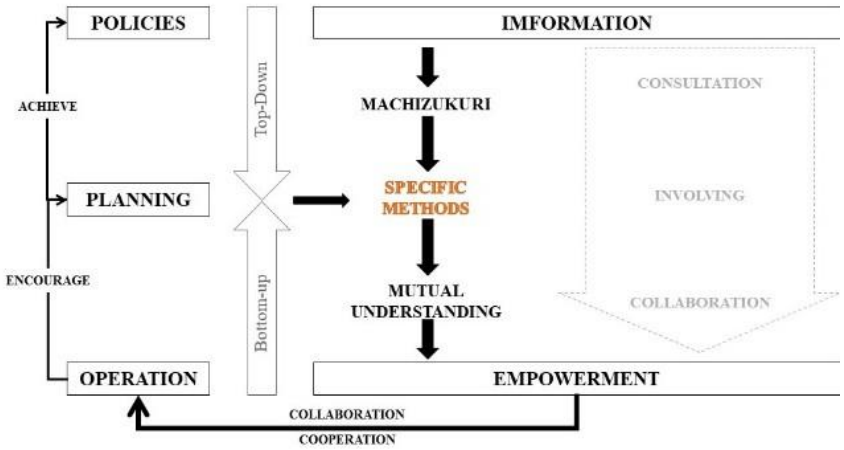


Fig. 1 Framework of study

Following studying framework, conceptual idea of study was formed to find a method of bottom-up development approach in Thailand. Participatory tool relating the Thai nature to efficiently generate interaction is an assumption that resulting specific efficient tool finding for Thai community planning participation has set as aim of study.

Methods

To find the efficiency interaction in planning participation, the best practice in urban management and operation with collaboration is required. Even if this study is a part of participatory tools, focusing point of the major study; the *Social Approach in Community Development and Applicable Conservation Methods in Thailand* aim to create additional social-based method into the formal procedure of developing controlling system (Poomchalit, 2019). Studying cases in the level of policy was selected through WHC based heritage sites ((WHC, 2012), (Poomchalit, 2019)). The balancing of modern and preservation character was the most prioritized criterion (Poomchalit, 2019). For this parting method, managing establishing procedure with collaboration and mutual understanding interaction had been carefully examined before the other research tools were selected and specified.

As the comparison-based analysis, case study of urban management in preservation city was selected. Processes of study were set matching the case study procedure. The interest of study was focused onto the connection and link between top-down and bottom- up processes of urban development controlling system. So that, urban managing system through the collaboration between local authority and community members is the key interesting. It makes methods of research are operated as following processes.

Cast study selection

This is a part of target studying area specification and identification. The best practice of urban conservation or preservation management was selected. Specific cases within the preservation managing area had been review also as obviously apparent characters. Processes of the managing methods both within whole preservation boundary and specific areas were set as starting criteria to find matching cases in Thai community developing, planning, and managing methods.

Comparison on the case study review

After matching cases were selected, Comparison will be started to identify the identical methods of interaction both in best practice and selected communities. Certainly, participatory methods followed the participation theory and Japanese Machizukuri will be framed of this part.

Rechecking questionnaire

Questionnaire in this part is not only used for collecting data but also be a tool of mutual rechecking followed the interaction methods that used for planning. However, the questionnaire is only used in Thailand.

The questionnaire rechecking consists of two interesting issues;

(1) Interaction and participation method that influenced mutual understanding.

(2) Connection between mutual understanding and controlling enforcement characters and system.

Resulting analysis and presentation

Statistical analysis is the basic method that is in the general perception of people. By the facilitation of several types of graphs, the numbering image of questionnaire results will be generating obvious understanding through the easiest infographic of numbers.

III. RESULTS AND DISCUSSION

For clear understanding on processes, research methods and results, the description forward will be followed the former explanation on research methods. So that, the results and discussion have consisted of four parts as showing items below;

Cast study selection

Following the main idea of the whole study that connected to urban and community conservation management, it is concerning point that framed case study criteria. Connection between urban planning procedure and enforcement results in specific areas is expected. Therefore, there is the only case based on World Heritage Committee awarded in 2012 (Centre, U. W. H., n.d.); Kyoto City, Japan.

Kyoto City has been announced as the best practice in urban preservation management (Centre, U. W. H., n.d.) after established the new Landscape Policy 2007 as an urban development framework. This plan has included of top-down expecting image and allowed bottom-up system for controlling achievement. The participation in the level of people empowerment in the specific areas has brought Kyoto City success to reach the preservation expectation.

The key of succession is two systems that have been adapted in the area; the formal system that is the top-down processes and the informal that allow local people participate and control development resulting community change themselves through the interaction and collaboration. That system is called "Opinion Exchange" as presenting in

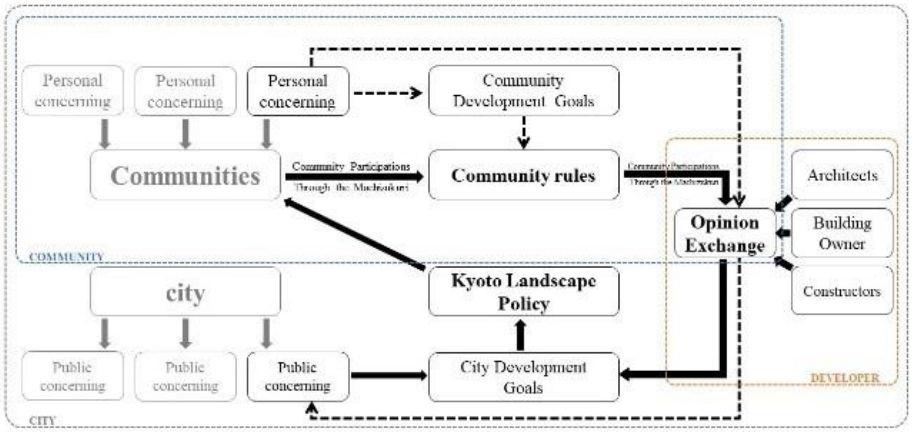


Fig. 2 The two-operation-system of Kyoto City

As the *Figure 2*, the "Opinion Exchange" is a connecting system that makes Kyoto City, specific community committee, community members, architects, designers, owners and constructers together meet on the urban development issue; here is referred to the building construction allowance. This specific system results building characters in building controlling areas (Kyoto City, n.d.). Concerning and awareness of people based on the community rules and building restrictions that have been mentioned in the opinion exchange procedure will be reported to the city and responded by the building owners and constructers. It shows the successfulness of top-down and bottom-up developments by create a method to connect those both systems together.

Additionally, the opinion exchange is framed by the community rules or the building restrictions; the building agreement in specific areas. For this part, specific procedures based on Machizukuri in specific areas of agreement have been review also. It is the specific cases that can find the specific methods of interaction making.

Specific communities in Kyoto were selected as specific cases of study under the three general and six additional criteria (Poomchalit, 2019).

General criteria consist of;

(1) The selected communities must be under community controlling system; the agreement, the declaration or rules.

(2) That systems concern community developments or changes.

(3) There is some character of the specific civil society methods.

The six additional criteria are;

(1) Accessible data of community development process and participatory methods

(2) Boundary and characters are clearly specified

(3) Identification of the apparent characters.

(4) Suitable size of field survey

(5) Community rules or agreement are available operation

(6) The other important or specific notifications or characters.

There are nine specific control areas that interested. Three have been selected by the designated criteria (Poomchalit and Suzuki, 2018). The selection cases; the Anekoji, the Ichinenzaka-Ninenzaka and the Pontocho and their locations are showing as following figure.

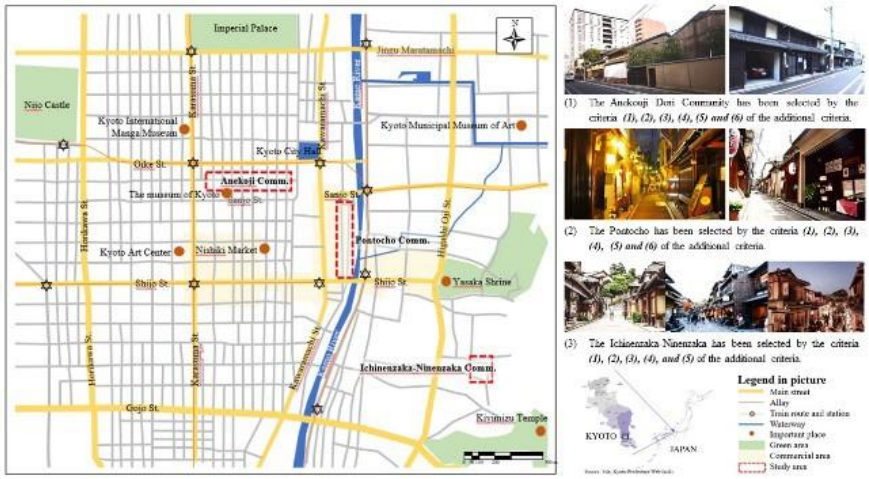


Fig. 3 Specific cases and locations ((Poomchalit & Suzuki, 2018), (Poomchalit, 2019))

For Thailand, procedure of planning is general. However, for the part of specific case study, there is only one community that followed general criteria; the old Chiang-Khan Community. So that, the specific criteria must be additionally designated as following (Poomchalit, 2019);

(1) *Independent controlling system* can be selected Or,

(2) *Cultural system, norm or the traditional practice* can be selected.

(3) Either *written or unwritten controlling system* with clear information is possible.

(4) Cases can be *rural communities.*

(5) The *property differences* are concerned.

Based on the above criteria, the selected cases in Thailand are the old Chiang-Khan community, the Mae-Kampong community and the Kiriwong community. Fortunately, these three had win the Managing Award of self-development announced by Ministry of Interior.

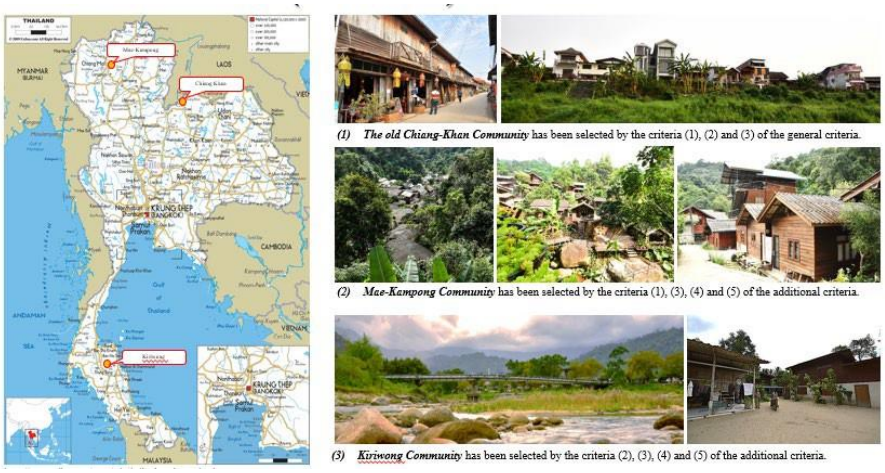


Fig. 4 Specific cases in Thailand (Poomchalit, 2019)

Comparison on the case study review

The comparison separates into 2 parts; the part of planning processes and the enforcement. The top-down and whole systems concern in the part of planning. Also, the bottom-up system concern on the operation processes, enforcement and invert system of operation. The connection system is the focal point. The participation and motivating methods of interaction are the key concerning in the discussion.

A part of top-down planning procedure

Comparing of community planning and controlling system of studying cases, by the level of plan, the Kyoto landscape policy is identical to the local authority or district plan that operated in local authority areas. Development aims and strategies that is key elements are elements of plan. Zoning and urban expectative image that is the original Kyoto included in the Kyoto Landscape Policy look similar to the urban or district comprehensive plan that is another plan responded by the other department of planning. The building agreement that established in the specific communities of Kyoto is a local ordinance on building control that local authority announced as tool of urban controlling tool in Thailand. These are the complicated system and difficult control of the whole system of urban developments.

In Thailand, the several systems of Thailand sometimes have linked together, sometimes they are concerned in the different issue. The local ordinance on building control and urban or district comprehensive plan sometimes used as the identical level of controlling laws. Actually, the local ordinance is a local restriction while the urban or district comprehensive plan is Act. They are not the same level of laws but control the same thing. However, the local restriction is more powered of control because there is a penalty also included in the restriction.

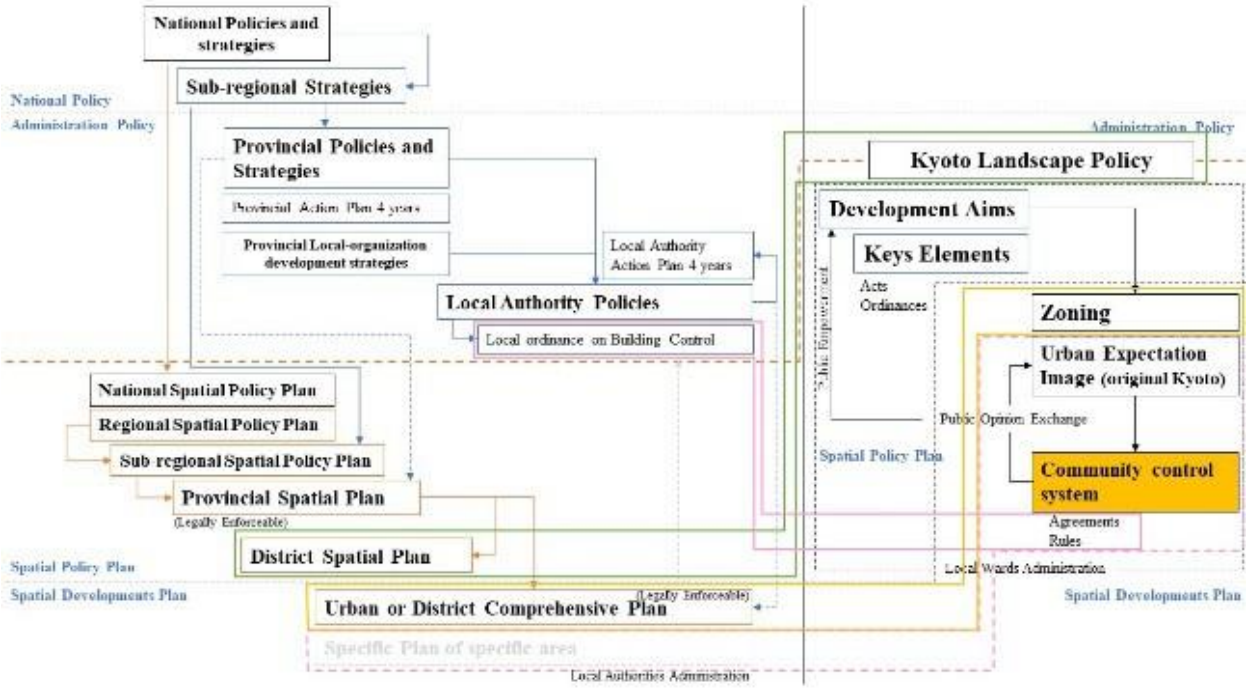


Fig. 5 The comparison of planning system between Thailand and Kyoto City (Poomchalit, 2019)

As the part of Kyoto City that is presenting in *Figure 5*, the specific method of planning operation has been adopted. The system and planning elements that former explained have been linked through the "Opinion Exchange". The urban images that make the distinct vision and mutual understanding in each urban development zones have been generated to the areas through the community controlling systems such as agreement or rules of building concern. By using the Opinion Exchange system, development in specific area will achieve the expectative images of development zones. Also, when the zones are reaching the achievement of development, the Kyoto landscape policy will be reaching its aims and succession.

The different process between general planning of Thailand and specific planning system of Kyoto is the "Opinion Exchange". It is the bottom-up empowerment system that allowed local people participate in community planning and controlling operation.

A part of bottom-up operating procedure

As former description, the succession of top-down and bottom-up operation in Kyoto City is generated by the opinion exchange. How Kyoto make this system? The effort of preservation in Kyoto was started in 1976. Until 2007, the city has operated the new landscape policy as an urban development framework. Cooperation and collaboration to create specific preservation plan and method was started during the time of urban modernization (Kyoto City, n.d.). Community development control was first considered in the Anekoji area at the time of high-rise prosperity. After 19 years of preparation and hundreds of times of discussion and cooperation, the area reaches the first specific controlling rules of building development in 2014. It is the beginning of building agreement operation in other specific areas (Anekoji Community Development Committee, 2015). For the other two cases; the Ichinenzaka-Ninenzaka and the Pontocho, they take 24 and 39 years (Pontocho Town Development Committee, n.d.) before establishing of agreement or town rule. The timelines of controlling preparation are showing as *Figure 6*.

Time is a significant factor to generate mutual understanding to community members. Re-mindsetting requests for a gradual reforming of thinking. Experience in life is the key to generate method of individual thinking (Poomchalit & Suzuki, 2018). However, in urban development, the same attitude or mutual thinking is very important to lead urbanization reach its goals. Methods of new mindset suited behavior or people's nature to motivate people think of the same thing to reach the same goal is explored in everywhere that concern in effect of planning.

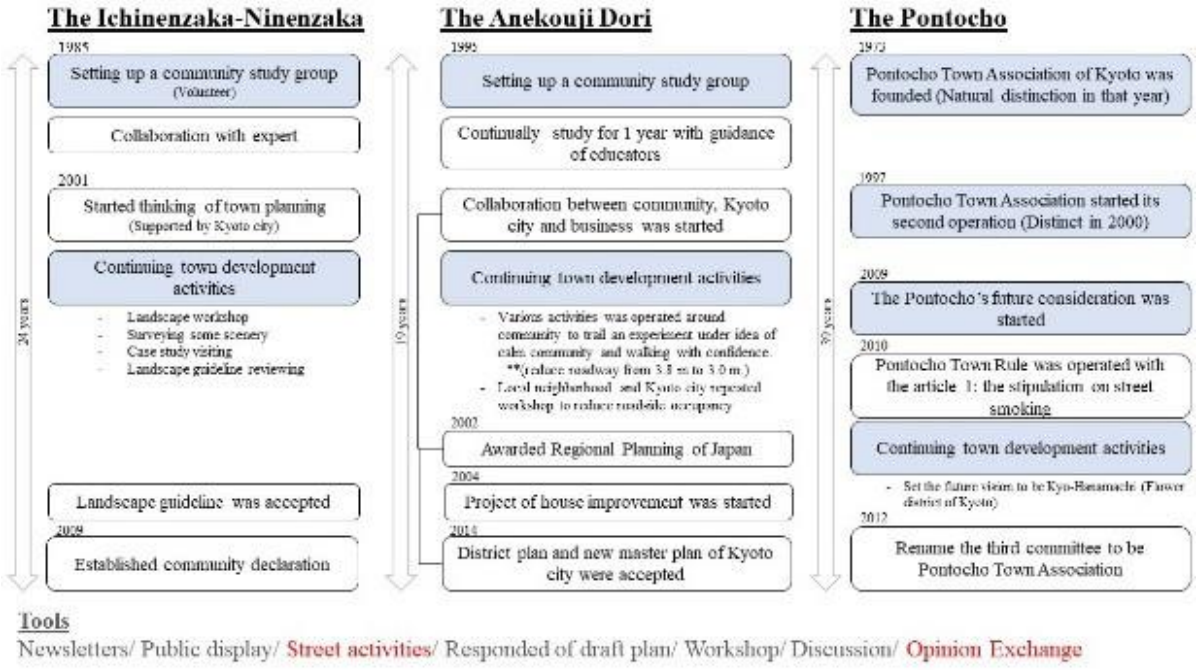


Fig. 6 Timeline of controlling preparation in Kyoto cases

Table 1. Specific methods of interaction motivation in specific studying cases (Poomchalit, 2019)

Area	Communities' name	Participatory methods	Problems
JP	Anekoji	Public meeting, Cooperation development.	High rise building
		Street and community's activities, Workshop, Pilot project of house repairing.	Calm living community
	Ichinenzaka-Ninenzaka	Case study visiting, Street and community's activities, Group meeting,	Historical felling preservation
	Pontocho	Street and community's activities.	Historical appearance character
			Community atmosphere
TH	Chiang-Khan	Case study visiting.	*Local authority's policy
	Mae-Kampong	Community's activities, Community's member cooperation works.	Insufficiency
		**Rule by community committee	Outstanding debt
			House ownership
	Kiriwong	Private discussion, Groups of sharing.	Natural resources usage

Generally, participatory methods have useful. Although, when the specific goals have been set in the specific characterized area, the specific methods to motivate mutual mindset of urban thinking will be requested also. By the specific studying cases both in Kyoto City and Thailand, the specific methods have been adapted to motivate interaction. The specific problems and concerns make those communities efforted to find the best participatory methods to generate mutual concern and problem resolving solutions. In Kyoto City, the street and community's activities look suitable to Japanese behavior and interests. Comparing to the Thai cases, there are many methods depended on communities' problems. The finding specific method of participation are now showing as the *Table 1*.

Rechecking questionnaire

For Kyoto studying cases, the successfulness of specific controlling system based on the specific methods of community building agreements have distinct perceived through the building apparent characters that matched the zoning expecting images designated as goals of urban developments. The comparing images of plan and community spatial characters are presenting in the *Figure 7*.

How success in Thai community controlling? It is difficult to discuss because many apparent characters are not matched the goals or details of community restriction or rule. In this study found that, those characters of mismatching are related to the methods of participation. Questionnaire is a tool used for data collection. Comparing to the interview data, the results show that methods of participation generate less understanding on the enforcement characters and details.

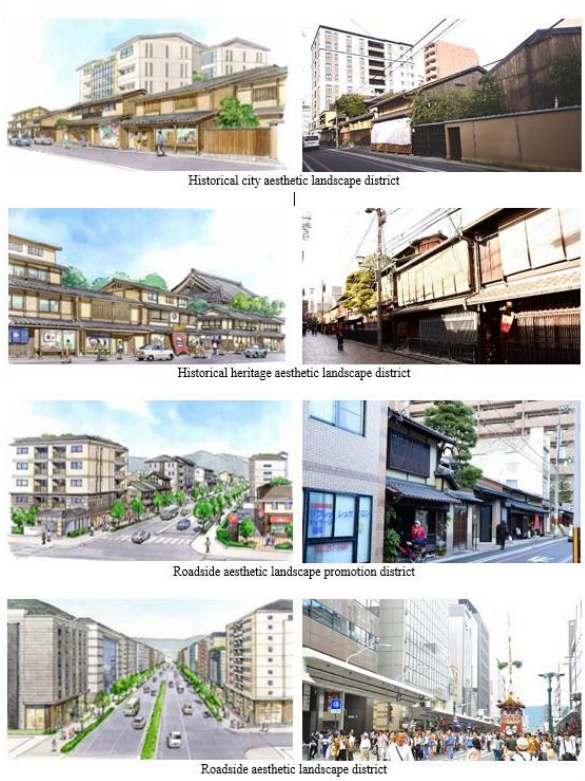


Fig. 7 Comparing images of plan and community spatial characters ((Poomchalit & Suzuki, 2018), (Poomchalit, 2019))

For example through ***Figure 8***; In Chiang-Khan community, the controlling system is local ordinance. But, over 50% show that community members have other understandings. Or; In Mae-Kampong, the community operated independent rules of community development that concerning on building and environment. But, the members understand that it is a local ordinance. Or;

In Kiriwong; a beautiful agricultural village that the cultural rule or norm is the controlling system. But, the member do not feel of it. This is the special character that the study found from this case. When people feel like the rules are their everyday life, they do not think, they are under control. They automatically act that rule because it significant impacts their lives.

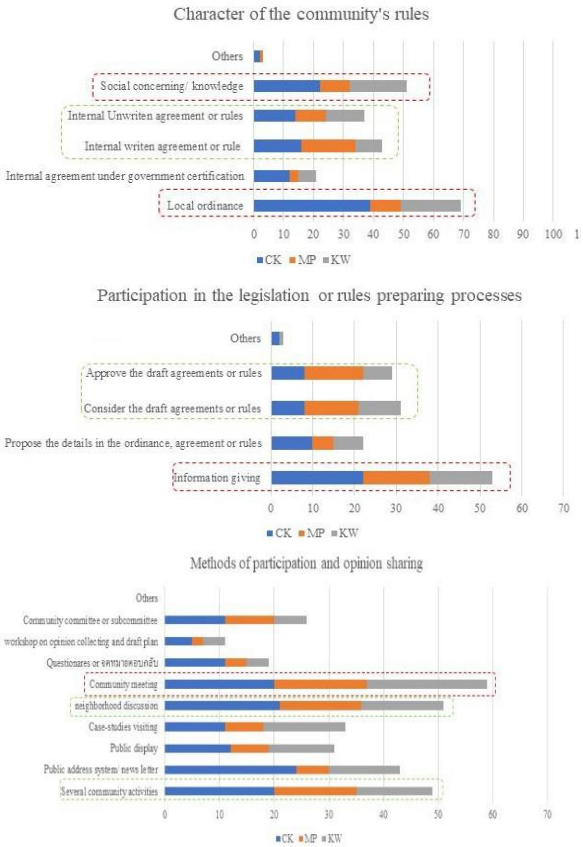


Fig. 8 Questionnaire results (Poomchalit, 2019)

For the participatory processes, the figure shows, people almost participated in the process of information giving. Some joins in the consideration and draft plan approval. The most popular method is community meeting. By observation, in community meeting, community members do not question or request more information in development issues. However, after meeting, the private groups discussion always occurred. It relates to the questionnaire results also because the neighborhood discussion is the second run result. The other way from questionnaire that generate mutual understanding is community activities that connected to the community cultural events, beliefs and other specific characters (Poomchalit, 2019).

IV. CONCLUSION

There are 3 generating factors that show how important of Interaction and mutual understanding in community development. They are consisted of;

(1) The mutual interest or similar interest is the key. It always come from basic requirement of living. Through the case- studies, *mutual needs of people are powerful* to motivate social cohesion. It became one of an important to create interaction in community developments.

(2) Through the case studies have shown, controlling system that *public goal and personal interest are similar* as in Kyoto cases, it easily makes the action achieve the goal.

(3) The specific participatory method is unable to specify. It depends on specific character of each community. However, *neighborhood discussion and community activities are powerful* and suitable for Thai communities through the questionnaires.

REFERENCES

[1] Anekoji Community Development Committee, "Anekoji Community Regional Landscape Planning Plan," 2015.

[2] H. Armstrong, "Sustainability and Housing: The Government View," in *Sustainable Housing Principle and Practice*, 1st ed. London: E & FN spon, 2000, pp. 1–6.

[3] U. W. H. Centre (n.d.-b). (2018, Apr 25). *Sharing best practices in World Heritage management* [Online]. Available: https://whc.unesco.org/en/recognition-of- best-practices/

[4] Chiang-Khan Municipal, Chiang-Khan Municipal Plan 2018-2021. 2018.

[5] T. and C. D. B., "Department of Public Works and Town & Country Planning," *Journal of Department of Public Works and Town & Country Planning*, vol. 44, pp. 31–358. 2014.

[6] U. Doung-ngern, "Development timelines and rules of living in Kiriwong community," 2018.

[7] IAP2 Southern Africa. (2018, Apr 25). *IAP2 Spectrum – IAP2 Southern Africa* [Online]. Available: http://iap2sa.org/?page_id=908

[8] P. Kaewkanya, "Chiang-Khan community development and concern," 2018.

[9] T. Kedtongma, "Chiang-Khan community ordinance legislation processes," 2018.

[10] A. Khuntod, "Development timelines and rules of living in Kiriwong community," 2018.

[11] Y. KraChanglok, "Development timelines and rules of living in Kiriwong community," 2018.

[12] Kyoto City, "Kyoto City Landscape Policy: Forming Timeless and Radiant Kyoto Landscapes," 2007.

[13] Kyoto City. (n.d.-b). Landscape of Kyoto. Kyoto City.

[14] Mea-Kampong Community Committee. "Mea-Kampong Rules," 2016.

[15] S. Morishige, "Environmental Governance of Dwellings of a Small Scale Community along a Historical Alley in Kyoto City," in *Rural and Urban Sustainability Governance*, 1st ed. Tokyo: United Nation University Press. 2014.

[16] Office of the National Economic and Social Development Board (2017, Apr 30). *The National Economic and Social Development Plan* [Online]. Available:, http://www.nesdb.go.th/main.php?filename =develop_issue.

[17] Pontocho Town Development Committee. (n.d.). Landscape Planning Plan. Pontocho Town Development Committee.

[18] W. Poomchalit and K. Suzuki, (2018). "A Study of the Importance of Personal Interests Concerning on Urban Planning: Case Studies in Kyoto City, Japan," *Journal of Architectural/ Planning Research and Studies (JARS)*, vol. 15, no. 1, 2018.

[19] P. Poungmala and Others, "A Pattern on Sustainable Ecotourism Management," *The Thailand Research Fund*, pp.131, 2004.

[20] P. Poungmala and Others, "Economic Guidance through the Community based Tourism Management, Baan Mae- Kampong, Mae-On, Chiang-Mai," *The Thailand Research Fund*, pp. 93, 2009.

[21] P. Poungmala, "Development timelines and rules of living in Mea-Kampong community," 2018.

[22] Roger Schwarz & Associates, Inc. (n.d.) (2018, Apr 25). *An approach that gets you and your team moving forward together* [Online]. Available: http://www.schwarzassociates.com/ what- is-the-mutual-learning-approach/

[23] P. Sripromboot, "Chiang-Khan community development and concern," 2018.

[24] K. Sudsai, "Development timelines and rules of living in Kiriwong community," 2018.

[25] P. SukonthaJit, "Baan Khun-Nam Kiriwong: Self-development community," *RomPruk Journal*, vol. *27, no.* 1, pp. 91–123, 2007.

[26] The Landscape Creation Committee, "Ichinenzaka-Ninenzaka Pegional Landscape Planning Plan. Ichinenzaka- Ninenzaka Landscape Creation Committee," 2013.

[27] The Secretariat of the Cabinet, "Chiang- Khan Ordinance on Building Controlling Area, 128 § 51D (Extra section)," 2009.

[28] P. Thomma, "Development timelines and rules of living in Mea-Kampong community," 2018.

[29] J. S. Watanabe, "Toshi Keikaku vs Machizukuri Emerging paradigm of civil society in Japan," in *Living City in Japan* (Digital Printing, 2009). New York: Simultaneously published, 2009, pp. 1950-1980.

The study of teaching and learning method in Architectural design 1

Chidsanucha Khamparat
Department of Architectural Technology, Faculty of Architecture, Rajamangala University of Technology Thanyaburi, Pathumthani, Thailand
*E-Mail: kchidsanucha@rmutt.ac.th (Phone: +669 4617 1532)

Abstract

This research, the study of teaching and learning method in Architectural design 1 classroom for teaching and learning method, this is not only created for Architectural design 1 classroom environment but is also supporting and adjuvant. Architectural design 1 is the core course in faculty of Architecture, Project-based learning is the approach for subject. Teaching and learning activities have passive learning and active learning. The objectives are providing an opportunity, demonstrate and bring about to development or efficiency adaptation. The difference of teaching and learning method, it is depending on the program's objectives and assessment. How to select the properly method for the program. In the part and detail of active learning method are similar to CDIO Framework. It's can be use or adapt to program as well. From research result, the demonstration of CDIO Framework in Architectural design 1. It reveals to the important of CDIO Framework, build up confidence and engagement. The study of teaching and learning method in Architectural design 1 classroom, it was providing an opportunity, demonstrate and bring about to development or efficiency adaptation in faculty of Architecture, RMUTT.

Keyword: Disciplinary, Architectural design, Teaching Method, Learning Activity, Engagement

I. INTRODUCTION

The Research is one of the processes which have solved about development of learning skills. The teacher has designed for learning activities and created environment to engage students who interact in the class. Teaching approach in architectural Design 1 is a project-based learning and studio-based learning, the teacher should define objectives for being consistent with the way of the teaching and learning activity to relate with assessments. Moreover the good result, the feedback of evaluation will effect to improvement in the next semester or others. The conceptual idea of active learning is a learning process that supports for hands-on of the creative thinking process and learner skills. In this research, the teaching and learning processes are learning by doing the practice which gains some experiences, not only learning from textbooks and lectures but also the teacher need to provide some opportunities. This process will be motivated the learner lead to critical thinking, hypothesis and evaluation by themself. CDIO framework is a practical guideline to set a structure of curriculum, for appropriately applied the teaching method to cultivate attitude and knowledge to the learner.

II. METHODS

Collect Data

Divided into 2 groups including Primary data (Interviews, Questionnaire, Test, and Observation) and Secondary data (Disciplinary, Assessments, Thai Qualifications Framework for Higher Education, TQF: HEd).

Analysis

The objectives of learning in 16 weeks have consists of Cognitive Domain, Psychomotor Domain and Affective Domain, which were analyze the result by observation, statistical estimation and interviews.

Teaching and Learning Approach

In this research, CDIO framework was applied by the teacher has used teaching methods in learning activities. Following project-based learning is one approaching which is used in architectural design 1 project assignment for long term. Therefore, the learner would do the research, group working and individual study. All of the semester, studio-based learning was adapted to mostly learning activities with the team teaching needs to advise all the time in the studio classroom.

Learning Activity and Assessment

A part of teaching method is a learning activity in CDIO framework which is similar to a concept of active learning. A researcher has selected the properly methods, There are 1) Team Teaching 2) Flipped classroom 3) Jigsaw teaching 4) Concept question 5) Cooperative team learning 6) Think –pair Share 7) Online and Mobile balance learning.

Assessment methods, a total score from 100 percent are divided into 5 parts. Include 1) Affective Domain for 10 percent 2) Mini Project for 20 percent 3) Assignment in each week for 20 percent 4) Final Project (long term) for 30 percent and 5) Sketch design or test (group and individual person) for 20 percent. By defining the learning outcomes for check all skills (Thinking, Feeling, and Doing) are exam or test, projects, practical exercise, case study, assignment, discussion, oral presentation, writing, model making that categorize 2 forms: Formative and

Summative. Formative refers to a wide variety of methods that teachers conduct in-process evaluations of the learner comprehension. And Summative refers to the assessment of the learner that the focus on the outcome of a program.

Table 1

Architectural Design 1			Domain (Objectives)		
Week	**Teaching Program**	**Learning Activity**	**Cog**	**Psycho**	**Affect**
1st	Introduction & Program Analysis	Lecture	●	-	○
		Q&A	●	●	○
		Discussion Group	●	○	●
2nd	User Analysis and Human behavior	Flipped classroom	●	-	-
		Cooperative Team Learning	●	●	●
		Presentation	●	●	●
3rd	Functional Relationship Diagram	Lecture	●	-	○
		Case study / Field trip	●	●	●
		Online & mobile	○	●	-
4th	Functional Relationship Diagram (*F)	Lecture / Case study	●	-	○
		Assignment	●	○	-
		Presentation	●	●	●
5th	Site Analysis (*F)	Lecture / Case study	●	-	○
		Site survey / Group working	●	●	●
		Presentation	●	●	●
6th	Area Requirement (*F)	Lecture	●	-	○
		Assignment & SKD	●	●	○
7th	Circulation & Zoning analysis	Lecture / Case study	●	-	○
		Assignment	●	●	○
8th	Conceptual & Potential of space	Lecture / Case study	●	-	○
		Assignment	●	●	○
9th	Mini Project (Mid-term) (*S)	Presentation	●	●	●
		Model making	●	●	-
10th	Design Development (*F)	Case study	●	●	○
		Discussion & Assignment	●	●	●
11th	Design Development (*F)	Case study	●	●	○
		Discussion & Assignment	●	●	●
12th	Pin up (1st time) (*S)	Presentation & Advice	●	●	●
13th	Design Development (*F)	Discussion & Assignment	●	●	●
14th	Pin up (2nd time) (*S)	Presentation & Advice	●	●	●
15th	Design Development (*F)	Discussion & Assignment	●	●	●
16th	Final Project (*S)	Presentation	●	●	●
		Exam / Test	●	●	●

* F = Formative , S = Summative

Following the table that represent for a relationship of objectives and learning activity in 16 weeks

III. RESULTS AND DISCUSSION

The results of improvement in teaching and learning activities (CDIO Framework) are divided into 3 parts. There are about objectives, teaching and learning activities and assessments.

The objectives were followed the curriculum. Engagement is the main idea of goal, the learner should be more confidence and develop in soft skills. By put the various activities in class.

Teaching and learning activity reveals that the learner has more participate in class, get inspired, new experiences and each activities can be applied to appropriate field, flexibly and easily to use as follow: (Table 2)

Assessment of subject is the rubric score from CDIO Framework for recheck to objectives as follow: (Table 3) (Step of outcomes there are level 1 = Knowing, level 2 = Understanding, level 3 = Applying, level 4 = Analysis, level 5 = Synthesis and level 6 = Evaluation)

Table 2 to show questionnaire of satisfy about learning activity

Learning Activity	Questionnaire (Focus group 40 persons Total 100%)				
	Excellent	**Good**	**Medium**	**Fair**	**Poor**
Lecture	**80**	20			
Q & A		30	**50**	20	
Discussion group	5	**80**	15		
Cooperative Team Learning	20	**50**	30		
Concept Question	15	**45**	25	15	
Flipped Classroom		10	**45**	**45**	
Online & Mobile Balance learning	**75**	25			
Think-pair Share		30	**50**	20	
Field Trip	**70**	30			
Advice & Guide	**60**	40			
Assignment : Mini Project / Sketch Design	45	**55**			
Presentation	**85**	15			

Table 3 to show the relationship of Rubric score and learning activity

No.	Objectives	Learning Activity	Level of outcomes					
			1	**2**	**3**	**4**	**5**	**6**
1	Understand and specify type of spaces and proportion of human scales for the task.	Lecture	●	●				
		Q & A	●	●		●		
		Group discussion	●	●		●		
		Cooperative Team Learning	●	●	●	●	●	
		Assignment: Sketch Design	●	●	●	●	●	
		Presentation	●	●	●	●	●	●
2	Categorize activities to create many functional relationships in the house and design for effective spaces.	Lecture	●	●				
		Flipped Classroom	●	●		●		
		Case study	●	●		●		
		Think-pair Share	●	●		●	●	
		Assignment: Sketch Design	●	●	●	●	●	
		Presentation	●	●	●	●	●	●
3	Critique each other's design proposal and prototype. To have a Reasonably presentation.	Lecture	●	●				
		Q & A	●	●		●		
		Assignment: Concept question	●	●	●			
		Field trip	●	●		●		
		Mini project / Final Project	●	●	●	●	●	
		Presentation	●	●	●	●	●	●
4	Know and compare type or relevant with spaces and activities / wooden structural system or choose appropriate wooden structural system.	Lecture	●	●				
		Q & A	●	●		●		
		Case study	●	●	●			
		Group discussion	●	●		●		
		Mini project / Final Project	●	●	●	●	●	
		Presentation	●	●	●	●	●	●
		Model making	●	●	●		●	

The results of questionnaire on table 2 reveal about the learning activity that the learner feels very satisfied to Lecture, Online & Mobile Balance learning, Field trip, Advice & guide and Presentation (excellent level).

On the other hand, Flipped classroom is the one of all learning activities that the learner feels little satisfied it (fair level).

Following table 3 reveals about the learning activity, Presentation is one of the importance activities because the learner can show their competency (soft skills) by project description, present their products to colleagues by proficiency and comprehension.

IV. CONCLUSION

Part of assessment, Step of outcomes cannot evaluate all learning activities. The teacher has to emphasize on the main of competency and selected to appropriately methods for the learner.

Moreover, environment and facilities in context, can give some convenience and support the efficient thinking, are the part of all components to engage the learner as well.

REFERENCES

[1] D. o. I. E. F. o. E. RMUTT, "CDIO-based Education at RMUTT," pp. 4-5, 2014.

[2] F. o. Architecture, Architectural curriculum (5 years), Pathumtani: Faculty of Architecture Rajamangala Thanyaburi University of Technology, 2012.

[3] Biggs, "Enhancing teaching through constructive alignment," *Higher eduation*, vol. 32, no. 3, pp. 347-364, 1996.

[4] J. Biggs and C. Tang. "Setting the stagee of effective teaching," in *Teaching For Quality Learning At University*, vol. Open University Press, pp. 34-57, 2011.

[5] N. Zepke and Leach, "Improving Student Engagement: Ten proposals for action," *Action Learning in Higher Education*, vol. 11 , no. 3, pp. 167-177, 2010.

[6] C. Khamparat, “The study of teaching and learning method in Architectural design 1 classroom, Pathumtani: Rajamangala University of Technology Thanyaburi,” 2018.

The relationship between health status and health behavior of the Thai population

Issara siramaneerat, Saifon boocha and Chalit chaowilai
Department of social science, Faculty of Liberal Arts, Rajamangala University of Technology Thanyaburi, Thanyaburi, Pathumthani, THAILAND
*E-mail: issara_s@rmutt.ac.th, issara_sira@hormail.com

Abstract

Lifestyle and behavior are two important determinants of an individual's health status. Health-related behaviors, including eating habits, smoking, alcohol consumption, drug abuse, and physical activity affect health. The risk factors for disease for some health conditions are symptoms of disease while others are diseases in their own right. Among the lifestyle practices and behaviors examined for their potential health impact are tobacco use, alcohol consumption, sleep, exercise/inactivity, nutrition and diet, immunization history, social support and stress.

The study will employ the data from the Evaluation of Health Promotion and Sports for health in Local Authorities Project in 2010. This survey applied a multi-stage design which a complex forms of cluster sampling. The total household in the survey were 8,886 households while the total sample universe is around 27,409 cases. Cross tabulations in order to explore the relationship between socioeconomic-demographic factors toward on health behavior (exercise, smoking and drinking) and health status (comprise hypertension, diabetes, CHD, hyperlipidemia and cancer).

The result has shown that people who have hypertension, diabetes, CHD, hyperlipidemia or cancer reported the same pattern and level of health behavior (for smoking, alcohol consumption and exercise). It is surprising that one-fourth of people with these diseases still maintain poor health behavior even though they already have a serious disease. In detail, the one-fourth of respondents who reported disease, are still smoking within hypertension (27.1%), diabetes (28.1%), CHD (27.9%), hyperlipidemia (25.2%) and cancer (24.3%). Moreover, people who have cancer are mostly still drinking alcohol (35.1%), followed by those with hypertension (35.1%), diabetes (31.7%), hyperlipidemia (30.2%) and CHD (27.3%). In additional, the sample 11.9% have hypertension ((N=1,024), 5.2% have diabetes (N= 445), 2.0% have CHD (N=172), 4.6% have hyperlipidemia (N=397), and 0.4% have cancer (N= 37).

Keyword: health behavior, heath status, mortality

I. INTRODUCTION

Thailand has gone through the process of demographic transition in approximate 60-70 years, or in two generations (since 1995). In the first half of the twentieth century, Thailand's crude death rates were approximately 30 per 1,000. After we improved public health and transferred new medical technologies from developed countries, crude death rates sharply dropped to below 20 per 1,000 by the mid-1950s. [1]. The reasons for decreasing rate of mortality due to infectious diseases differ between developing and developed countries. Thailand has had successes from transferring medical knowledge and techniques from developed countries, and by improving public health. The perspectives of demographers and sociologists on causes of Thai mortality declines can be separated into two camps: One emphasizes the rising standard of living, especially nutrition, which contributes to social and behavioral improvements. The other viewpoint is that mortality declined rapidly because people adopted health behaviors and preferred modern medicine over traditional remedies [2].

There is a relationship between health related behavior factors (such as Alcohol consumption, involvement on sport campaign, involvement to health/sport club and the duration of year in exercise) and health status.

II. METHODS

Source of data

The study will employ the data from the Evaluation of Health Promotion and Sports for health in Local Authorities Project in year 2010 conducted by the Institute for Population and Social Research (IPSR) Mahidol University. This project was following National Strategy "to develop Healthy Thai population by regularly exercise" which aimed to integrate all sectors, to develop a learning process, emphasis on public participation, to create good cooperation and public awareness. There was also an important goal which was to give people aged 6 years and above regular exercise for better health. To implement the policy, all regions administrative authority was expected to send a project proposal to Ministry of Public Health of Thailand. Mostly the project proposal came from the urban area due to their ability to write a proposal was better than their counter part who lived in rural. This situation might produce the selection sampling bias which urban respondents were higher than rural respondents.

Sample of the study

This survey applied a multi-stage design which a complex forms of cluster sampling. Cluster sampling is a type of sampling which involves dividing the population into groups (or clusters). Then, one or more clusters are chosen at random and everyone within the chosen cluster is sampled. Several levels of cluster selection may be applied before the final sample elements are reached. The multi-stage of this study was region, province, district, municipality and village, respectively. In order to ensure a representative sample of the population, the cluster sampling process involved several steps. Firstly; 20 provinces were selected from six sub-regions which reflect the different social, economic and ecological conditions of Thailand. Next, two districts each were selected from the 20 provinces. Thirdly, two municipalities each were selected from the 40 sampled districts. The last stage, the author selected two villages each were selected from 80 municipalities and collected the information from every household in the villages. The total household in the survey were 8,886 households while the total sample universe is around 27,409 cases. the selection criteria for this research selected only the cases that answered the questionnaire and aged 15 years old and over because the author investigated health risk behavior such as smoking, alcohol consumption and exercise behavior that require retrospective self-reports about engaging in these behaviors. It could be more accurate and reliable from the first source than using the information answered by other family member [3]. Moreover, it is assumed that someone over age 15 years would have their own independent thinking, and have the freedom to choose an activity that they prefer, such as reading, watching movies, exercise, sports, etc. [4]. Thus, the size of the sample for analysis was 8,617 cases.

Data analysis

Cross tabulations in order to explore the relationship between health behavior (exercise, smoking and drinking) and health status (comprise hypertension, diabetes, CHD, hyperlipidemia and cancer).

III. RESULTS AND DISCUSSION

- Smoking

Cigarette smoking could lead to increased risk of heart disease and stroke for males and females. Cigarette smoking is the main important cause of CHD. According to a survey in industrialized countries, 22% of CVD are caused by cigarette smoking, and accounts for nearly five million who died from CVD [5]. The smoking behavior in developing countries is increasing to levels in developed countries. WHO has estimated by the year 2020, tobacco will be the most important cause of death globally. More than 12 percent of tobacco-related mortality was contributed by India, China, and countries in the Middle Eastern Crescent. In this study the one-fourth of respondents who reported disease, are still smoking within hypertension (27.1%), diabetes (28.1%), CHD (27.9%), hyperlipidemia (25.2%) and cancer (24.3%). In addition to the potential harm smoking causes smokers, secondary inhalation of smoke by non-smokers is also a risk for CVD. According to the WHO, smoking behavior may increase risk of CVD threefold. Moreover, a project that aimed to reduce cardiovascular mortality through reduction of heath behavior risk such as smoking was able to reduce almost half of cardiovascular mortality [6].

- Alcohol

Research findings differ as to the amount of certain drugs that would have to be ingested to be harmful. Alcohol consumption in small amounts each day has been found to be helpful in retarding CVD. On the other hand, no one is advised to begin drinking alcohol for this purpose, and consumption of more than several drinks a day is considered unhealthful. Indeed, some studies found that lowering alcohol consumption is related with reducing the risk of CVD such as CHD. That said, other studies found that alcohol consumption of 1-2 drinks per day is related with the decreased cardiovascular risk by approximately 30 to 50 percent [7]. In this study, people who have cancer are mostly still drinking alcohol (35.1%), followed by those with hypertension (35.1%), diabetes (31.7%), hyperlipidemia (30.2%) and CHD (27.3%). One study found that the lower rate of alcohol drinking is associated with a lower rate of cardiovascular problems, for example, CHD [8]. Another study of the association and consequences of alcohol consumption and CHD found that several cardiovascular biomarkers are proxies for CHD. However, other studies found no relationship between the intake of vitamin C and T2D [10], and alcohol consumption and smoking were not associated with diabetes [11].

- Exercise

In this study, the sample 11.9% have hypertension ((N=1,024), 5.2% have diabetes (N= 445), 2.0% have CHD (N=172), 4.6% have hyperlipidemia (N=397), and 0.4% have cancer (N= 37). As noted earlier, decision-making theory states that people will decide to engage in a particular behavior based on their perceptions of risk-benefit [12]. In other words, if they have disease they are more likely to perceive the benefits of being active (e.g., improved health by doing exercise). By contrast, in this study, it was found that more than half of those having disease reported not exercising for health: Hypertension (53.7%), diabetes (51.7%), and CHD (65.1%), hyperlipidemia (65.5%) and

cancer (51.4%). A study in the United Kingdom found that the perceived barriers toward exercise was significant influence on exercise followed by the lack of time, expense, exercise environment, and family discouragement barriers [13]. The reason that people who have disease but still do not exercise may be due to a combination of several barriers, e.g., no facility to exercise, don't like to exercise, and no place to exercise. The policy of government should promote exercising for health at least three 30minute sessions, three times per week. Government should also try to reduce the cost barriers to exercise by promoting daily walks, riding a bicycle, and running or walking with house pets.

IV. CONCLUSION

Lifestyle and behavior are two important determinants of an individual's health status [14]. Health-related behaviors, including eating habits, smoking, alcohol consumption, drug abuse, and physical activity affect health. Some studies have examined eating, smoking, alcohol consumption, physical activity and sleep patterns [15]. According to Mendis, S., Puska, P., & Norrving, B. [16] the risk factors for disease for some health conditions are symptoms of disease while others are diseases in their own right. Among the lifestyle practices and behaviors examined for their potential health impact are tobacco use, alcohol consumption, sleep, exercise/inactivity, nutrition and diet, immunization history, social support and stress. Moreover, studies have found an association between exercising such as running, swimming, cycling and CHD risk. Furthermore, the Women's Health Study found a relationship between walking and CDV [17].

REFERENCES

[1] C. Kanchanachitra and C, Podhisita, "HIA: A Mechanism for Healthy Public Policy," *Thai Health 2011*, A. Hall, Bangkok, Institute for Population and Social Research - Mahidol University, 2011, pp. 84.

[2] J. C. Caldwell, "Population health in transition," *Bulletin of the World Health Organization*, vol. 79, no. 2, pp. 159-160, 2001.

[3] M. Blater, "Health and lifestyle," 1st ed. London: Routledge, 1990.

[4] C. Imes and F. Lewis, "Family history of cardiovascular disease, perceived cardiovascular disease risk, and health-related behavior: a review of the literature," *J Cardiovasc Nurs*, vol. 29, no. 2, pp. 108-129, 2014.

[5] D. R. Labarthe, "Epidemiology and prevention of cardiovascular diseases: A global challenge," *Journal of Public Health Policy*, vol. 23, no. 3, pp. 364, 2002.

[6] W. C. Willett, "Dietary fats and coronary heart disease," *Journal of Internal Medicine*, vol. 272, no. 1, pp. 13-24, 2012.

[7] D. Cutler, A. Deaton and A. Lleras-Muney, "The determinants of mortality," *Journal of Economic Perspective*, vol. 20, pp. 97-120, 2006.

[8] A. L. Klatsky, "Alcohol and Cardiovascular Health," *Integrative and Comparative Biology*, vol. 44, no. 4, pp. 324-328, 2004.

[10] J. Montonen, P. Knekt, R. J¨Arvinen and A. Reunanen, Dietary antioxidant intake and risk of Type 2 diabetes. *Diabetes Care*, vol. 27, pp. 362–366, 2004.

[11] W. Aekplakorn, P. Bunnag, M. Woodward, P. Sritara, S. Cheepudomwit and S. Yamwong, "A risk score for predicting incident diabetes in the Thai population," *Diabetes Care*, vol. 29, no. 8, pp. 1872-1877, 2006.

[12] S. Jacob, "The Demography and Epidemiology of Human Health and Aging, Springer," 2012.

[13] Grunbaum, J., Kann, L., Kinchen, S., Ross, J., & Hawkins, J. Centers for Disease Control and Prevention. Risk Behavior Surveillance, 53: 1–96. 2004.

[14] D. R. Williams, and C. Collins, "Race, socioeconomic status, and health: Complexities, ongoing challenges, and research opportunities," *Ann N Y Acad Sci.*, vol. 1186, pp. 69-101, 2010.

[15] S. Jacob, "The Demography and Epidemiology of Human Health and Aging," Springer, 2012.

[16] S. Mendis, P. Puska and B. Norrving, "Global atlas on cardiovascular disease prevention and control," Geneva: World Health Organization, 2011.

[17] E. H. Adrianne and J. S. David, "Physical activity and health," 2nd ed. London and New York: Routledge. 2009.

Recognition and access to health insurance benefits of migrant workers in Samut Prakan province

Issara siramaneerat
Department of social science, Faculty of Liberal Arts, Rajamangala University of Technology Thanyaburi, Thanyaburi, Pathumthani, THAILAND
*E-mail: issara_s@rmutt.ac.th, issara_sira@hormail.com

Abstract

Many migrant workers have to use migrant workers and be part of a country with migrant workers entering the health insurance system. This research objective is to study the perception of health insurance benefits of migrant workers in Samut Prakan Province and to study access to health insurance benefits of migrant workers in Samut Prakan Province.

This study was quantitative research by cross-sectional study method. The sample of this research was migrant workers who live in Samut Prakan Province, aged over 18 years and over. The total cases were 420 people. The statistical analysis was frequency, percentage percent, average and standard deviation. For data collection tools included 5 part; questionnaire about personal information, psychological factors, media exposure regarding health insurance benefits, perceived benefits of health insurance system and access to health insurance system.

The results of the perception of the benefits of the health insurance system found that most of them were not aware / did not know at all, accounting for 83.8 percent for access to health insurance benefits. It was found that most of them never had health problems, accounting for 81.7 percent. Most of them stopped work due to health problems for the last 1-2 days, accounting for 89.3 percent. Most of them did not treat by medical (86.9 percent). Most of them did not have access to health care centers, accounting for 81.7%, and most of them did not have health insurance card systems, accounting for 65.7%.

Keyword: Health insurance system, Recognition of benefits, Migrant workers

I. INTRODUCTION

Migrant workers are increasingly migrating to the Kingdom of Thailand and therefore have different impacts as a result. Public health impacts due to difficulties in accessing public health and receiving useful information that has a negative impact on health conditions for migrant workers such as the spread or distribution of important communicable diseases [1]. Therefore, the provision of public health services is necessary to provide services to groups of people in order to prevent the spread of diseases that may be attached to migrants [2]. In Samutprakarn Province, a total of 8,454 foreign workers classified into 3 categories (Myanmar, Laos, Cambodia).

This research aims to study the perception of health insurance benefits of migrant workers in Samut Prakan province and to study access to health insurance benefits of migrant workers in Samut Prakan province.

II. METHODS

Population and sample

The population is migrant workers (Cambodia, Myanmar and Laos) registered to live in Samut Prakan province aged 18 years or more. The researcher determined the confidence value at 95 percent. The tolerance was acceptable in the estimation of not more than 5 percent. A total of 425 people, and then selected a stratified sampling group, divided by a large factory with foreign workers making up the top 5 positions and dividing each group equally to 84 people.

Scope of research time

Project duration 1 year (1 October 2018 - 30 September 2019)

Research tools

In this data collection the researcher created a questionnaire as a tool to collect data which consisting of 6 parts:

(1) Questionnaire about personal information that can be answered by one answer, consisting of gender, age, status, nationality, education level, occupation, monthly income, number of family members, duration of stay in Thailand and having congenital diseases.

(2) Questionnaire about psychological factors contains information about attitudes towards health services and information about the perceived illness situation

(3) Questionnaire about media exposure regarding health insurance benefits by using a question that has answers by using the measurement level, Interval Scale, Likert Scale with 5 levels.

(4) Questionnaire about the perceived benefits of the health insurance system, including what benefits should be covered by health insurance and social security

(5) A questionnaire about access to health insurance is a question that can only be answered by

one answer, including health problems, work breaks, access to health facilities, health insurance cards.

Tool testing

1. The person who tests the accuracy (Validity), the researcher has studied the concepts and theories involved. To be used as a framework for creating queries After that, the researcher applied the questionnaire that was compiled to 3 experts, who considered the content validity, the appropriateness of the language used. To ask for suggestions for improvement and select only the questions that are accurate and then test before collecting the actual data to find the reliability of the questionnaire.

2. Reliability test the researcher has applied the revised questionnaire by using the experiment (Pre-Test) to find the confidence value (Reliability) using the Cronbach's Alpha Coefficient to test the reliability and consistency of the questionnaire which the overall reliability of the questionnaire is 0.86, which is greater than 0.70.

Descriptive Statistics Analysis

Descriptive statistics analysis including frequency, percentage, mean, standard deviation

III. RESULTS AND DISCUSSION

Personal characteristics

The results showed that most of the samples were female, accounting for 50.2 percent, most of them aged between 25-30 years (41.7 percent). Most of them had the highest single status (80.7 percent), most of whom have Cambodian nationality, accounting for 36.7 percent, most of them have the highest level of secondary education, accounting for 50.2 percent. Most of them have an average family membership of 2.624. Most of them lived in Thailand an average of 2.667 years. In addition, most of them have no underlying disease, accounting for 65.2 percent.

Results of the analysis of information about the perceived benefits of the health insurance system

The perception of the benefits of the health insurance system is mostly unknown / unknown at all, representing 83.8 percent, followed by the deposit / childbirth / postpartum care of 12.6 percent and medical treatment. Minor illness (outpatient), representing 11.4 percent.

Table 1 Number and percentage of perceived benefits of health insurance system (answer more than one)

Recognition of benefits of health insurance systems	frequency	percent
Don't know / don't know	352	83.8
Medical treatment for minor illnesses (outpatients)	48	11.4
Hospital stay (inpatient)	47	11.2
Injury, work accident	47	11.2
Deposit / childbirth / postpartum care	53	12.6
Health promotion / disease prevention	18	4.3
ARV antiviral drug	46	11.0
Vaccination for children	6	1.4
Dental / dental treatment	7	1.7
The treatment is very expensive.	69	16.4

Results of data analysis on access to health insurance benefits

From Table 2, the amount and percentage of access to health insurance benefits. The details are as follows.

The last health problem was that most of them had never had health problems, accounting for 81.7 percent, followed by health problems 1-3 years ago, representing 4.3 percent and having Health problems 1 month ago, representing 4.0 percent.

Day off due to the last health problem, most of them stopped work due to health problems for the last 1-2 days, accounting for 89.3 percent, followed half day (4.3 percent) and 1-2 hours, representing 3.1 percent.

Maintaining health problems is mostly not treated (86.9 percent), followed by taking medicine and resting (5.7 percent) and buying drugs at pharmacies (3.1 percent).

Access to health facilities is mostly not accessing, accounting for 81.7 percent, followed by access to public hospitals (8.1 percent) and health centers (4.5 percent).

The health insurance card system is mostly without the health insurance card, accounting for 65.7%, followed by the health insurance of the Ministry of Health (16.9%) and social security (6.4 percent).

Table 2 frequency and percentage of access to health insurance benefits of migrant workers in Samut Prakan province

Access to health insurance benefits	frequency	percent
Last health problem		
never	343	81.7
Ever		
1 month ago	17	4.0
6 months ago	16	3.8
1 year ago	10	2.4
1-3 years ago	18	4.3
More than 3 years	16	3.8
Day off due to the last health problem		
1-2 hours	13	3.1
Half Day	18	4.3
1-2 days	375	89.3
3-4 days	4	1.0
1 week	5	1.2
1 month	3	0.7
More than 1 month	2	0.5
Caring for health problems		
Not keeping	365	86.9
Rest only	8	1.9
Take medicine and rest	24	5.7
Find a doctor, don't have to sleep at	6	1.4
Looking for a doctor to sleep at the hospital	4	1.0
Buy medicine at the pharmacy	13	3.1
Use herbal medicine	-	-
Access to health facilities		
No	343	81.7
Yes		
Traditional doctor	15	3.6
public health Center	19	4.5
State Hospital	34	8.1
Private clinic	9	2.1
Private hospital	-	-
drugstore	-	-
NGO clinic	-	-
Health insurance card system		
None	276	65.7
Health insurance of the Ministry of Public Health, which is provided with a work permit	71	16.9
Health insurance of the Ministry of Public Health / Government hospitals that buy themselves	23	5.5
Social Security	27	6.4
Private health insurance purchased by yourself	23	5.5
Total	420	100.0

IV. CONCLUSION

From this research, leading to the support of the theoretical concepts that explain the importance of factors [3-5]. Attitude of foreign workers with access to health services of foreign workers, that is the more foreign workers have good attitude about how guidelines for accessing health services of alienate worker [6]. As well as if having accurate, clear, understandable communication, will result in more access to the health services of workers with more practical results.

ACKNOWLEDGEMENT

Research report on "Recognition and access to health insurance benefits of migrant workers in Samut Prakan province" with supporting by Faculty of Liberal Arts, Rajamangala University of Technology Thanyaburi. The researcher would like to thank you very much for this opportunity.

REFERENCES

[1] H. Abdul-Rahman and et al., "Negative impact induced by foreign workers: Evidence in Malaysian construction sector," *Habitat International*, vol. 36, no. 4, pp. 433-443, 2012

[2] M. Gulliford, "Access to Health care," London: King's College London, 2001.

[3] F. Y. Y. Ling and et al, "Strategies for Managing Migrant Construction Workers from China, India, and the Philippines," *Journal of Professional Issues in Engineering Education & Practice*, vol. 139, no. 1, pp. 19-26, 2013.

[4] J. D. Millet, "Management in public service: The quest for effective performance," *American Political Science Review*, vol. 48, no. 4, pp. 1173, 1954.

[5] R. Penchamsky and J. W. Thomas, "The concept of Access Definition and Relationship to Consumer Satisfaction," *Med Care*., vol. 19, no. 2, pp. 127-140, 1981.

[6] World Health Organizatio, "Towards age-friendly primary health care," Geneva: World Health Organization, 2004.

Stress and Stress management behavior of students at Rajamangala University of Technology

Issara siramaneerat and Pimnapat Bhumkittipich
Department of social science, Faculty of Liberal Arts, Rajamangala University of Technology Thanyaburi, Thanyaburi, Pathumthani, THAILAND
*E-mail: issara_s@rmutt.ac.th, issara_sira@hormail.com

Abstract

This research is interested about stress and stress management behavior of students at Rajamangala University of Technology in order to be a basic information in life, useful for development planning strategies in stress management. The objective of studying stress levels and stress management behavior of Rajamangala University of Technology students. The researcher collected samples from Rajamangala University of Technology students which consisted of Rajamangala University of Technology Thanyaburi, Rajamangala University of Technology Krungthep, Rajamangala University of Technology Tawan- ok, Rajamangala University of Technology Phra Nakhon, Rajamangala University of Technology Rattanakosin, Rajamangala University of Technology Lanna, Rajamangala University of Technology Srivijaya, Rajamangala University of Technology Suvarnabhumi and Rajamangala University of Technology Isan. The total number of samples is 1,625 people.

The researcher created a questionnaire consisting of 7 parts, including questionnaires about personal information. Psychological factors social factors, media exposure about stress management, student stress levels and questionnaires about student stress management behavior. The statistics used in this research were frequency, percentage, mean and standard deviation.

The results showed that students had moderate levels of stress. Most students feel that they do not concentrate as much as possible followed by nervousness, annoyance and heart attacks. In addition, the results of student stress management behavior analysis found that most students feel that the problem is an opportunity to learn and develop themselves. Followed by try to consult and ask for help from others and meditate to calm the mind.

Keywords: stress, stress management, student

I. INTRODUCTION

Stress from anxiety is considered the most important mental health problem in the world. Reported that stress from anxiety, in addition to being unhappy and causing various diseases. "Higher education is the age in which students are thinking. Learning process especially the new knowledge in the abstract Students therefore have to adjust themselves to suit the changing age. Which affects stress in individuals in the life of students, there must be many adaptations. When entering the university fence Since getting younger Adaptation to teaching methods at the university level Change of residence, environment, living in a new society that needs to prepare to enter the role of starting to work and build a family in the future [1-2].

In addition to other environments surrounding students, including Social, economic, family and friends including relationships with people at various levels Expectations for yourself, family and people around you all of which are related factors for students to stress the lifestyle of students at all levels of education. Students face stress that cannot be avoided [3-4]. Which, if the student evaluated and found that the stress occurred beyond the capacity of the student Students will feel threatened, lost, or challenged for personal security [4]. Coping behavior has many forms. Proper and effective coping behaviors must be behaviors that can handle the causes of stress. Can successfully reduce the uneasiness from problems that can help people to live in society together with others Snacks and normally do not cause hardship to society. Leading to adaptation into equilibrium On the other hand, individuals with inappropriate coping behavior will not be able to deal with stress to stay relaxed or sparse [3].

Therefore, when students assess the situation and find that the situation causes stress Students try to find ways to manage the stress that occurs by each individual student. There are strategies or methods for dealing with stress. And how it affects the mental health of students the researcher is interested in studying about stress. And factors that affect stress management behavior and mental health conditions of students at Rajamangala University of Technology in order to be a basic information in life, useful for development planning strategies in teaching and learning management of faculty members and used to manage student stress. In addition, the results of the study found and recommendations for stress management of students can be used and the results of the research will be developed to improve operations, prevent students from stress in their lives.

II. METHODS

Population and sample

The population used in the research is Rajamangala University of Technology, 147,780 students (Office of the Higher Education Commission Ministry of Education, 2015) Rajamangala University of Technology Thanyaburi Rajamangala University of Technology Krungthep Rajamangala University of Technology Tawan-ok Rajamangala University of Technology Phra Nakhon Rajamangala University of Technology Rattanakosin Rajamangala University of Technology Lanna Rajamangala University of Technology Srivijaya Rajamangala University of Technology Suvarnabhumi And Rajamangala University of Technology Isan.

The researcher determined the size of the sample group by using criteria as percentage of the population. Which is used in cases where the researcher knows the exact population by determining if the population size is hundred thousand should use at least 1% of the sample, with a total of 1,478 samples. 10% in the case of the returned questionnaire, there may be errors, including a total of 1,625 samples.

Scope of research time

Project duration 1 year (1 October 2018 - 30 September 2019)

Research tools

In this data collection The researcher created a questionnaire as a tool to collect data which consisting of 6 parts: Part 1 Personal information Part 2 Survey of stress levels Part 3 Mental Health Survey Part 4 Stress Management Survey Part 5 Social Factors Survey and Part 6: Media exposure survey on stress management

Tool testing

1. The person who tests the accuracy (Validity), the researcher has studied the concepts and theories involved. To be used as a framework for creating queries. After that, the researcher applied the questionnaire that was compiled to 3 experts, who considered the content validity, the appropriateness of the language used. To ask for suggestions for improvement and select only the questions that are accurate and then test before collecting the actual data to find the reliability of the questionnaire.

2. Reliability test the researcher has applied the revised questionnaire by using the experiment (Pre-Test) to find the confidence value (Reliability) using the Cronbach's Alpha Coefficient to test the reliability and consistency of the questionnaire which the overall reliability of the questionnaire is 0.79, which is greater than 0.70.

Descriptive Statistics Analysis

Descriptive statistics analysis including frequency, percentage, mean, standard deviation

III. RESULTS AND DISCUSSION

Personal characteristics

Part 1 General information

From the results of the research found that the sample group studied this time Most of them are female (96.80%). The average age is 20.96 (SD = 2.051), the first year (26.60%), the second year (22.20%), the third year (25.90%) and the year 4 (24.10 percent).

The average grade point average of grade 2-4 is 2.73 (S.D = 0.35). Parents / month, mostly 2,000 - 11,000 (96.80 percent), more than half the amount of education expenses (75.49 percent), no disease (94.30 percent), living in the same room for 4 people (86.90%).

Educational level of primary or lower fathers (46.5%), educational level of primary or lower mothers (48.40%), father / agriculture occupation (40.80%), maternal career, civil servants / state enterprises (percent 45.20).

Part 2 Stress levels

From the results of the research, it was found that most stress levels were at a moderate level (55.12 percent), followed by less stress (37.82 percent) and very stressful (7.05 percent).

Part 3 Stress causes

From the results of the research, it was found that educational commitment Is the cause that causes High level stress only one side with an average score of 17.17 (S.D. = 2.61) and the theoretical teaching, practical teaching Relationships with financial teachers and dormitories cause stress. Moderate level with an average score of 14.97 (S.D. = 3.18), 24.5 (S.D. = 5.15), 12.42 (S.D. = 3.37), 10.19 (S.D. = 2.83), 11.89 (S.D. = 3.45), respectively. In addition, health status is the cause that causes stress at a low level with an average score of 9.40 (S.D. = 2.95)

IV. CONCLUSION

Most of the samples had moderate stress levels. Because teaching and learning is both theoretical and practical, it is the education that is prepared to be capable of both academic and competent to follow the characteristics of the profession [5]. By focusing on teaching and learning by using the interaction process between learners and instructors continuously on the basis of caring for generosity, with students being the center of teaching and learning [6]. The instructor is the only person who encourages, supports and facilitates learning, creates opportunities and creates learning experiences for

learners, giving freedom to think critically and make rational decisions, emphasizing systematic thinking processes that result allowing students to fully express and participate in teaching and learning.

ACKNOWLEDGEMENT

Research report on "Stress and Stress management behavior of students at Rajamangala University of Technology" with supporting by institute of Research and Development, Rajamangala University of Technology Thanyaburi in the fiscal year 2019. The researcher would like to thank you very much for this opportunity.

REFERENCES

[1] Tassanaweekan "The Study of Stress Factors of Master of Nursing Students". Bangkok: Rangsit University. *Journal of Nursing*, Ministry of Public Health, 2012.

[2] T. Pha Tai, “Stress and stress management of students at Sakon Nakhon Rajabhat University,” Master of Public Health (Program thesis), Sakon Nakhon Rajabhat University, Sakon Nakhon, Thailand, 2010.

[3] P. Sangkhapan, “Stress and mental health problems of veterinary students in Khon Kaen University Education Services,” Faculty of Veterinary Medicine. Khonkaen University, 2013.

[4] P. Pensuwan, “Attitude, measurement, change and health behavior,” Bangkok: Thai Wattana Panich, 2007, pp. 1-2.

[5] P. Waisai, “Intellectual process,” Bangkok: Sodsri-Saritwong Foundation and the Office of the National Education Commission, 1999.

[6] Malee Vallert Sakornsiri, “Stress and stress management of nursing students while practicing delivery room,” Kueakarun Nursing College, *Kueakarun Journal*, vol. 22, no. 1, 2015.

Creative cultural: Application of Tai Lue woven apparels into cultural fashion

Jaipak Burapajattana
Faculty of Fine and Applied Arts, Rajamangala University of Technology Thanyaburi, Pathumthani, Thailand, E-mail: jaipakb@rmutt.ac.th, jaipak.on@gmail.com, (Phone: +668 3780 9522)

Abstract

This research has purpose to study type and uniqueness of woven apparel of Tai Lue tribe in Chiang Gong district, Chiangrai province for applying with fashions apparel in accordance to the concept of taking cultural into renovations. The research was carried out by quantitative and qualitative methods with 3 steps as the first step is to evaluation characteristic of the woven fabric apparel of Tai Lue in which the assesment revealed that uniqueness of Tai Lue woven fabric are from 1) style of original apparel of men and women of Tai Lue tribe 2) Patterns and weaving technique such as geometric patterns of Ko Luang technique, Jok technique, patterns from animals and plants, Kid technique, mythical creatures patterns 3) distinguished indigo, red and white colours. The second step is to asses target customers for their demand in fashions and took the result of assessment to make guidline in designing. The third step is to design and create colllection of apparel which origninalted from taking uniqueness of patterns and production of woven apparel of Tai Lue to apply with Deconstruction style fashions, and make it to a collection of Contemporary Tai Lue fashions consists of party apparel and fashion accessories according to current popularity cultural style fashions.

Keyword: Tai Lue weaving apparels, Fashionable of cultural apparels, Tai Lue contemporary fashion

I. INTRODUCTION

This research was made in accordance with strategic of the goverment to research and develop local wisdoms for commecial purpose and to take local culture and art to apply with products and services and to take local culture to develop for increasing local incomes that could be developed into creative cultural industrial and commercial value increasing.

Creative Cultural Concepts

Culture creation is to take cultural heritage and wisdoms to apply and developing productions and services. Throsby gave definition of culture that a culture is a valuable asset which consist of 2 types as tangible culture, such as archaeologgical sites, antiquities, temples, arts etc., and intangible culture which appears in form of intellectual property such as idea, believes, popularity, festival and traditions (Throsby David, 2001).

Culture creation also connects with cultural industrial of art and productive innovation products industials from cultural objects which made by original and contemporary wisdoms in the products and services. (Offce of Contemporary Art and Culture, 2552. B.E.)

This research took wisdoms in making woven fabric of Tai Lue to apply with fashion apparel. Tai Lue is a tribe that migrated from Sibsongpana state in China 200 years ago and inhabited in the area of Lanna state in northern area of Thailand which nowadays are Maehongson, Payaw, Chiangrai, Chiangmai, Lampoon, Lampang and Nan provinces. Notable and uniqueness in colours, patterns and delicately technic in woven fabric of Tai Lue which becomes important heritagee of Lanna was originated from combination of Tai-Lao cultures in languages, believes, livings and traditions.

Tai Lue woven fabric in Chiang Rai

Tai Lue woven fabric are made in 4 districts as Chiang Gong, Wiang Gan, Chiang San and Mae Sai. This research was scoped in woven fabric of Tai Lue which made in Tai Lue village at Sridonchai village in Chiang Gon district which is notable in Ko Luang technique with vivid colours and woven fabric of Had Bai village is notable in Jok technique with patterns in various colour. For woven fabric which made in Wiang Gan district, they were made by Ko technique into large diamon shape pattern on tube skirts. Patterns which made in Wiang Gan distric has similary style as patterns made in Sridonchai and Had Bai. However, their colour and size are different. There is no remarkable style in woven fabric which made in Chiang San and Mae Sai districts. Most of them are factorial made. (Songsak Prangwattanakul, 2008: 7)

From tentative research in original woven fabric of Tai Lue, their woven fabric is a handicrafts which made for specific purpose in official ceremonies. Their products are costly and inconvenience in real usage. Consumers demand products from modern combination styles and convenient for daily usage and made in other forms such as fashion apparel or accessories.

This research gives a guideline in design and development in commercial woven products of Tai Lue tribe in Lanna with technology/innovation and artistic creation for fashion designs of applied clothings suitable for present.

II. METHODS

There are 3 steps of quantitative and quanlitative evaluation in the research as follows:

First step: Evaluate characteristic of the woven fabric apparel of Tai Lue. Samples are Tai Lue woven fabric of Sridonchai village and Ban Had Bai village in Chiang Gong district, Chiangrai province. The sampling of sample clothings was made by purposive sampling. Tools in the research are by interviwing and questionaires to 5 specialists in Tai Lue fabric to obtain notable characteristic of Tai Lue woven fabric. The research is carried out by document analysis, field study and descriptive statistics analysis.

Second step: Evaluate demands of target consumers. The assessment was carried out to demand of target consumers to current fashion and clothings. The research was carried out by quantitative research. The samples were from 200 persons Gen.Y and Gen.X fashion consumers of ages between 25 and 39 years from tourists attraction area where fashion products are sold in Chiangrai and Chiangmai provinces. Tools of research are questionaires in demands and satisfactions in style, patterns, colour, production method, type and property of raw material and price. Analysis of data for conclusion in demands and satisfaction of consumers to style of cultural clothings was made by statistics and deviation calculation method.

Third step: Design and making prototype product. Designs and making prototype products was from taking the result of analysis to type and uniqueness of Tai Lue fabric and behavior of demands of target consumers to apply with the designs of current fashion. Prototype product was selected and developed by fabric specialists.

III. RESULTS AND DISCUSSION

In conclusion, result of analysis consists of followings 3 steps

First step: Evaluate characteristic of the woven fabric apparel of Tai Lue. could be concluded as follows:

1. Type and uniqueness of Tai Lue weaving apparel

Type and uniqueness of men's apparel are Puad shirts, trousers or " Teao Pao" which are decorated with colour strip clothes. The accessories consist of sash, turban, shoulder scarf for special ceremony which called "Ched" that weaved by Kid and Jok weaving technique and shoulder strap bag.

Type and uniqueness of women's apparel are women style Puad shirts in oblique layers, decorated by colour strip clothes at neck, waist, sleeves and bottom of its body, rope with tassel at side of the body and silver buttons.

Fig. 1 Apparel, origins: Lue Lai Kam museum, Sridonchai village and Thai Lue woven fabric maker group of Had Bai village, Chiang Gon district, Chiang Rai province.

Fig. 2 Women apparel, origin: Tai Lue woven fabric group of Had Bai village and Lue Lai Kam museum of Sridonchai village, Chiang Gon district, Chiang Rai province.

Tube skirts consist of 3 steps. Middle of the tube skirt is the most notable part. The tube skirts of Ban Sridonchai are made of varicolour weaving and connected with woven patterns which made of vivid colour thread by Ko Luang weaving technique. The tube skirts of Ban Had Bai are made of Jok woven

technique and have vivid colour. Main patterns is three- lines Jok. Accessories are turban and silver ornaments.

2. Concept and origin of patterns creation in Tai Lue woven fabric

Patterns in woven fabric of Tai Lue were from ordinary livings style including culture and their believes the patterns show origin of local, and separated for men and women usage. For example, animal patterns appear on shoulder scarf of men. They would not be used for women tube skirts. Patterns for women apparel are from various kinds flowers such as Hub flower, violet flower and Jai flower. Colour of woven fabric reflects classification in the society. Patterns in the woven fabric could be categorized into following 3 groups

1. Simple pattern group consists of patterns from composition of lines into triangles and squares. This kind of patterns thereafter developed to complex patterns and sometimes used as supplementary patterns such as patterns of Hub flower, Jai flower etc.

2. Patterns from plants which developed from simple patterns, originated from steps of plants such as leaves, flowers, and full plant such as Kaew flower, Jun flower, fern etc. for reflecting abundant.

Fig. 3 Patterns from plants, Kaew flower, origin: Woven group of Tai Lue Had Bai village by Sukawadee Tiyata.

3. Patterns from animals were originated from figure of animal to reflect greatness, abundant, fortune and prosperity. Samples of these patterns are birds, elephant, horse and myth animals.

Fig. 4 Animal patterns of Tai Lue woven fabric of Chiang Gon. Origin: Lue Tai Kam Musuem of Sridonchai village.

3. Technique of patterns

Patterns in Tai Lue fabric are made of following 3 techniques

Ko Luang or Luang technique used for ordinary crossing woven fabric. Patterns are resulted from various colour threads with weft yarn looping around the warp yarns caused alternative vivid colour in zigzag and geometry patterns.

Fig. 5 Ko Luang technique in woven fabric of Sridonchai village. Origin: Tai Lue woven fabric maker group fo Sridonchai village by Dokkaew Teerakote

Jok technique Patterns are resulted from using special weft yarn and picking it by hand to cross with the warp yarn to intended patterns and colour.

Fig. 6 Pattern from Jok technique in Tai Lue woven fabric of Chiang Gon. Origin: interviewing with Dokkaeq Teerakot and Sukawadee Tiyata

Kid technique (Fig.7) Patterns in woven fabric are resulted from grouping of warp yarns and additional weft yarns along the width of the fabric during weaving. Patterns which caused from weft yarn has same colour or made into steps of same colour along the length of the fabric. Patterns made of Kid Technique are myth animals such as mythical birds, elephants, horses, Naga or Hong (Swan) etc.

Fig. 7 Tai Lue woven fabric made of Kid technique with cock and horse patterns (Songsak Prangwattanakul, 2016: 41)

4. Uniqueness of Tai Lue woven fabric

Uniqueness of Tai Lue woven fabric appear in patterns and colour of apparel for men and women of Ban Sridonchai which made by Ko Luang technique. Uniqueness of woven fabric of Ban Had Bai is from Jok technique.

5. Material and colour

Woven fabric are made of cotton yarn with original colours as red from shellac, green, yellow, indigo, pink and black. In general, notable colours of Tai Lue woven fabric are indigo, red and white.

6. Development of production method, colours and patterns

Original woven fabric of Had Bai village are made with small patterns with average colour from hand made cottons. Nowadays, the woven fabric are made according to order of customers with larger patterns in colorful or contrast colours. They are made from factorial yarn. The products are made for 2 categories customers as for customers who prefer original weaving style with colour from natural materials and for customers who prefer new weaving technique with large patterns and vivid colours. Original woven fabric of Sridonchai village are made from original style with colour from nature material and hand made yarn. However, nowadays, they are made of factorial yarn in colorful.

7. Recommendation in preserving, developing or applying culture of Tai Lue woven fabric with modern lifestyle

Nowadays, there are 2 different demand of customers in the products as one prefer preservative works and another prefer modern style works. Both kinds of products should be made according to skill of makers. New patterns should be developed with trends of colour. The products should be made in modern forms and applied with other categories products such as bags, souvenirs and small items etc.

Second step: Result of evaluate demands of target consumers

Affective domain data to cultural fashion apparel

Preferable style in fashion products is from combination of original and modern style. Preference fashion is semi party and casual wears made of natural fibers. Most preferable texture is soft and thick. Preference production is by weaving which decorated with objects. Most favorable pattern is from combination of local and new design patterns. Reasonable costs should be between Baht 1,001 and Baht 3,000. Most preferable style of fashion are modern style and decon style. Personality of apparel is creative style. Most preferable accessories are bags, shoes and shoulder scarf.

Influence factors in decision to purchase cultural fashion apparel are uniqueness style, beauty and delicate works of the products local.

Third step: Design and making prototype product

From analyzing uniqueness of Tai Lue weaving apparel and evaluate preference to behavior of target consumers, the researcher took conclusion from the findings and concept in fashion design to create guidelines and factors for designing cultural contemporary apparel as follows

Inspiration mood board

Fig. 8 Inspiration mood board in the collection Contemporary Tai Lue**.**

Concept & Inspiration: Contemporary Tai Lue collection

Designing of the collection of Tai Lue contemporary fashion is a combination of pattern and production from original unique Tai Lue apparel and woven fabric, and Deconstruction style fashions into creation of fashion for party for Gen-Y consumers who have creative personality character and prefer modern design apparel with uniqueness. The design was made from trend WGSN Autumn/Winter 2016-2017 as a concept for learning and creation. The prototype products are added by local art works such as decorated with handicraft artworks to make collection of cultural contemporary fashions.

Table 1 Guideline of collection design

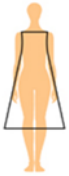
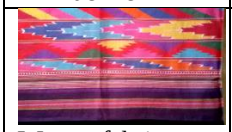
Concept & Inspiration	Silhouette	Detail finishing	Fabric & Surface	Color	style
 Shirts of Tai Lue	 A-Line	 Special yarn at surface of woven fabric	 Hemp yarn	 Colour of woven fabric	 Deconstruction style fashion
 Apparel of Tai Lue women	 Straight	 Line embroidering	 Handmade woven fabric	 Colour Theme, Blue indigo red and white	
 Apparel of Tail Lue men	 Trapeze	 Embroidering	 Weaving texture fabric		
 Woven fabric with Ko Luang technique	 Tunic	 Embroidering with beads			
 Woven fabric with mythical animals		 Connecting of different pieces of clothes			

Table 2 Applied patterns from woven fabric of Tai Lue

Original: Pattern of Tai Lue woven fabric with Ko Luang Technique	Original: Pattern of Tai Lue weaving technique in mythical animal and plants
  Applied: Weaving by Ko Luang technique with special yarns	  Applied: Cock, horses, Naga and flowers pattern which made of special yard with toned colours and leaving end of yarns
 Animal patterns by Ko Luang technique  Wooden beads applied with patterns from Ko Luang weaving teachnique	  Naga and flowers patterns made of special gold and silver yarns.

Illustration of the collection Contemporary Tai Lue

Fig. 9 Sample picture of collection of contemporary style fashion from Tai Lue apparel

From the concept, 10 samples of mix and match apparel for party wear with accessories such as shoes, bags, shoulder scarfs were created.

Sample of design process of a dress in collection Contemporary Tai Lue (Fig. 10)

2 layers skirts. Inner layer skirt is strapless, outer layer skirt is single side oblique shoulder scarf. The sample is from silhouette of Tunic decorated with woven fabric which applied from Ko Luang weaving pattern and horses pattern, added with special wavy and fluffy golden and silver weft yarns and embroiled with wooden beads. Layout of patterns on the dresses is applied from positioning of shoulder scarf in traditional wears of Tai Lue for men. The sample made of white and indigo woven fabric. The

design was originated from concept of applying deconstruction style fashions to create a collection of Contemporary Tai Lue apparel for party.

Collection consist of dress, shirt, coats, skirts and pants. Each of them could be applied together by mixing and matching. Design of the dress was applied from Deconstruction Style fashions detailed by decorated with patterns that applied from patterns in Tai Lue woven fabric and finishing on surface of woven fabric part on the dress with special yarn, embroidering and put wooden beads in the yarn during weaving process. This collection is for occasion of party or business party.

Fig. 10 Samples of design process of a dress in collection Contemporary Tai Lue.

Fig. 11 Prototype products of fashion of the collection Contemporary Tai Lue.

Prototype accessories for the collection Contemporary Tai Lue

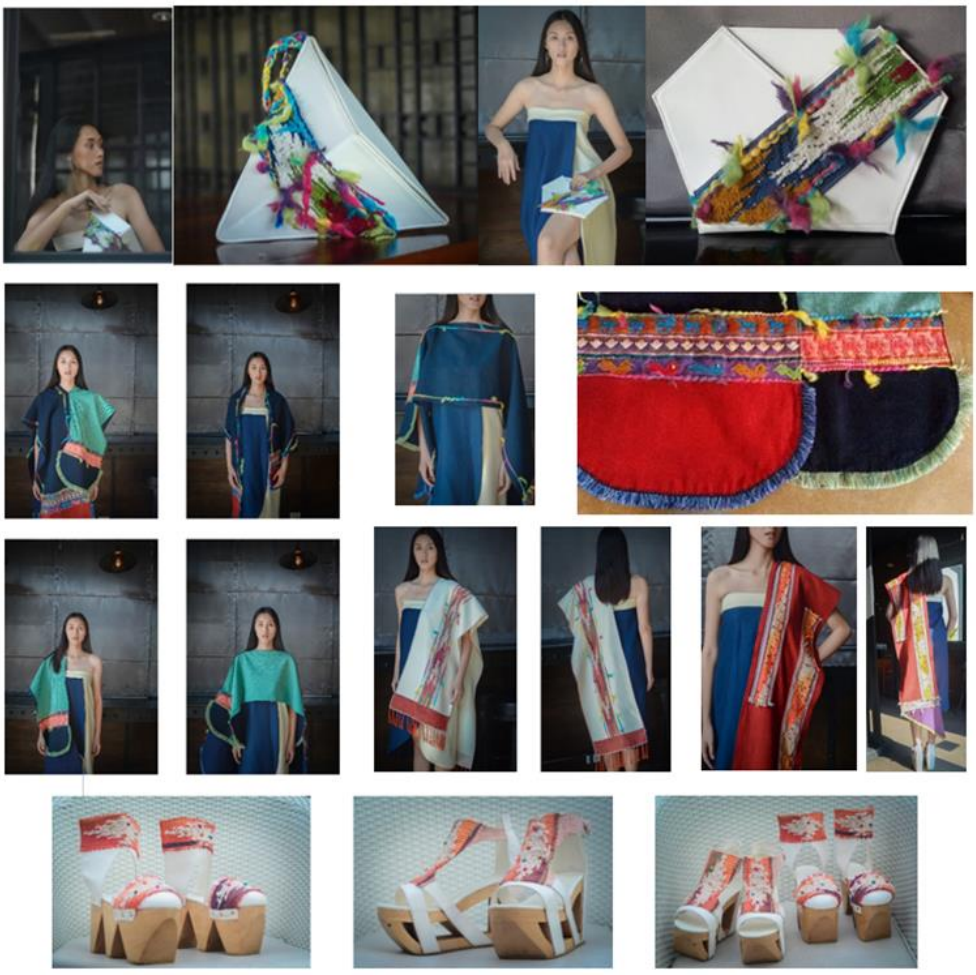


Fig. 12 Prototype accessories for the collection Contemporary Tai Lue consists of triangular and pentagon shape bags, adjustable shoulder scarf (could be adjusted to 5 styles) and shoes made of woven fabric of Tai Lue.

IV. CONCLUSION

From the research, the researcher took cultural wisdoms and concept of traditional contemporary design of Department of International Promotion Ministry of Commerce, Thailand (2558) to study and created sample contemporary products. The idea was originated from countries attempt to apply new creative ideas with their own cultural heritage and local wisdoms to create cultural products. In taking cultural heritage to apply with designs of a product, it is necessary to understand relation and changing of culture when time passed. Designing of contemporary cultural products is the matter of applying value of an original product with present lifestyle to increase value or make alternative usage of products in the present. In conclusion of this research, it could be categorized as follows**:**

1. Cultural Wisdoms Taking beauty from cultural wisdoms products to apply with new designed products. Subjects of cultural wisdoms products are shirts, Tai Lue type tube skirts, patterns which made by Ko Luang and Jok techniques, patterns of mythical animals ie. Cocks, Naga, Horses, Flowers to apply with new designed woven fabric and apparel.

2. Customers Target group of customers was specific and studied their taste, behavior, lifestyle and requirement in fashion design products. The created products were designed for Gen. Y customers who have creative behavior and personality, prefer uniqueness and new style of designs, emphasized on patterns, materials texture and various colour.

3. Innovation Took uniqueness in woven fabric, weaving technique of original apparel of Tai Lue tribe to develop by applying modern yarns which are wavy, fluffy, colorful, golden yarn and silver yarn in original weaving to create new fabric and added embroidering technique and creating of texture senses by leaving yarns' end to the fabric.

4. Style and trends of fashion Took concepts of deconstruction style fashions, concepts of imperfect figures, trends of design from TREND WGSN Autumn/ Winter 016- 2017, studying and creation concepts, beauty and uniqueness of cultural local arts and handicrafts into designing of contemporary party fashions from cultural woven fabric of Tai Lue.

ACKNOWLEDGEMENT

I would like to thank you Asst. Prof. Songsak Prangwattanakul who is professional specialist in Tai Lue woven fabric, Mrs. Dokkaew Teerakott; the leader of Tai Lue woven fabric maker group of Sridonchai village, Mrs. Sukawadee Tiyata; the leader of Tai Lue woven fabric maker group of Had Bai village, Mr. Suriya Wonchai the founder of Lue Lai Kam museum in Sridonchai village and professional weavers in Chiang Gong districts for their knowledge and information to complete this research.

This research is supported by Institute of Research and Development Rajamangala University of Technology Thanyaburi.

REFERENCE

[1] Department of International Promotion Ministry of Commerce, " Made for Asian 5 consumer Trends," http: / / ditp. com, 25 July 2014.

[2] Institute for Small and Medium Enterprises Development (ISMED), "Creative Capital for from Thai Identity," Ministry of Industrial Bangkok, 2012.

[3] Office of Contemporary Art and Culture (2014, Dec 25), *What is Industrial Culture and Creative Industrial* [Online], Available: http://www.ocac.go.th

[4] S. Prangwatanakun, "Cultural Heritage of Tai Lue Fabric Chiang Mai" , Thai Department, Faculty of Humanities Chiang Mai University, pp. 7, 2008.

[5] S. Prangwatanakun, "Inherited Tai Lue woven fabric, Lue Lai Kam Museum," *A. P. Graphic Designs and Printing*, vol. 1, pp. 41, 2016.

[6] Trend A/W 2016-2017, http: www. wgsn. com, 2015.

[7] Throsby, David, " Economic and Culture" , United Kingdom: University Press Cambridge, 2001.

Information Techmology and Reinforcement of a Family Relationship

Manipat Saimek
Department of Social and Humanities Sciences, Faculty of Libraral Arts, Rajamangala University of Technology Thanyaburi, Thanyaburi, Pathumthani, THAILAND
*E-Mail: manipat_s@rmutt.ac.th, mysaimek2016@gmail.com (Phone: +668 3705 1823)

Abstract

Study has two purposes: 1. To study characteristics of a population and the utilization of technology 2. To study the connection between the technology utilization and a family relationship. Purposive sampling is adopted during this analysis including 385 samples of the population utilizing information technology for family communication solely. According to the research, an activity relating family participation is food consumption calculated as 65.2 percent from the entire respondents. With regard to the technology utilization of the samples, it is reported that the percentage of Line, Facebook, and mobile phone applications. The peak time that the entire respondents individually utilize those applications is after office hours. Furthermore, the utilization of technology as a medium for family communication is at a higher level. Regarding the preferences for family communication, the samples are likely to have face-to-face communication that technology assists in reinforcing family relationship moderately. In other words, technology assists in a stronger family relationship. As reported by the analysis result with the utilization of Correlation for the relationship between the population and the family relationship, it is determined that the mother with higher educational level might have a lower family relationship.

Keyword: Technology, Reinforcement relationship, Family

I. INTRODUCTION

A family refers to an institution, an organization or a smallest social unit established by male and female members who assume the roles of a father and a mother. They are paternal and maternal role models who cultivate a seed of knowledge to a new member in order to shape his or her personalities. Moreover, a parent is a powerful physical and mental source who strengthens family members to take a step on any social roles in relevant institutions. Furthermore, a family unit is able to fulfill the basic human needs at all levels such as physiological needs, psychological needs and social needs (Pinyo Thongdee, 2017). With regard to a healthy family relationship, it can be built by good communication, share quality time all together and take care of each other. However, due to an increase in a single parent family, this problem requires understanding and considerable significance. A healthy family relationship is a key factor that strengthens family members love, a relationship, understanding, forgiveness and encouragement to overcome challenges and obstacles. All family members are inextricably intertwined by this healthy relationship. On the other hand, an unhealthy one results in a higher rate of abandonment and divorce. Both are current issues in Thai society especially for working members whose family roles include child rearing, elderly care and family well-being.

Regarding the future change of Thailand in the next 20 years (in 2036), "A National Strategy" was formulated to be a long-term strategy for supporting significant changes since the beginning of the 21st century. It was devised due to a current phase of intense globalization. Many countries have adopted a free trade policy among a giant leap of technological advancement in various fields especially information technology, which conveniently assists people to connect globally. In the phase of intense globalization, the following ones can be transferred effortlessly and globally: products, services, capitals, people, news information, knowledge, including technologies. A borderless world exerts an influence on rapid changes in an economic and social landscape as well as the world's geopolitics. In addition, the economic affairs of each country are closely connected. They must be reciprocated because of extensive opportunities, rapid adverse effects, combining with a giant leap of technological advancement.

We Are Social, a digital agency, as well as Hootsuite, a service provider of Social Media and Marketing Solutions management system, have gathered the statistical data of global internet usage. They aimed to project changes in online businesses and internet usage behaviors of consumers in each country. Regarding the statistical data, it was discovered that a recent number of worldwide internet users were more than 4,000 million people. In anticipation of the 2017 global internet usage data, a number of new smartphone users were more than 200 million people. Furthermore, two over three of 7,600 million of the world's population possessed mobiles. The growth of smartphones, as well as internet users on smartphones, directly contributed to an increasing number of Social Media users. Recently, 3,000 million of the world's population has accessed Social Media monthly. Nine over ten of Social Media users has accessed Social Media via Mobile Device (Brand Buffet, 2018:1). Considering

the statistical data of Thailand, the number of the entire population was 69.11 million (53% of the population lived in urban areas). The number of the female population was 51.3% whereas the number of the male population was 48.7%. The average of a personal income was 16,946 United States dollars annually. The proportion of an educated person was 97% out of the entire population. The number of internet users was 57 million while the number of Social Media users was up to 51 million. The number of mobile numbers utilized by mobile users was up to 93.61, which was higher than a number of the entire population. In addition, considering the number of the entire internet users, the number of Social Media users who has daily accessed the internet via Smart Device was 46 million people (Brand Buffet, 2018:4).

With regard to current family issues, they might be caused by ineffective communication or a lack of communication in the family. This lack of communication might arise from the notion that family members already have a close sense of intimacy; hence, it is not necessary for in-depth communication. However, it is essential to communicate in family and the communication must be an effective and creative one. Positive communication techniques can bring about mutual understanding, which further contributes to the fulfillment especially of love and filiation (Nuanchavee Prasertsuk, 2015: 737-747). According to Patsara Pongsukvajchakul's abstract in 2011, it was found out that new communication technologies did not exert an influence over family members to communicate more frequently. This insignificance of new technologies was a result of family members attaching significance to a face-to-face conversation or meeting. However, communication via new technologies assisted family members to build a healthy relationship, look after each other, and live comfortably. Nevertheless, some families expressed their similar opinion that a family life with new communication technologies was not different from life without new communication technologies (Wellman, Smith, Wells, and Kennedy, 2008).

Therefore, the purposes of this research are to study on characteristics of the population and technology utilization as well as the correlation between information technology and a family relationship. The scope of the research is quite limited to information technology and a family relationship.

II. METHODS

A survey research was utilized in this research. This method includes a preliminary interview with the utilization of a questionnaire. Regarding the infinite population who utilized information technology for family communication, sample selection was based on the Household Survey on the Use of Information and Communication Technology by the National Statistical Office under the authority of the Ministry of Information and Communication Technology. The researcher specifically selected the population aged between 16 and 23 who utilized information technology for family communication. Purposive Sampling was utilized for the sample selection with the following criteria: 1. the samples must be the population aged between 16 and 23 who use information technology for communicating in a family only 2. the samples must be the population who live in the Bangkok Metropolitan Region. The total number of samples is 385. A survey research method with the utilization of a questionnaire was conducted for data collection. Content validity, as well as a non-structured interview, were utilized in this research. The data collection period was between 1 October 2016 and 30 June 2018.

This research consists of 3 variables: 1. Independent Variable, which consists of gender, age, a dwelling, an educational level of each family member, a family size, family status, the number of family members, a domicile and a family income 2. Intervening Variable, which consists of technology utilization, and 3. Dependent Variable, which consists of a family relationship. Additionally, descriptive statistics were used for data analysis consisting of a number, a percentage as well as the correlation analysis. This analysis includes the correlation between characteristics of the population and a family relationship as well as the correlation between technology utilization and a family relationship. A correlation coefficient at the significant level of 0.05 was utilized in this analysis.

III. RESULTS AND DISCUSSION

According to the survey research answered by the entire respondents, it is found out that the majority of the population from 385 samples are female calculated as 71.2%. Samples' age is in the range of 16 to 23 years old with the highest number of 20-year-old population calculated as 40.8%. 19-year-old and 21-year-old populations are the second and the third highest numbers with percentages of 32.7 and 18.2 respectively. Furthermore, 70.9% of samples lives with their parents whereas 12.2% of samples lives in a single parent family. While the percentage of samples whose parents are divorced is 10.6, the percentage of samples whose parents are dead is 12.2. Besides, the highest educational level of samples' fathers and mothers is a high school level calculated as 39.0% and 34.0% respectively. Apart from parental educational level, the majority of samples lives in a nuclear family (a parent and child) with approximately 3-5 family members calculated as 64.9%. When looking into more details, the percentage of samples who have 4 family members is 34.3. While the percentage of samples who have 5 family members is 22.6, 20.3% of samples has 3 family members. Additionally, the average income of samples' families is 32,242.42 baht per month. Aside from the average income, the percentage of the

samples who apply for tenancies is 64.1. While samples' family dwellings are in perimeters calculated as 31.7%, the percentage of samples whose family dwellings are out of town is 28.8. In addition, the most popular family activity for the samples is family dining calculated as 65.2% whereas the second and the third ones are television watching and traveling.

Regarding the study on technology utilization of the entire respondents, it is revealed that the most popular technology utilization is Line Application with a percentage of 95.8. The second one is Facebook calculated as 90.4% while the third popular one is a phone call with 80.8%. Furthermore, samples' technology utilization reaches a peak after the work calculated as 25.1% whereas the second popular hours of technology use is during lunch break with a percentage of 19.7. Additionally, respondents tend to have a conversation or share technology utilization mostly with their friends calculated as 75.5%. The second one is a family member with 41.7%. In addition, respondents highly use technology as a device for communicating in their families calculated as 53.0%. Considering the preference for family communication style, it is displayed that 83.9% of respondents prefers face-to-face conversations while 10.9% prefers phone calls. Nevertheless, only 5.2% of respondents prefers communication via mobile applications as follows:

Table 1 Preference for Family Communication Styles

Family Communication Styles Preferred	Number of Respondents	Percentage
Through various applications	20	5.2
Face-to-Face conversations	323	83.9
Talking on the phone	42	10.9

Table 2 The Correlation between the Population and a Family Relationship

Characteristics of the Population	Percentage
Gender	0.006
Age	-0.096
Parental Status	0.030
A Number of Family Members	0.037
Average Income of Family	0.033
Educational Level of Father	0.049
Educational Level of Mother	-0.107*

*Correlation is significant at the 0.05 level (2-tailed)

Furthermore, it is found out that 55.1% of respondents views that technology assists in building a stronger family relationship. While 32.5% of respondents views that technology has no influence on a family relationship, 12.5% considers that technology has a negative impact on a family relationship.

With regard to the correlation between the population and a family relationship, it emphasizes variables of gender, age, parental status, a number of family members, the average income of a family, a parental educational level and a family relationship as shown in the Table No. 2 above.

According to the preference for communication styles, it is revealed that 83.9% of respondents prefers face-to-face conversations while 10.9% prefers phone calls. However, only 5.2% prefers communication via mobile applications. These results correspond to the results of the study of Suthida Chokprasombut (2008: 566-580) as well as Patsara Pongsukvajchakul (2011: abstract) that new communication technologies did not exert an influence over family members to communicate more frequently because they attached significance to a face-to-face conversation or reaction.

The significant variable of a family relationship is the educational level of a mother. The higher educational level of a mother is; the unhealthier family relationship is. Nevertheless, other variables have no impact on a family relationship. This zero impact correspond to the study of Chittinun Dejagupta and the Advisory Committee (2010: 71-79) that a social change had a tendency to reduce family hours.

Therefore, this study on information technology and family relationship enhancement indicated that technology assisted a healthy family relationship to forge a closer relationship. However, based on the result of this research, face-to-face communication is preferred to technology utilization for family communication, which conforms to the result of the study of Wellman, Smith, Wells, and Kennedy (2008).

IV. CONCLUSION

Purposive Sampling was utilized in this research in order to select 385 samples from the population who used information technology for communicating in their families only. According to the results of this study, it is found out that the percentage of female samples aged between 16 and 23 is 71.2. Furthermore, 70.9% of the samples' parental status is living together. Apart from parental status, an educational level of a father and a mother is a high school level calculated as 39.0% and 34.0% respectively. Besides, 64.9% of samples lives in a nuclear family, which 77.2% of them lives with approximately 3-5 family members. Additionally, the average income of each family is 32,242.42 baht per month. Aside from the income, 64.1% of samples lives in dormitories or applies for tenancies. Their families live in perimeters and provincial areas with percentages of 31.7 and 28.8 respectively. In addition, the most popular family activity is family dining calculated as 65.2%. All of the aforementioned data is based on answers from the entire respondents.

With regard to technology utilization, it is discovered that the percentages of Line users, Facebook users and Phone users are 95.8%, 90.4% and 80.8% respectively. Moreover, the peak hours of the utilization is after the work calculated as 25.1%. Furthermore, 53.0% of the respondents mostly uses technology as a device for communicating in their families. With a percentage of 83.9, the respondents prefer face-to-face communication. In addition, 45.5% of the respondents considers that technology moderately strengthens a family relationship whereas 55.1% views that technology strengthens a healthier family relationship.

ACKNOWLEDGEMENT

The researcher is highly appreciated and indebted to a faculty of Liberal Arts from the Rajamangala University of Technology Thanyaburi for their support in providing the research fund.

REFERENCES

[1] C. Dejagupta and the Advisory Committee for the 2010 Government Budget of Department of Women's Affairs and Family Development. 2010 (2017, Dec 05). *A Study and Development of Model Promoting Thai Family Security* [Online]. Available: http://humaneco.stou.ac.th/UploadedFile/Tittle%20HE%20Journal%207.pdf.

[2] N. Prasertsuk, "Constructive Communication for Family Happiness. Veridian E-Journal. Slipakorn University," *(Humanities, Social Sciences and Arts) Thai Edition*, vol. 8, no. 2, pp. 737-747, 2015.

[3] P. Pongsukvajchakul, "New Media Technologies and Communication in Thai Families in Bangkok Metropolitan. A Thesis for the Degree of Doctor of Philosophy in Communication Arts," Department of Communication Arts, Graduate School, Dhurakij Pundit University, Bangkok, 2011.

[4] P. Thongdee (2017, Aug 4), Family Institution. [Online]. Available: human.cmu.ac.th/home/he/ebook/006103/lesson1/02.htm

[5] S. Thayansin, "Family Relationship," *Thai Health*, National Institute for Child and Family Development, Mahidol University. Nakhon Pathom. 2011. pp. 22-23.

[6] Office of the National Economic and Social Development Council. 2015. Directions and Strategic Frameworks for the Twelfth National Economic and Social Development Plan (2017-2021. Focus Group Documents for the directions of the Twelfth National Economic and Social Development Plan. Office of the National Economic and Social Development Council. Bangkok.

[7] Office of the National Economic and Social Development Council. 2017 (2018, Aug 28), *The 20-Year National Strategy Draft Summary* (2017-2036) [Online], Available: http://www.nesdb.go.th/download/document/ร่างยุทธศาสตร์%20ระยะ%2020%20ปี%20(พ.ศ.2560%20-%202579).pdf.

[8] S. Chokprasombut, "Internet and Family Relationships of Bangkok's Adolescents," *Ramkhamhaeng University Journal*, vol. 27, Special Edition of the Graduate School no.3, pp. 566-580, 2008.

[9] Brand Buffet(2018, Aug 28), Key Statistical Indicators for the Global Digital Users, "Thais" the Majority of Internet Addiction – "Bangkok" the City of the Highest Number of Facebook Users [Online] Source:http://www.brandbuffet.in. th/ 2018/ 02/ global- and- thailand- digital-report-2018/

[10] B. Wellman, A. Smith, A. Wells and T. Kennedy, "Networked Families. Pew Internet & American Life Project," The USA. Washington D.C. 2008.

2ND ASEIS 2019
AND 4TH PRN-CON

Institue od Research and Development, Rajamangala University of Technology Thanyaburi

0 2549 4681 www.aseis2019.rmutt.ac.th