Proceedings of ICRU
International Conference
Rajabhat University Networks
Sustainable Community Development

The 1st ICRU International Conference: Sustainable Community Development
Hosted by 6 Rajabhat Universities and 3 overseas university networks
Organized by Chiang Mai Rajabhat University
February 18-20, 2019
The Empress Hotel Chiang Mai

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Proceedings of the 1st ICRU International Conference: Sustainable Community Development (ICRU 2019)

February 18-19, 2019
The Empress Hotel Chiang Mai

Organized by
Chiang Mai Rajabhat University
Chiang Rai Rajabhat University
Nakhon Sawan Rajabhat University
Nakhon Si Thammarat Rajabhat University
Rambhai Barni Rajabhat University
Lampang Rajabhat University
Feng Chia University
National Chin-Yi University of Technology
National Pingtung University
Proceedings of the 1st ICRU International Conference: Sustainable Community Development (ICRU 2019)

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Sutthinan Chuenchom  
Khontaros Chaiyasut

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Message from the President of Chiang Mai Rajabhat University

Presidents of Rajabhat Universities and the overseas university networks, Distinguished Keynote Speakers and Guests

Ladies and Gentlemen

It gives me very great pleasure to welcome you all to The 1st ICRU International Conference: Sustainable Community Development (ICRU 2019), which is hosted by 6 Rajabhat Universities and 3 overseas university networks.

I wish to congratulate all the parties involved in organizing this conference for their sincere efforts to make it a really successful event. We have a most interesting and exciting program for the conference and expect that this conference will be a venue for academicians and researchers to express and share their findings, together with building relationships and networks with others, so as with a purpose to mutually achieve the ultimate goal of sustainable development. It is crucial to learn lessons from other countries concerning business, science, economics, society and culture fields, and we are all here today to achieve this aim.

Once again I welcome all the 5 Presidents of Rajabhat Universities and the overseas university networks, as well as the local and overseas participants to Chiang Mai, a beautiful and innovative city with its own unique culture. Hope you all have a great time here with us!

Thank you.

Associate Professor Dr. Prapan Thumachai
President of Chiang Mai Rajabhat University
Message from the President of Nakhon Si Thammarat Rajabhat University

Presidents of Rajabhat Universities, the presidents of overseas university networks, distinguished keynote speakers, presenters, honored participants, ladies and gentlemen,

It is a great honor and pleasure for me to act on behalf of 6 Rajabhat Universities and 3 overseas university networks to host the 2nd ICRU International Conference: Sustainable Community Development at Nakhon Si Thammarat Rajabhat University.

I would like, first of all, to thank you Chiangmai Rajabhat University who organized the first conference and made it to be such a really successful event. We did appreciate all the interesting and valuable programs and presentations from that conference. I do anticipate that this upcoming 2nd conference will also be once again a venue for scholars and researchers from different academic fields of discipline to provide an opened forum for all essential issues and new valuable knowledge, along with building a mutual relationship and a sustainable academic network. As last year, I do hope that the 2nd conference will reaffirm the need and importance of the 2nd ICRU International Conference: Sustainable Community Development.

Once again, I would like to express my sincere gratitude and warm welcome to all the 5 presidents of Rajabhat Universities and 3 overseas university networks, local and overseas participants to Nakhon Si Thammarat Rajabhat University. The city is located in Nakhon Si Thammarat province, the most ancient province in the South of Thailand. We have not only historical and religious sites, but also arts and cultural events, handicraft centers, green landscapes and serene beaches to be appreciated.

I wish success to the conference and wish you all to have the most pleasant time in Nakhon Si Thammarat.

Assistant Professor Dr. Kanata Thatthong
President of Nakhon Si Thammarat Rajabhat University
Message from the President of of Chiang Rai Rajabhat University

Fellow presidents representing the Rajabhat University Network, the overseas university network representatives, distinguished keynote speakers, honorable guests, ladies and gentlemen.

As spokesperson I am extremely delighted to welcome all of you to The 1st ICRU International Conference: Sustainable Community Development (ICRU 2019) which is being co-organized by the 6 Rajabhat University Network and 3 overseas university networks.

I am particularly delighted in welcoming all the participants and experts from the various disciplines including those from education, business, economics, science and technology, environmental studies, social science and cultural studies. All of you are here today because of your strong commitment to sustainable development. We applaud your enthusiasm in participating in today’s important event.

The UN 17 Sustainable Development Goals Framework has evolved into a declaration of mutual concern for addressing the key global issues facing our universities today. I am proud to say that we are part of an important shared vision that collectively work together in preparing a competent roadmap for driving us into the rapidly changing future. Our mutual aim is to ultimately end poverty, ensure well-being and human rights for all, promote peace, protect our planet and have sustainable prosperity for all, especially during these turbulent times. We are working extremely hard to achieve these ambitious goals by 2030.

Here today, we come to harmonize together, with pride and strength, and to move the SDGs initiatives forward. All of you will be sharing your unique experiences and insights, your research findings, your suggestions and concerns in order to build strong and lasting networks for sustainable development. I applaud your efforts because they will have practical application in propelling SDGs forward and for ensuring that we meet our goals by 2030.

I would like to extend my personal gratitude for the excellent support and cooperation from the Presidents of Rajabhat Universities, our honorable delegates from the overseas university networks, and all of the many distinguished participants from both local and overseas venues for making this conference happen and for serving as the springboard for today’s conference and for others to follow in the future.

I wish you all a very successful meeting and please do enjoy your time in Chiang Mai. I encourage you to take time out of your busy schedule to appreciate the beauty of Chiang Mai City and to experience the hospitality of the local people who reflect the traditional culture of Lanna.

Thank you.

Assistant Professor Dr. Sornchai Munthaisong
President of Chiang Rai Rajabhat University
Message from the President of Nakhon Sawan Rajabhat University

Nakhon Sawan Rajabhat University as a co-host with 6 other Rajabhat Universities and 3 international universities network is organizing the 1st ICRU International Conference during February 18 - 20, 2019 at the Empress Hotel, Mueang District, Chiang Mai Province. This conference is entitled ICRU 2019, with the theme of ‘Sustainable Community Development’. The focus of this conference is on providing new knowledge of interests from keynote speakers and participants together with special lectures on concepts and experiences of sustainable development. This conference is also an academic forum for students from various institutions across the world. It will provide them the opportunity to present their research on a wide range of knowledge from various disciplines namely, Science, Humanities and Social Sciences, and Education. Being a platform of cooperation and exchanging not only academic knowledge, but also research experiences of researchers from various institutions, it will be beneficial for developing sustainable development knowledge as well.

On behalf of the conference committee, we welcome all researchers and participants to the conference. This event will lead to build up a powerful network of partners in driving all research towards the goals of sustainable development of the community and the world.

Assistant Professor Dr. Banyat Chumnankit
President of Nakhon Sawan Rajabhat University
Message from the President of Nakhon Sawan Rajabhat University

Presidents of Rajabhat Universities, the presidents of the oversea university networks, honorable participants, ladies and gentlemen,

On behalf of Rambhai Barni Rajabhat University, it's my pleasure and honor to be a co-host of The 1st ICRU International Conference: Sustainable Community Development (ICRU 2019) during February 18 - 20, 2019 at The Empress hotel, Chiang Mai. The sustainable research and development are important for country development, and they are the origin of world development in various ways. In which, the research is mainly recognized as the foundation of world progress. Therefore, giving a chance for the researchers to share and learn from each other at an international level will lead to sustainable development and lead to knowledge extension of research works that help to develop quality of life, economy, society and technology of the world population.

Rambhai Barni Rajabhat University is a higher education institution that is willing to develop and support the sustainable research in order to serve the social needs both at the national and international levels. Rambhai Barni Rajabhat University's also ready to create academic collaboration and network with other universities for sustainable development of our country.

Finally, I would like to thank you to all honorable participants for collaboration in submitting your research works to this International conference and hope that this conference will enhance the prosperous friendship and relationship.

Associate Professor Porphan Suttiwattana
Acting President of Rambhai Barni Rajabhat University
Message from the President of National Chin-Yi University of Technology

Professor Dr. Prapan Thumachai, Presidents of Rajabhat Universities, the representatives from overseas, honourable keynote speakers and guests, ladies and gentlemen

On behalf of National Chin-Yi University of Technology, it is our pleasure and privilege to be a part of The 1st ICRU International Conference on Sustainable Community Development (ICRU 2019).


Thank the host university, Chiang Mai Rajabhat University, the other Rajabhat universities and co-host universities from overseas who worked on planning and executing the conference that we see today.

Your support for the collaboration between Chiang Mai Rajabhat University and NCUT has contributed greatly to our success, and we are pretty sure that we will work more closely in the future.

In concluding I wish all participants a successful and fruitful conference today!

Thank you.

Professor Dr. Wen-Yuan CHEN
President of National Chin-Yi University of Technology
Message from the President of Feng Chia University

Presidents of Rajabhat Universities and the three overseas university networks, Distinguished Keynote Speakers and Guests

Ladies and Gentlemen

On behalf of Feng Chia University, I would like to extend my warmest welcome to all the honorable guests to attend the 1st ICRU International Conference on Sustainable Community Development (ICRU2019). This groundbreaking conference is hosted by the six Rajabhat Universities and their three overseas university networks. It is our honor and pleasure to be one member of the great team.

This is the very first time here for higher educational institutes from Thai, Taiwan, and other countries to work together, to communicate with and learn from each other. We believe such a conference will increase mutual understanding of involved universities across nations, as well as better opportunities for our younger generation. The Conference sure can provide us with an excellent chance to build further upon our long-standing friendship and expand cooperation to our mutual benefit.

It is a significant mission for Feng Chia University to co-host this Conference and we appreciate and value this opportunity to share and learn new technical knowledge with you all. I truly believe that our conference will be a wonderful and successful event, and I appreciate the efforts of all the parties contributing to this conference.

I expect you will enjoy the elaborately planned schedule. Though I am unable to attend this Conference, I do hope you all can feel my sincere greetings. Thank you and again best wishes to the success of the 1st ICRU International Conference on Sustainable Community Development held in Chiang Mai!!

Professor Bing-Jean Lee
President of Feng Chia University
Preface

This Proceedings volume contains the full papers, short papers, and posters presented at the 1st ICRU International Conference: Sustainable Community Development (ICRU 2019) that takes place on February 18-19, 2019 in Chaing Mai, Thailand. This is the first ICRU conference to be held together with 6 Rajabhat Universities and 3 overseas University Networks on the sustainable development theme. Chiang Mai Rajabhat University initiates, hosts, and chairs conferences to celebrate the special occasion for commemorating the 94th Anniversary of the Chiang Mai Rajabhat University in 2019.

The 1st ICRU International Conference continues to bring together experts, academics, researchers, professionals, and students from the discipline of sustainable development as well as in the other Community-related fields, pushing forward the boundaries of research, academic and practical knowledge for understanding Sustainable Development Goals. Over 59 works have been accepted for presentations at ICRU 2019’s parallel sessions and inclusion in this Proceedings volume.

The editors would like to express our sincere gratitude to the authors and presenters, program committee members as our reviewers, members of organizing committee, volunteers; without whose support this Proceedings volume would not reach such quality and standards. Thanks are also due to the various sponsors and supporting organizations of ICRU 2019.

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<table>
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<tr>
<td>Dr. Amnaj Khaokhrueamuang</td>
<td>Wakayama University</td>
<td>Japan</td>
</tr>
</tbody>
</table>
# Contents

Welcome speech ................................................................. i  
Message from the Presidents of Hosted Universities ............... ii  
Preface .................................................................................. viii  
Conference Organization ......................................................... ix  
Abstract of Keynotes’ Address ................................................ xvi  
Conference Schedule .............................................................. xxi  

**Education** ............................................................................

**Poster session**  
The Effectiveness of ICT Competencies Training Program for Pre-service Teacher Practicum in Small Sized Schools: Case of Small Sized Schools in Krok Pra District, Nakhon Sawan Province  
*Wudhijaya Philuek¹, Sirirat Janyarat², Thitipong Raksarikorn¹*

**Science** ..............................................................................

**Oral session**  
Technology Transfer on Organic Waste Transformation in Local Community of Lamphun  
*Klinpratoom Panyaping, Rungnapha Khiewwijit, Pattra Wongpankamol*

A Study of Factors Influencing Travel Behaviors in Chiang Mai City  
*Thitipong Chiracharoenwong¹, Poon Thiengburanatham², Puttipol Dumrongchai²*

**Poster session**  
Cellulose Degradation by White Fungus Isolated from Pig Manure  
*Sattr Laipala¹, Wichayarat Thipwangkul¹, Songphorn Ouanal¹  
Sukee Sukdee², Haruthai Thaisuchat¹*

Diversity of Freshwater Algae and Aquatic Insects Community in Paddy Field Areas, Chom Thong, Chiang Mai  
*Pongpan Leelakriengkrai¹², Rungnupa Tagun¹², Tatporn Kunpradid¹²*

Analysis of Nutritional Value of Ventilago denticulata Willd  
*Jiraporn Palee, Wathana Panyamaneesorn, Somchai Jaiban*

Fatty acid analysis of *Horsfieldia glabra* Warb. seeds  
*Natthiya Chaichana*

Developing an Optimal Hydroponic Fertilizer Formula To Increase Growth Rate and Chlorophyll Quantity of *Wolffia globosa*  
*Patcharawarin Ruanto*
Isotherm, Kinetic and Thermodynamic Adsorption of Methylene Blue Dye onto Shrimp Shell

Suchada Sawasdee, Disorn Kaewkanha, Sawitra Tonsaree, Prachart Watcharabundit

Using Raspberry Pi in Teaching and Learning Python: Case of Matthayomsuksa 3 Students of Wat Nongyao School, Ladyao District, Nakhon Sawan Province

Thitipong Raksarikorn¹, Sirirat Janyarat², Wudhijaya Philuek¹

Social Sciences .................................................................

Oral session

Chinese Female Characters’ Identity and Chinese Consumer Culture and Globalization in the Novel of Shanghai Baby

Aphiradi Suphap

A Hierarchical Stimulus-Organism-Response Framework of Tourist Perceptions of Community as Brand and its Implication for Business Model

Chai Ching Tan

A Balanced Scorecard Configuration of Business Model: A Case of Community-based Tourism

Chai Ching Tan

Muslim Tourists’ Satisfactory Behaviors Influencing Halal Tourism in Song Khla Province

Arun Billee¹, Waraporn Duangsaeng², Keerati Siriwanich², Parnprae Khaoprayoon²

Poster session

Comprehensive Evaluation index System for China’s Industrial Transformation and Medium-to-high Level Economic Growth in the Connectivity Blueprint

Jinghui Wu, Yan Wang, Xiangqian Zhang
Abstract of Keynote address

Mr. Suvat Chirapant
Deputy Secretary General, Chaipattana Foundation

The King’s Philosophy for Sustainable Community Development

The keynote address will focus on the idea behind His Majesty, the late King Bhumibol’s Sufficiency Economy Philosophy during his 70 year reign. Highlights will be given to the evolution of the philosophy within the context of Thailand’s economic and social development. Throughout Thailand’s contemporary history, the philosophy has been helpful in lessening the impact of external shocks on Thailand and has had profound impact in guiding the mindset and lives of people in Thailand. In recent years, given the philosophy’s contribution to the global achievement of the Millennium Development Goals and later the Sustainable Development Goals, it has also become a cornerstone of Thailand development cooperation and foreign policy with other countries.
Abstract of Keynote address

Prof. Dr. M. İlhan ÇAĞIRGAN
Antalya Mutation Project, Department of Field Crops
Faculty of Agriculture, Akdeniz University, Antalya, Turkey
E-mail: cagirgan@akdeniz.edu.tr

King Bhumibol’s Sufficiency Philosophy: A point of View of Foreign Scholar

Alleviating poverty and food insecurity have been given the priority in developing countries. Sustainable development requires responsibility for resource use and management intended to meet humans’ present needs without compromising the resource for future generations. To succeed sustainable development goals (SDGs), it is crucial for governments to stay in touch with the rapidly evolving ideas about innovation systems globally and across various sectors, and to understand how these ideas would translate into productivity. His Majesty Late King of Thailand, Adulyadej Bhumibol (Rama IX), the world’s longest-served head of state, spent decades on nurturing a philosophy of life in balance with nature, known as the sufficiency economy where “people are more self-reliant and have an adequate livelihood for themselves”. Greater self-sufficiency is encouraged as a way of increasing independence and autonomy, though not as an absolute. The sufficiency economy philosophy highlights a balanced way of living, aims at improving human well-being as a development goal, and seeks to harmonize the social, economic and environmental aspects of development. Consequently, His Late Majesty’s personal efforts to respond to problems of the rural areas resulted in over 4,000 development projects increasing the quality of life of his people while providing inspirations for those searching possibilities to extend the borders of the philosophy of sufficiency beyond an economic approach. Many countries have followed the philosophy with the support of Thai Government. His Majesty Late King’s efforts in achieving SDGs were recognized internationally, and the United Nations Development Program presented Him “Lifetime Human Achievement Award”. The sufficiency philosophy is applicable in an individual, society or country basis; and not only in agriculture to empower the resource poor but also to other sectors, including tourism, industry and any other. Although the recent passing of King Adulyadej Bhumibol has caused much sadness, the keynote speech aims to demonstrate how to extend the sufficiency philosophy to different perspectives based on the remarks made by the speaker in the condolences’ book placed in Thai Pavilion, Antalya, Turkey; and how to relate the sufficiency philosophy with similar applications -based on engagement, participatory paradigm, inclusive research- in the countries where the philosophy has travelled so far as a guide to sustainable development through community empowerment.

Keywords: community development, engagement, inclusive research, participatory paradigm, sustainable development
Abstract of Keynote address
Prof. Dr. Andreas H. Zins
Adjunct Full Professor of Tourism Management
MODUL University, Vienna, Austria

The Role of Higher Education in Sustainable Tourism Development

For almost two generations the post-modern civilization has been working on raising the knowledge and awareness level of negative impacts on the natural environment, on economic and social stability. International climate conferences with their political struggles are the best mirror for the tip of the iceberg of this development. However, not only research but also our daily routines tell us that we need more than abstract knowledge to make progress towards improved sustainability. Higher education institutions have the chance and the responsibility to shape young people’s attitudes through engaging, interactive, participative, critical, reflective pedagogical learning and training approaches. And yet, it seems that institutional value-driven objectives will fail their ambitious goals unless the institution itself and its very individual representatives do not demonstrate and live their alternative lifestyle convincingly. “The Triple Benefit Principle”, developed by an Austrian physician and a graduate of MODUL University Vienna, displays and promotes such an alternative path in life.
# Conference Schedule

<table>
<thead>
<tr>
<th>16-Feb-19</th>
<th>19-Feb-19</th>
<th>20-Feb-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00-9:00</td>
<td>Registration</td>
<td></td>
</tr>
<tr>
<td>9:00-9:45</td>
<td>Opening Ceremony</td>
<td></td>
</tr>
<tr>
<td>9:45-10:15</td>
<td><strong>Keynote I</strong>&lt;br&gt;Mr. Suvat Chirapant</td>
<td>Oral Presentation Session III</td>
</tr>
<tr>
<td>10:15-10:30</td>
<td></td>
<td>Refreshment</td>
</tr>
<tr>
<td>10:30-10:40</td>
<td><strong>Keynote II</strong>&lt;br&gt;Prof. Dr. M. İlhan ÇAĞIRGAŞ</td>
<td>Poster Presentation Section II</td>
</tr>
<tr>
<td>10:40-11:00</td>
<td>Refreshment</td>
<td></td>
</tr>
<tr>
<td>11:00-11:20</td>
<td>Refreshment</td>
<td></td>
</tr>
<tr>
<td>11:20-11:40</td>
<td><strong>Keynote IV</strong>&lt;br&gt;Dr. Thapara Srivadhanabhakdi</td>
<td><strong>Keynote V</strong>&lt;br&gt;Prof. Dr. Andreas Zins</td>
</tr>
<tr>
<td>11:40-12:00</td>
<td></td>
<td>Cultural visit</td>
</tr>
<tr>
<td>12:00-12:30</td>
<td>Lunch</td>
<td>Closing Ceremony</td>
</tr>
<tr>
<td>12:30-13:00</td>
<td></td>
<td>Best Paper and Best Poster Award</td>
</tr>
<tr>
<td>13:00-14:00</td>
<td>Oral Presentation Session I A-B-C-D</td>
<td>Lunch</td>
</tr>
<tr>
<td>14:15-15:35</td>
<td>Oral Presentation Session II A-B-C-D</td>
<td></td>
</tr>
<tr>
<td>15:35-15:55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18:00-20:00</td>
<td>Conference Reception</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Session A: SOCIAL SCIENCE</td>
<td>Session B: SCIENCE</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------</td>
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</tr>
<tr>
<td>12:00-13:20</td>
<td>Belt and Road Initiative: An Accelerator to Achieve Sustainable Development Goals</td>
<td>Ecosystem Services of Urban Park in Bangkok Metropolis</td>
</tr>
<tr>
<td></td>
<td>Jonathan Harrington, Yee Liu, Yei Luang Thinn University (S14)</td>
<td>Wanpat Charoentsukitpeel</td>
</tr>
<tr>
<td>12:20-13:40</td>
<td>Chinese Female Characters Identity and Chinese Consumer Culture and Globalization in the Novel of Shanghai Baby</td>
<td>Technology Transfer on Organic Waste Transformation in Local Community of Lamphun</td>
</tr>
<tr>
<td></td>
<td>Aphratr Suphap Chiang Mai Rajabhat University (S17)</td>
<td>Kampasuk Panypayap, Rungraoph Wachuwiwatt, Patthi Vanpengkorn Rangsit University of Technology (S31)</td>
</tr>
<tr>
<td>12:40-14:00</td>
<td>Self-concept and Social Supports on Public Consciousness Behavior toward Environment of Chiang Mai Rajabhat University Students</td>
<td>An application of augmented reality for monitoring coastal fishing vessels</td>
</tr>
<tr>
<td></td>
<td>Sawatsuck Uamsa-ad, Varunut Hirunyati Chiang Mai Rajabhat University (S2)</td>
<td>Wirat Simha, Kumpoe Teslwich Ramthana Bari Rajabhat University (S26)</td>
</tr>
<tr>
<td>Time</td>
<td>Session A: SOCIAL SCIENCE</td>
<td>Session B: SCIENCE</td>
</tr>
<tr>
<td>--------</td>
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<td>--------------------</td>
</tr>
<tr>
<td>14:15-14:35</td>
<td>Kang Tung Market Place* in the context of trade and ethnicity&lt;br&gt;Duysadee Kongtawan&lt;br&gt;Chiang Rai Rajabhat University (S20)</td>
<td>Developing a Commercial Facility for Mass Production of Biochar&lt;br&gt;Keng-Tung Var*&lt;br&gt;National Chung Hsing University (Sc 36)</td>
</tr>
<tr>
<td>14:35-14:55</td>
<td>Product Line Management and Distribution Channels for Sustainable Community Enterprises in Bean Fermented Soybean Products, Peanut Products, Pea Bean Products, and Sesame Oil of Ban Pong Moa Housewife Group, Pang Moei District, Amphoe Mueang, Mae Hong Son Province&lt;br&gt;Manop Chum-Ue, Anonkwan Jeawee, and Pongpon Kamoul&lt;br&gt;Chiang Mai Rajabhat University (S23)</td>
<td>Real Time Monitoring System for Detecting Humidity in Pain Farms&lt;br&gt;Utha Kheprong&lt;br&gt;Phakthana Maha Taksin Hakhkhsanhammarat Rajabhat University (Sc1)</td>
</tr>
<tr>
<td>14:55-15:15</td>
<td>Reviving of Chiang Saen Trade route with the Knowledge Center and Community Engagement&lt;br&gt;Naphar Narakdee&lt;br&gt;Chiang Rai Rajabhat University (S18)</td>
<td>Forecasting System for Regional Solar Power Generation&lt;br&gt;Chung-Heen Cheng, Chen-Yeon Chi, Shu-Yi Yiu, Chi-Yee Lin, and Sy-Ren Huang&lt;br&gt;Feng Chia University (Sc37)</td>
</tr>
<tr>
<td>15:15-15:35</td>
<td>The Problems and Impacts on Multicultural Ethnic Societies in the Special Economic Border Zone, Mae Sai District, Chiang Rai Province&lt;br&gt;Noppachai Yingyaa, Saipit Mekati&lt;br&gt;Chiang Rai Rajabhat University (S19)</td>
<td>A Study of Factors Influencing Travel Behavior in Chiang Mai City&lt;br&gt;Thipong Chiahanoomwong&lt;br&gt;Poon Thongloramarm&lt;br&gt;P управления Chiang Rai&lt;br&gt;Chiang Mai University (Sc39)</td>
</tr>
<tr>
<td>15:35-15:55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Oral Presentation III: Tuesday 19th February 2019

**Session A:**
**Room Chiangmai 1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00-09:20</td>
<td>Tea Cultural Commodification in Sustainable Tourism: Perspectives from Thai and Japanese Farmer Exchange</td>
<td>Amnaj Khachinunnasang and Pipatporn Chuanacharttrikun, National Chiang-Yi University of Technology (T31)</td>
</tr>
<tr>
<td>09:20-09:40</td>
<td>The effect of Life Satisfaction After the Trip in Tourist Recovery Experience as Stress Reliever Model on Chinese Student’s Future Behaviors in Educational Destination at Vajira Alongsorn Rajabhat University Under the Royal Patronage: A Case Study of Central China Normal University</td>
<td>Yotrapoj Sirikanenchai and Rawapee Klangnau, Vajira Alongsorn Rajabhat University (T25)</td>
</tr>
<tr>
<td>09:40-10:00</td>
<td>A Balanced Scorecard Configuration of Business Model: A Case of Community-based Tourism</td>
<td>Chai Ching Tan, Mae Fah Luang University (T26)</td>
</tr>
<tr>
<td>10:00-10:20</td>
<td>Muslim Tourists’ Satisfactory Behaviors Influencing Halal Tourism in Songkhla Province</td>
<td>Arun Bilko, Waraporn Duangsapong, Kesarit Belvanich and Paniprap Jaiaprayoon, Maejo University (T30)</td>
</tr>
<tr>
<td>10:20-10:40</td>
<td>Community-Based Tourism Development Benefits and Challenges of Muan Nongkong Community, Chiang Mai</td>
<td>Mau Yu-Chin Lo, Phipporn Janita and Me-Jane Terg, National Chiang-Yi University of Technology (T30)</td>
</tr>
</tbody>
</table>

### Oral Presentation IV: Tuesday 19th February 2019

**Session A: TOURISM**
**Room Chiangmai 1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00-11:20</td>
<td>A Hierarchical Stimulus-Organism-Response Framework of Tourist Perceptions of Community as Brand and its Implication for Business Model</td>
<td>Chai Ching Tan, Mae Fah Luang University (T25)</td>
</tr>
<tr>
<td>Time</td>
<td>Title</td>
<td>Authors/Institutions</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>08:00-08:10</td>
<td>Antibacterial activities from leaf extracts of Titania diversiflora</td>
<td>Moniketha Thompson, Pawessa Thonggai, Chittharam Baining, Nakhonsawan Rajabhat University (54)</td>
</tr>
<tr>
<td></td>
<td>Anti-Semiprotosca Mutans Efficacy of Chitosan Nanoparticles Containing Krahla and Guava Leaf Extracts</td>
<td>Somnanda Tamra Chiang Rai Rajabhat University (61)</td>
</tr>
<tr>
<td></td>
<td>The Exploration of Sustainable Development Circumstance on Food Security and Ending Hunger in Thailand for Goal No. 2 under the Research Program on Exploring the Goal of Sustainable Development in Thailand and the Optional Economic, Social, and Legal Measures</td>
<td>Saisan Guanda Chiang Rai Rajabhat University (61)</td>
</tr>
<tr>
<td></td>
<td>The Comparison of Learning Achievement on Management Learning in Classroom by Using Graphic Organizer and Normal Teaching Strategy for Students Faculty of Education, Chiang Rai Rajabhat University</td>
<td>Aumporn Chonocha, Thana Kumanpraparn, Pak Khun Charoen Nakhon Kumphawapi Rajabhat University (54)</td>
</tr>
<tr>
<td>08:10-08:20</td>
<td>Development of optimal hydroponic fertilizer formula to increase growth rate and chlorophyll quantity of Wolffia globosa</td>
<td>Prasertwatanasak Chiang Rai Rajabhat University (61)</td>
</tr>
<tr>
<td></td>
<td>Humanities and Social Sciences Examining the relationship between personality traits, interpersonal relationships and loneliness from the privacy of online communities</td>
<td>Mita Jaisay Thatchakan Pongpak, Chana Suek, Thitapap Jurentakul, Mita Yua Chai National Chi Y University of Technology (54)</td>
</tr>
<tr>
<td></td>
<td>Active Learning Model to Develop English Proficiency of Students of Chiang Rai Rajabhat University</td>
<td>Demonstration School Supapat Tien, Bi Granthawatan, Prongnit Jaitup, et al Chiang Rai Rajabhat University (61)</td>
</tr>
<tr>
<td>08:20-08:30</td>
<td>Adsorption performance of graphene quantum dots for cadmium (II) removal from synthetic wastewater</td>
<td>Proint Naengpeth, Kamornpet Mongkut, Jirawut Sukzangkrong, Krittida Thongphiphat Nakhon Chaiyaphum Rajabhat University (64)</td>
</tr>
<tr>
<td></td>
<td>Insecticidal Activity of Bosphorus (Annona muricata L.) against Common Caterpillar (Spodoptera hurna Fabricius)</td>
<td>Saonanda Chaiying, Suphattra Songpronya Chaiyaphum Rajabhat University (61)</td>
</tr>
<tr>
<td></td>
<td>Comprehensive Evaluation Index System for China’s Industrial Transformation and Medium-High Level Economic Growth in the Connectivity Blueprint</td>
<td>Jing Hui Yu Hualien University (511)</td>
</tr>
<tr>
<td>08:30-08:40</td>
<td>Cellulase degradation by white fungus isolated from pig manure</td>
<td>Sathit La John, Wichayat Thepangkul, Songtham Chaiyak, Nakhon Thepasuth Lamphang Rajabhat University (60)</td>
</tr>
<tr>
<td></td>
<td>Efficiency of Bacillus spp. to enhance plant growth promotion in hydroponics</td>
<td>Kamsuda Chaungkham Thepasut Rajabhat University (60)</td>
</tr>
<tr>
<td>08:40-08:50</td>
<td>Isolation of bacteria contaminated in plant tissue cultures and their effect on mung bean (Vigna radiata) growth</td>
<td>Thanathat Thepasut, Apichart Chosuang, Pornman Bonkoon, Sathit La John, Chaiorang Wongsak, Ortporn Tangs Lamphang Rajabhat University (60)</td>
</tr>
<tr>
<td></td>
<td>Isolation of toxic and probiotic properties from fermented fish (Pha Soi) in Lop Buri Province</td>
<td>Jana Prasitkas Thepasut Rajabhat University (612)</td>
</tr>
<tr>
<td>08:50-09:00</td>
<td>Adverse Effects of Cocomatodema on Pollen Morphology, Yield and Tube Growth of ‘Super Hot’ Chili Pepper</td>
<td>Pornman Bonkoon, Angkhana Chuitarat, Thanathat Thepasut Lamphang Rajabhat University (57)</td>
</tr>
<tr>
<td></td>
<td>Isolation, kinetic and thermodynamic adsorption of methylene blue dye using straining shell</td>
<td>Somtop Sakolwan, Saeam Kaewkayoon, Buncha Tongpae, Phongpanich Watcharunon Thepasut Rajabhat University (62)</td>
</tr>
<tr>
<td>09:00-09:10</td>
<td>Microwave-assisted Extraction of Crude Light from Wax Wood from Wood-Harvesting</td>
<td>Wanichan Kanyaworaj, Pornman Bonkoon, Angkhana Chuitarat Lamphang Rajabhat University (60)</td>
</tr>
<tr>
<td></td>
<td>SEASONAL VARIATION OF PARLITIC SHELLFISH TOXICITY OF GREEN MUSSEL (Perna viridis) IN THE GULF OF THAILAND</td>
<td>Bomsorn Prapthipkaesarn, Wuttikorn Kalawat, Phuwee Namo Thailand Institute-of Nuclear Technology (62)</td>
</tr>
<tr>
<td>Time</td>
<td>SCIENCE A</td>
<td>SCIENCE B</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
<tr>
<td>10:30-10:40</td>
<td>Diversity of freshwater algae and aquatic insects community in paddy field areas, Chom Thong District, Chiang Mai Province</td>
<td>Application of Stable Isotope Signatures for Assessing Groundwater Recharge in Semi-arid Kampong Phet, Thailand</td>
</tr>
<tr>
<td></td>
<td>Pongpan Leeladhisriengkrat, Rungrupa Tagun, Talporn Kuepradit</td>
<td>Wuthikrai Kulsanont, Boonsom amtepkanisnan, Phatchada Nocht</td>
</tr>
<tr>
<td></td>
<td>Chiang Mai Rajabhat University (Sc19)</td>
<td></td>
</tr>
<tr>
<td>10:40-10:50</td>
<td>Analysis of Nutritional Value of Ventilago denticulata Willd</td>
<td>Comparison of East Asian Bullfrogs' growth reared in cement pot holes and plastic condominium units</td>
</tr>
<tr>
<td></td>
<td>Jiraporn Ploey, Wuthana Panyamaneeson</td>
<td>Onppreacha Wongbow, Natthida Supahan</td>
</tr>
<tr>
<td></td>
<td>Chiang Rai Rajabhat University (Sc11)</td>
<td></td>
</tr>
<tr>
<td>10:50-11:30</td>
<td>Fatty acid analysis of Horsfieldia giabra Warb. Seeds</td>
<td>Using Raspberry Pi in Teaching and Learning Python: Case of Matthayommuksa 3 Students of Wat Nongyao School, Ladayat District, Nakhon Sawan Province</td>
</tr>
<tr>
<td></td>
<td>Nathiya Chaichana, Chiang Rai Rajabhat University (Sc12)</td>
<td>Thrirong Raksakorn, Sirarat Jaryarat, Wuthikijaya, Phitoe, Nakhon Sawan, Rajabhat University (Sc22)</td>
</tr>
</tbody>
</table>
Education
The Effectiveness of ICT Competencies Training Program for Pre-service Teacher Students Practicum in Small Sized Schools: Case of Small Sized Schools in Krok Pra District, Nakhon Sawan Province

Wudjijaya Philuek¹, Sirirat Janyarat², Thitipong Raksarikorn¹

¹Faculty of Education, Nakhon Sawan Rajabhat University, Nakhon Sawan, THAILAND
²Innovative Learning Center, Srinakharinwirot University, Bangkok, THAILAND

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Abstract

The aims of this study were 1) to develop training program to test the ICT competencies of pre-service teacher students practicum in small sized schools, 2) to experiment the training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools, and 3) to study students’ satisfaction among the ICT competencies training program. The target group was 45 pre-service teacher students of the Faculty of Education, Nakhon Sawan Rajabhat University who practicum in 20 small sized schools in Krok Pra District, Nakhon Sawan Province, and a group of specialists in training program, educational technology, and computer in education. Mean, Standard Deviation (S.D.), Modified Priority Needs Index (PNI Modified), and T-Test were used in this study.

The results show that 1) The ICT competencies training program for pre-service teachers consisted of training topics such as developing Computer Aids Instruction, How using program in developing instruction media, using software package in developing instructional media, and using Microsoft Office, 2) There was different between pretest and posttest of ICT competencies training program at .05 level of significant, and 3) The students’ satisfaction of the ICT competencies training program was at high level (X̅ = 3.71), this shows that the training activities were support their needs and suitable for pre-service teacher students with various majors.

Keywords: ICT competencies training program, pre-service teacher students

Introduction

Information technology plays an important role today and it tend to play a bigger role in the future. This may be because technology is a tool for effective information operations from the production, storage, processing, retrieval, communication, and information exchange. The use of information resources to fully benefit from the importance of information technology such as 1) helps to organize the information system in the daily, 2) improves the efficiency of information production, 3) sorting information, etc., 4) helps to store information in a convenient way. 5) helps to access information quickly more effective, and 7) helps to communicate quickly and easily which reducing barriers to time and distance by using the telephone system and so on for instance. There are many processes and methods to develop knowledge about technology. One of them is workshop which provide activities to be applied need to be diversified so that the participants are alert and ready to learn and practice. Harinsuwan (2014) claimed that the Information and Communication Technology (ICT) capabilities which teachers need to know and have were 1) implementation of foundation of Information Technology capability (how to use computer, using program application, how to store information, file management etc., 2) using Information Technology in education capability (Spreadsheet Software, Presentation Software, Graphics, Database, Web Builder, and Statistical Package), 3) using of the internet capability (can connect to internet, web browser, website, e-mail, search engine, bookmark, download information, access all information and collect it, learning resource), 4) law, regulation, and ethics of Information Technology usage capability such as software license and creative commons, 3) using Information Technology in teaching and learning, 5) using Information technology in evaluation and measurement, 6) using Information Technology for academic work and professional development, and 7)
using Information technology for knowledge exchange. In this research, the increasing technology especially Information Technology capabilities to pre-service teachers is essentials because they will become in-service teachers in the future. Chinachot (1988); Kreranand and Prechaphan (1987); Chandrapat and Raksorn (1992) claimed that training was kind of methodology in staff or personal development which enhance leaning, and work performance especially knowledge, skills, and attitude. The question is why small sized schools, this is because the use of Information Technology is widely used in all size of communities. The rights of education is provide the balance or equal opportunity to rural students learned same as students in urban schools. This research focused on rural schools with small sized because researchers would like to provide the IT workshop to pre-service teacher students and they will used the knowledge and practice to rural students.

Research Objectives

The aims of this study were: 1) To develop training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools, 2) To experiment the training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools, and 3) To study students’ satisfaction among the ICT competencies training program.

Methodology

This research aimed to develop, test the training program, and to study students’ satisfaction to enhance the ICT competencies of pre-service teacher students practicum in small sized schools. Sample group was 45 fifth year pre-service teacher students who practicing in small-sized schools in Krok Pra District, Nakhon Sawan Province.

There was two phases of conduction in this research:. 1) development of Workshop Training activities and 2) test the training program.

Phrase 1: Training activities development for enhancing ICT competencies of pre-service teacher students.

<table>
<thead>
<tr>
<th>Phase 1 Developing training program based on ADDIE Model (A-D-D)</th>
<th>Results from Phase 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Study and analysis on training needs</td>
<td>Results of data analytics from questionnaire (Training needs)</td>
</tr>
<tr>
<td>1.1 review research on Information and Communication Technology details</td>
<td>The element of activities to enhance ICT competencies</td>
</tr>
<tr>
<td>1.2 developing scope of question to develop the questionnaire</td>
<td></td>
</tr>
<tr>
<td>1.3 modifying the questionnaire from the advised</td>
<td></td>
</tr>
<tr>
<td>1.4 surveyed by sampling group</td>
<td></td>
</tr>
<tr>
<td>1.5 data analytics</td>
<td></td>
</tr>
<tr>
<td>2 Design</td>
<td>Training program draft</td>
</tr>
<tr>
<td>1. designing the contents for training program.</td>
<td></td>
</tr>
<tr>
<td>2. setting the theories, contents, learning object, presentation structures, measurement and evaluation.</td>
<td></td>
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<tr>
<td>3. Development</td>
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<tr>
<td>Developing training draft, which contain of learning activities process, evaluation/measurement form, testing, and give to experts for reviewing.</td>
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</tr>
</tbody>
</table>

*Figure 1 Training activities development*
Phase 2: Actual experiment based on ADDIE Model (I-E)

4. Implementation
Implementation the training program to train pre-service teacher students.

5. Evaluation
Analysis the data from implementation phase and summary the research findings

Results from Phase 2
Learning activities in training program to enhance ICT competencies

Results from using learning activities in training program to enhance ICT competencies

Figure 2 Flowchart of actual experiment

The analysis which used in this were T-Test for dependent samples (paired T-Test) Mean, Standard Deviation (S.D.), and Modified Priority Needs Index (PNI Modified).

Results
The results from the training activities development for enhancing ICT competencies of pre-service teacher students shows as follow.

1) Developing of training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools.

Table 1 PNI modified of competencies

<table>
<thead>
<tr>
<th>List of competencies</th>
<th>Current competencies of pre-service teacher students</th>
<th>Desirable competencies of pre-service teacher students</th>
<th>Different</th>
<th>PNI modified</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{X}1 )</td>
<td>( \bar{X}2 )</td>
<td>( \bar{X}1 - \bar{X}2 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Understanding in Information Technology such as computer or internet.</td>
<td>3.79</td>
<td>2.85</td>
<td>0.94</td>
<td>-0.25</td>
<td>6</td>
</tr>
<tr>
<td>2 Understanding in using hardware equipment.</td>
<td>3.42</td>
<td>2.86</td>
<td>0.56</td>
<td>-0.17</td>
<td>3</td>
</tr>
<tr>
<td>3 Knowledge in computer maintenance.</td>
<td>4.24</td>
<td>2.83</td>
<td>1.40</td>
<td>-0.33</td>
<td>9</td>
</tr>
<tr>
<td>4 Knowledge in implementation Information Technology in education.</td>
<td>3.79</td>
<td>2.73</td>
<td>1.06</td>
<td>-0.28</td>
<td>8</td>
</tr>
<tr>
<td>5 Can use word processing and presentation software such as MS Words, MS PowerPoint.</td>
<td>3.77</td>
<td>2.75</td>
<td>1.02</td>
<td>-0.27</td>
<td>7</td>
</tr>
<tr>
<td>6 Can use spreadsheet software such as MS Excel.</td>
<td>3.74</td>
<td>2.80</td>
<td>0.94</td>
<td>-0.25</td>
<td>5</td>
</tr>
<tr>
<td>7 Ability to use IT in create instructional media such as CAI.</td>
<td>2.70</td>
<td>4.14</td>
<td>-1.44</td>
<td>0.53</td>
<td>1</td>
</tr>
<tr>
<td>8 Ability to use IT in classroom.</td>
<td>3.04</td>
<td>3.37</td>
<td>-0.33</td>
<td>0.11</td>
<td>2</td>
</tr>
<tr>
<td>9 Ability to create video for teaching and learning such as Photoshop, Sony Vegas</td>
<td>3.57</td>
<td>2.92</td>
<td>0.65</td>
<td>-0.18</td>
<td>4</td>
</tr>
</tbody>
</table>
According to Table 1 shows that pre-service teacher students have overview and training need by using PNI Modified technique in interpret data on their ICT competencies. They would like to develop their skill on ability to use IT in create instructional media such as CAI (PNI = 0.53) at the first rate followed by ability to use IT in classroom (PNI = 0.11) in contrast with knowledge in computer maintenance (PNI = -0.33) which is last competency they do not want to develop.

The developing of training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools used the information on Table 1 to develop training program and shows that the training program consisted of 8 elements which were 1) training activities objectives, 2) training types, 3) training curriculum, 4) training activities, 5) trainee roles, 6) trainer roles, 7) training facilities supported, 8) evaluation.

2) To experiment the training program to enhance the ICT competencies of pre-service teacher students practicum in small sized schools.

Table 2 The results of Pretest and Posttest of ICT competencies

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>X</th>
<th>S.D.</th>
<th>t</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>45</td>
<td>6.24</td>
<td>2.047</td>
<td>-4.837</td>
<td>.000*</td>
</tr>
<tr>
<td>Posttest</td>
<td>45</td>
<td>10.76</td>
<td>2.078</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P<0.05

According to Table 2, there was score of Posttest (X = 10.76; S.D. = 2.078) higher than Pretest (X = 6.24; S.D. = 2.047) with significant of statistics at .05. This mean that the training program increase the ICT capabilities of pre-service teacher students.

3) To study students’ satisfaction among the ICT competencies training program.
The results of pre-service teacher students towards the IVT competencies training program as follow.

Table 3 The results of Students’ satisfaction

<table>
<thead>
<tr>
<th>Evaluation lists</th>
<th>X</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training readiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. The room and training areas were appropriated.</td>
<td>2.93</td>
<td>Fair</td>
</tr>
<tr>
<td>2. The equipment and facilities were appropriated.</td>
<td>4.13</td>
<td>Good</td>
</tr>
<tr>
<td>3. The quality of training package</td>
<td>3.87</td>
<td>Good</td>
</tr>
<tr>
<td>4. Training time</td>
<td>3.93</td>
<td>Good</td>
</tr>
<tr>
<td>5. The coordination and availability of staffs</td>
<td>4.07</td>
<td>Good</td>
</tr>
<tr>
<td>6. Training program is new and modern which appropriated to trainee.</td>
<td>3.73</td>
<td>Good</td>
</tr>
<tr>
<td>7. Trainee has some knowledge about ICT before train.</td>
<td>3.53</td>
<td>Good</td>
</tr>
<tr>
<td>8. Trainee has some skills about ICT before train.</td>
<td>4.13</td>
<td>Good</td>
</tr>
<tr>
<td>9. They can implement ICT in their work after trained.</td>
<td>3.69</td>
<td>Good</td>
</tr>
<tr>
<td>10. The overall satisfaction towards training program.</td>
<td>3.93</td>
<td>Good</td>
</tr>
<tr>
<td>The evaluation of trainer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Trainer has knowledge in ICT which is related to the training program.</td>
<td>4.33</td>
<td>Good</td>
</tr>
<tr>
<td>12. Trainer has described and lectured cover all objects of training program.</td>
<td>3.87</td>
<td>Good</td>
</tr>
<tr>
<td>13. Trainer used cleared, nice voice and tone in speaking.</td>
<td>3.34</td>
<td>Fair</td>
</tr>
<tr>
<td>14. Trainer gave clear ideas on ICT.</td>
<td>4.45</td>
<td>Good</td>
</tr>
<tr>
<td>15. Trainer allowed to ask the question.</td>
<td>3.27</td>
<td>Fair</td>
</tr>
<tr>
<td>16. Trainer used appropriated time.</td>
<td>4.21</td>
<td>Good</td>
</tr>
<tr>
<td>Total</td>
<td>3.71</td>
<td>Good</td>
</tr>
</tbody>
</table>

According to Table 4, it shows that the overall satisfaction of pre-service teacher students towards the training program was at good level (X = 3.71) which mean that participants have high satisfaction in this training program both in training readiness and trainer.
Conclusions and Discussions

The results show that

1) the ICT competencies training program for pre-service teachers consisted of training topics such as developing Computer Aids Instruction, How to use program in developing instruction media, using software package in developing instructional media, and using Microsoft Office. The training program consisted of 1) Pre-Training stages (training need assessment, participants analysis, content analysis, task development, designing materials) and 2) Training activities stage (training activities, navigation, pre/post training test), and Post-Training stage (evaluation) in accordance with Jaidamrong (2011).

2) there was different between pretest and posttest of ICT competencies training program at .05 level of significant. This may be because the training program has been developed by use the PNI modified of competencies which resulted on Table 1 so that it was related their skilled development of pre-service teacher students which related to Dabbagh and English (2015); Landmann (2013); Halpem (1999) who claimed that higher education should develop or evaluate of programs and curricula to enhance students’ performances and abilities in specific areas such as ICT competencies.

3) the students’ satisfaction of the ICT competencies training program was at good level ($\bar{X} = 3.71$), this shows that the training activities were support their needs and suitable for pre-service teacher students with various majors. Because the training program developed by their need assessment and the trainer gave good presentation and had knowledge about ICT and also delivered information to participants clearly, there could lead to students’ satisfaction.

References

Science
Technology Transfer on Organic Waste Transformation in Local Community of Lamphun

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Abstract

Huge volumes of organic wastes: food waste, mixed leaves waste, including Water hyacinth were generated. Much of these wastes were disposed by open dumping and burning resulting in waste and air pollution. Therefore, technology transfer on organic waste transformation (OWT) using anaerobic digestion technology (Adtech) that can turn organic waste into the value added by-products (VAP); clean fuel, and fertilizer is needed. To cope with a pollution problem and obtaining VAP, it was performed in local community. Two different ratios of mixed organic waste were proposed. Demonstration and implementation were performed as the center of OWT study, and distributed in other places in Lamphun. It was found that both ratios could be applied. Besides, the rapid and effective technology transfer could have occurred in the community that had ever experienced before on Adtech and needed to utilize the organic waste with a good benefit for sustaining the community.

Keywords: technology transfer, anaerobic digestion technology, organic waste, local community, Lamphun

Introduction

Lamphun is the smallest province in Northern Thailand. It is not only one of the best tourism towns but also one of the well-known places for many agricultural products usage; longan, mango, lychee, and several vegetables (Lamphun Provincial Agricultural Office, 2016). The main branch of Mae Ping river passed through this province. During dry season, Water hyacinth bloom in this river resulting in the lack of oxygen and the death of aquatic animals. Huge volumes of organic wastes: food waste, mixed leaves waste, including Water hyacinth were generated. Organic wastes are materials that are biodegradable and come from either a plant or an animal. Much of these wastes were disposed by open dumping and burning resulting in waste and air pollution. Although many campaigns were performed for proper waste reduction, the environmental pollution problem still persist, particularly, the haze problem during dry season (Panyaping, 2010). The use of anaerobic digestion technology (Adtech) for treating organic wastes and for cleaning wastewaters from food process is attractive for both economic and environmental aspects due to not only reduction the volumes of organic material to be disposed but also making a renewable and inexpensive energy, e.g. biogas (Lettinga, 2001; Barton, et al., 2008). Adtech is a biological process that organic matters are biodegradable in anaerobic digestion condition that can produce biogas/methane yield including liquid fertilizer as by-products. Anaerobic digestion is dependent on the environmental conditions such as temperature, pH, nutrient contents, and particles size in system performance (Mata-Alvarez et al, 2010). Through this research and development (R&D) on organic waste transformation using anaerobic digestion technology (Adtech) that can turn organic waste into the value added by-products: clean fuel, and fertilizer was conducted. Major findings showed mixed leaves waste could be used to accelerate food waste digestion in anaerobic condition (Panyaping and Moontee, 2018). Moreover, Water Hyacinth could be used to mix with mixed leaves waste and food waste for a higher quality of biogas yield (Panyaping et. al, 2018).

Based upon the result of R&D on organic waste transformation, and the waste problem of this province and the whole Northern Thailand, technology transfer on organic waste transformation was introduced to Lamphun province due to the distinguish characteristics on abundant of organic wastes, and the people’s experience on anaerobic digestion technology in some communities. Organic waste transformation reduce both organic waste and living cost with a good benefit: clean energy, liquid organic fertilizer, and saving cost from using clean fuel.
Methods

The methodology of the study was performed as shown in Figure 1.

1. Do the research and development (R&D) on organic wastes transformation (OWT) using anaerobic digestion.
2. Present the result of the research on OWT using anaerobic digestion for key performances in Lamphun province.
3. Select a community for performing technology transfer program: Tontong Sub-district Municipality.
4. Perform technology transfer: demonstration and implementation & follow up - two ratios of mixed organic waste (mixed leaf and food waste 2:3, and Water hyacinth, mixed leaf and food waste 3:2:3) using 3% NaOH for pH adjustment.

Figure 1 The methodology of technology transfer

From Figure 1, four steps of this study were performed.

1. Do the research and development on organic waste transformation (OWT) using anaerobic digestion technology.
2. Present the results of R&D on OWT at Lamphun Provincial Offices of Natural Resources and Environment during the meeting on ‘Waste Management Technology’ to key performances from 30 Sub-district Municipalities throughout Lamphun province. After that, some communities gained some interest and were selected based on their preparedness.
3. Site selection and sampling site: Technology transfer on OWT, demonstration, and implementation were performed in Tontong Sub-district Municipality (Tontong) due to the preparedness of the Tontong staff and some experience on anaerobic digestion technology in the community, especially, the public participation. Then, Tontong was selected as a center of study. It is 30 km from the south of Chiang Mai, and 670 km from the north of Bangkok.
4. Technology transfer performance and follow up: Both ratios of mixed organic wastes were performed during training, demonstration, and implementation. Follow up was also performed by the research staff after the operation of a household digester system.

Results

The selected local community

Tontong is only 2 km from the west-south of Mueang Lamphun District. It is located in the plain area about 22.78 km² or 14,611.21 rai near Chiang Mai, Lampang, and Tak provinces as shown in Fig 2. This municipality is a middle sized municipality since 2009, and divided into 11 villages. Mae Kung and Mae Ping rivers were the major natural water sources, which passed through the agricultural areas about 7,360 rai (1 rai = 1,600 km²) in the 6th, and 9th villages for Mae Ping river, and in the 2nd, 3rd, 4th, 5th, 9th, 10th villages for Mae Kuang river. According to the 2016 territory information from the Bureau of Registration Administration, Department of Provincial Administration, Tontong had 5,192 households. The socio-economic of Tontong was from the agricultural products as there was about 68% of agricultural areas: paddy field, longan, and guava farms, and some vegetables, and swine, chicken, and cow farms. In addition to some households, there were employed in general work, commercial and others. The major products of Tontong were Thai Yok-dok silk, cotton, Nam-prik, and fruit processed products. The major agricultural products of Tontong were rice, longan, mango, guava, some vegetables: lettuce, coriander, Chinese kale, chili, and corn. The Motto of Tontong is ‘Ancient town, Exceptionally culture, Local tradition and folkway, Strong community, Sustainable economic, Self-sufficient, Clean environment without pollution, Healthy quality of life, and Beautiful landscape throughout the sub-district’.
**Introduction of Organic Waste Transformation Technology to Lamphun**

Organic waste transformation technology using Adtech was performed by research and development (R&D) since 2007 e.g. the study by Panyaping et al., 2016, and Panyaping et al., 2017 due to the haze crisis occurred in the northern part of Thailand. It was introduced as one of the alternative technologies for waste management in order to solve environmental problem and produce bio-energy in Lamphun due to rich of organic material resources. Besides, there is a good cooperation among the people in this province. In addition, Organic waste transformation can provide the rapid returns to a user and an investor. Thus, several communities were very impressed and interested to use organic waste transformation technology in their local communities. Due to the limited resource, only some community was selected based on the mentioned criteria. Then, other communities that have abundant of organic material resources; food waste, mixed leaf waste, and Water hyacinth could be developed the program on organic waste transformation. However, there was a good chance for various communities to set up the program on organic waste transformation technology in the future.

**Type and process of Technology transfer on OWT**

Type of technology transfer was anaerobic digestion technology (Adtech) which convert organic waste into bioenergy and liquid organic fertilizer. This type of Adtech was based on the science and engineering research and their discoveries (Khalid et al., 2011). According to the needs of local community organizations and activities to solve environmental problem e.g. waste and air pollution, and save cost, process of technology transfer were developed into practical applications and products. The process of transferring scientific findings from R&D activity were from education institution (Rajamangala University of Technology Lanna; RMUTL) to local organization (Sub-district Municipality) for the purpose of solving pollution problem, and waste management. Moreover, organic waste transformation could be developed for local society in terms of commercialization as a social enterprise (SE) in the future, if there has been continually improvement.

In this work, the purpose of technology transfer is to strengthen both the economy and environment by accelerating the application of Adtech and local resources to public needs and opportunities. Thus, technology transfer on organic waste transformation includes the existing knowledge on Adtech, facilities (Anaerobic digesters and various equipments), and capabilities (Man power and capital investment availability) that are utilized to fulfill public and private needs.
Based upon the local resources, two different ratios of mixed organic waste were proposed. The first formula was the ratio of mixed leaf and food waste (2:3). The second formula was the ratio of Water Hyacinth, mixed leaf and food waste (3:2:3). The application of these ratios was due to the location of the community. If the community was located near the Mae Ping and Mae Kuang rivers, Water Hyacinth was always available. The second formula should be properly used as it provides the highest biogas. However, the first formula could be used in any place that food waste and leaf waste were generated. It also provided a higher biogas than a food waste digestion alone due to the accelerating effect of mixed leaf waste on food waste digestion (Panyakping and Moontee, 2018). Thus, both ratios could be applied in a local level.

The total benefit obtained from technology transfer on organic waste transformation was biogas as the major bioenergy product for cooking and for engine using both in a household and a farm. Besides, the value by-product was liquid organic fertilizer which could be used for cultivation and soil amendment. Moreover, the investment on organic waste transformation for biogas production could provide faster rate of return than other productions. In addition to the value added production from waste residues, renewable energy and a valuable nutrient were also obtained for sustaining ecology system and community. In terms of conservation benefits, there were benefits on energy, natural resources, and environmental conservations. Particularly, organic waste transformation could have reduce haze problem from open burning of organic waste during dry season. Furthermore, it will be needed to build a successful local community on organic waste transformation as a pilot community, and as a center of organic waste transformation study.

According to the data collected from public participation, it was found that half of male (50%) and female (50%) trainees were attended the technology transfer program in Tontong Sub-district Municipality. Over 50% had ever known on biogas technology, and about 40% had never experienced on practical biogas technology. As for the center of study on biogas production from organic waste transformation using anaerobic digestion technology/biogas technology, the people who were in charged on operation system at the Tontong’s center of sudy had ever experienced on biogas production before. After the training and demonstration of technology transfer on organic waste transformation at the Tontong’s center of study, biogas was generated within 7 days in a household anaerobic digestion. In order to increase more biogas yield, food waste was needed to feed every day about 2 kg/day/200L. In addition, the trainees had awareness for the benefits of organic waste transformation and could become the active players in using and promoting organic waste transformation. Moreover, the trainees thought that the technology transfer program was beneficial to their daily lives. They suggested that this type of program should be often and continually performed at the household level for a higher development of biogas production in their communities.

However, the risk of technology transfer on organic waste transformation is the failure of operation system of organic waste transformation using anaerobic digestion during the operation system may start due to some lack of skill performance on operation system. Therefore, not only basic knowledges but also trial and error should be learned. Operating performance skill requirements should be provided with their understanding. Training and demonstration with the following up should be performed.

This technology transfer project on organic waste transformation had been funded by the National Research Council of Thailand (NRCT), and was performed with the cooperation between Rajamangala University of Technology Lanna, and Tontong Sub-district Municipality in Muang District Lamphun. The purpose was to strengthen the local economy by accelerating the application of anaerobic digestion technology and organic material resources to public needs and opportunities.

**Demonstration and Implementation on OWT**

The type of anaerobic digester (AD) used was a household type digester (Fig 4-5) that consisted of AD tank, collected gas tank that was connecting to cooking burner. The operation system was fed with Water Hyacinth, mixed leaf waste, and food waste to produce energy consumption in household. Our research team was there to explain the technical and socio-economic aspects of organic waste transformation at the Tontong’s center of study. The technical team usually provided a necessary information for operation system performance, including follow up a technology transfer program on organic waste transformation.
Below was the five steps of demonstration on organic waste transformation to biogas production as shown in Fig 3 (Panyaping, 2018).

1. Preparation of raw material
e.g. mixed leaf, food waste, and starter

2. Preparation of anaerobic digester system
- Connecting a household anaerobic digester to a collected gas tank & leak checking

3. Running operation system
- Operating anaerobic digestion condition for organic waste transformation to produce biogas

4. Finishing operation system
- No feeding & stability of biogas yield

5. By-products utilization
- Biogas and liquid organic fertilizer

Figure 3  The five steps of demonstration on organic waste transformation

The first step called ‘Preparation of raw material’, both fresh and dry material; mixed leaf waste containing longan, mango, lychee, trek, and etc., including food waste were shredded into 0.1-0.5 mm. The starter from swine farm were prepared at the ratio of starter and raw material of 70:30.

The second step called ‘Preparation of a household anaerobic digester system’, Connect the digester tank to the collected gas tank. Checking the leak in pipe system of a household anaerobic digester size 200L should be performed before operating performance, and turned on the bottom tap to purge the air in AD. Fresh and dry leaf waste at the ratio of 3:1 was mixed with the starter in the mixed vessel before transferring to a household anaerobic digester.

The third step called ‘Running operation system’, prepared raw materials from the second step were transferred to a household anaerobic digester size 200L, and turn off the bottom tap to protect outside air into a household anaerobic digester. Observation biogas generation in a household anaerobic digester, and pH of a household anaerobic digester was measured. If pH was to be much acid (pH<6), 3%NaOH was used to adjust pH at a neutralize level (pH ≤ 9). The composition of biogas was also checked by lighting or measuring using biogas check. Mixing should be performed regularly, and every feeding.

The fourth step called ‘Finishing operation system’, No feeding, and pH was measured. The biogas quantity was stable, until there was no biogas. The operation system was shut down.

The fifth step called ‘By products utilization’, biogas was used for cooking, and liquid organic fertilizer was used as a fertilizer and a starter for compost.
**Figure 4** A set of household digester

**Figure 5** A cooking burner

**Cost of a Household Anaerobic Digester**

The cost of a household anaerobic digester was shown in Table 1.1

<table>
<thead>
<tr>
<th>Item</th>
<th>Full cost (baht)</th>
<th>Optional cost (baht)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic tank size 200L (650 baht/tank) 2 tanks</td>
<td>1,300</td>
<td>1,300</td>
</tr>
<tr>
<td>Plastic tank size 150L (580 baht/tank) 1 tank</td>
<td>580</td>
<td>580</td>
</tr>
<tr>
<td>PE equipment</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>PVC equipment</td>
<td>1,660</td>
<td>1,660</td>
</tr>
<tr>
<td>Cooking burner and adjuster</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Cooking burner accessories; valves and pipe</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Cooking burner stand</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Labor cost</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,500</td>
<td>4,240</td>
</tr>
</tbody>
</table>

From Table 1.1, if a household anaerobic digester could be built by a household that already used biogas for cooking, the household anaerobic digester cost as ‘an optional cost’ will be decreased more than a half price of ‘a full cost’ that was the cost for a household that had never been a household anaerobic digester before. An economic returns from this household anaerobic digester could be obtained less than 2 years for full cost, and less than 1 year for optional cost compared with the price of liquid petroleum gas for 1 tank (15kg) per month in October 2018. This household anaerobic digester could be used for a household size 5-8 persons.

**Discussion**

The selected local community was suitable for organic waste transformation technology in terms of the need, preparedness, cooperation of people, and the experience on anaerobic digestion technology. Introduction of organic waste transformation to Lamphun was a good alternative solution on waste management for the community to utilize organic waste resource with a high benefit. As organic waste transformation was approved through R&D, it has a huge potential to implement in local community, where organic waste resources could be turned into the value added by-products: both clean fuel, and liquid organic fertilizer.

Technology transfer on organic waste transformation through a demonstration and implementation provided the real system operation performance, including inspiration to implement a household anaerobic digester in other places such as some local school and university in Lamphun. However, the technical suggestion was still needed during the operation through the following up by the staff. The result of a household anaerobic digester implementation was well working and could be generated biogas for cooking. As compared the technology transfer program on organic waste transformation to other programs on biogas production both in developed countries and developing
countries, there were some differences in terms of raw materials used, types of anaerobic digester, local conditions, especially, the good cooperation and public participation in Tontong (Al-Hamamre, Z, 2017, El-Shimi, S. & Arafa, S, 2014, Edelmana, W., 1986, and Goling, D., 1982).

The research and development project on organic waste transformation provided the investment cost of a household anaerobic digester in the first time, the fiscal budget of each sub-district municipality could be used to support each community in a longer time. Besides, cost of a household anaerobic digester could be reduced when each community has a cooperation and a connection for the household anaerobic digester building. Particularly based upon sustainable development goals (SDGs) of United State in 2030 on the prosperity, organic waste transformation technology can help to sustain the community in terms of clean energy that everyone can reach based on the 7th sustainable development goals (SDG7), including the growth of economic and a valuable employment based on the 8th sustainable development goals (SDG8). Besides, organic waste transformation technology can help to cope with the climate change based on the 13th sustainable development goals (SDG13) that is SDGs on the planet. As organic waste transformation technology can also help to reduce greenhouse gas (GHG) emission as well as enhancing carbon trade. According to SDGs, technology transfer on organic waste transformation using anaerobic digestion technology is an alternative technology that can help to sustain the community. Furthermore, the success factors of organic waste transformation should be included the active interaction between government and community as well as the benefits sharing among local governments and residents in the local community.

**Conclusion and implications**

Organic waste transformation could contribute to clean energy, pollution prevention, and climate co-benefits. It could be used as a model for other areas. Some experiences on organic waste transformation technology, and the need to utilize the organic waste with a good benefit for sustaining the community were the major factors to successfully implement organic waste transformation in each community. Both ratios of mixed organic waste could be applied. The rapid and effective organic waste transformation technology should be made based on the requirement, local conditions, budget availability, personnel skill, and users of the products in order to sustain the community.

**Acknowledgements**

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A Study of Factors Influencing Travel Behaviors in Chiang Mai City

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Abstract

This paper report results of a study on (1) the relationship of socio-economic characteristics and urban form with travel behaviors and (2) the factors influencing travel mode choice in Chiang Mai city. Data was collected using purposive sampling by interviewing 410 people who living in Chiang Mai city area, and descriptive statistics was employed to analyzed data. The results of this study revealed that socio-economic characteristics and urban form were related to travel behaviors in Chiang Mai city. The top three factors affecting travel mode selection were (1) comfort and convenience (2) travel cost and (3) travel time. And the top three factors affecting the sample’s decision on using urban public transport were (1) traffic congestion (2) comfort and convenience and (3) travel cost. The results of this study could be applied to assist planners and policy makers, as an important information which needed to use in the urban transportation modeling system, to evaluate and prioritize urban public transport projects in Chiang Mai city.

Keywords: socio-economic characteristics, travel behaviors, travel mode choice factors, Chiang Mai city

Introduction

Transportation is one of the most important sectors of sustainable development (Cheba & Saniuk, 2016). At the city level, urban transport plays an important role in urban development, but it negatively affects public health in cities such as air pollution, noise, greenhouse gas emissions, and road accidents. Therefore, the comprehensive planning of transportation system, according consideration to social, economic, environmental and cultural elements of the city, can result in sustainable urban transportation. Establishing a sustainable urban transport system requires a comprehensive and integrated approach to policy-making and decision-making, with the aim of developing affordable, economically viable, people-oriented and environment-friendly urban transport systems (United Nations Department of Economic and Social Affairs [UNDESA], 2011).

The traditional and most important decision-oriented approach for urban transportation planning is the urban transportation modeling system (UTMS) or the four-step model (FSM). It consists of four major stages; trip generation is the prediction of the number of trips made within an urban area, trip distribution is the prediction of origin-destination (O-D) flow, modal split models predict the percentages of the available travel modes, and trip assignment places the O-D flows for each mode on specific routes of travel (Meyer & Miller, 2001). Since travel behavior can be characterized trip frequency, trip purpose, modal choice, and trip distance of each people in cities, then it is important information which needed to use in the four-step model.

Chiang Mai province is the economic, investment and transport center of northern Thailand. The urban area and development center of the province is called Chiang Mai city. Nowadays, Chiang Mai city is growing very fast and increasingly faces problems common to large cities; for example, unplanned and sprawling development, air and water pollution, waste management and traffic congestion (Chiang Mai Municipality, 2014). The uncontrollable land developments and urban sprawl affect to the transportation network of the city. The public transportation system (bus and red car taxi) unable to support the needs of the people; therefore, 90 percent of the Chiang Mai population uses private vehicle as the first mode of transportation (ExCITE, 2017). For this reason, Chiang Mai city
experiences more traffic congestion, which affects the sustainability of the city. Consequently, this city needs to focus on sustainable urban transportation in order to develop the city to meet sustainable growth. The suitable urban public transportation system is needed for Chiang Mai city. Therefore, the objective of this research was to study on (1) the relationship of socio-economic characteristics and urban form with travel behaviors and (2) the factors influencing travel mode choice in Chiang Mai city. The results of this study could be applied to help planners and policy makers to evaluate and prioritize urban public transport projects in Chiang Mai city.

Methods
Study area and samples
The study area is Chiang Mai urban area, which locates in a center of Chiang Mai province. It covers an area of 177 square kilometers and covers all Muang district with some part of six districts i.e. Mea Rim, San Sai, Doi Saket, San Kamphaeng, Saraphi, and Hang Dong. This area represents the development of settlement in Chiang Mai, which started from zone A to zone D (Chiang Mai Municipality, 2014), as shown in Fig.1.

The first settlement (zone A) is the old town square, locates in ancient city walls and surrounds by a moat. It is full of historical and cultural sites. This zone covers an area of 2.69 square kilometers. At present, the building heights in this zone are limited. This zone is the highest urban density.

The second phase (zone B) mostly expanded to the east of the city where the Ping river and the train station is located. It locates between a moat and the first ring road (or the first super-highway in Chiang Mai), covers an area of 28.71 square kilometers. The buildings in this area are commercial building, hotels, department stores and academic institutions. Nowadays, this zone is high urban density.

The third phase of settlement development (zone C) mainly expanded to the west of the city where the Chiang Mai university, the first public university in northern Thailand, was established, and also, the first ring road and the Chiang Mai international airport were built. This zone locates between the first ring road and the second ring road, covers an area of 59.2 square kilometers. At present, land uses in zone C are the same as zone B, but the urban density in this zone is less than zone B.

The fourth phase (zone D) locates between the second and the third ring road, covers an area of 86.4 square kilometers. This zone is lightly populated with housing projects and some agriculture area.
Population of this study is the total citizen living in Chiang Mai urban area. The sample size of this study was calculated from Eq.(1) (Madhuwanthi, Marasinghe, Rajapakse, Dharmawansa, & Nomura, 2016), by using 95% confidential interval (5% of error tolerance).

\[ n = \frac{N}{(1+Ne^2)} \]  
Eq.(1)

Since the number of populations in Chiang Mai urban area is 315,023 people in 2017 (Department of Provincial Administration, 2018), the minimum samples should be 400 samples to obtain a high accurate solution with a low error probability. However, this study conducted 410 samples by using cluster random sampling technique from four zones of the Chiang Mai urban area. The number of samples in each zone was a proportion of the total population in each zone: 29, 113, 114, and 154 samples for zone A, B, C, and D, respectively.

**Data collection and analysis**

The data were collected using a structured questionnaire which consists of three parts:

- The first part is the socio-economic characteristics data of the respondents; for example, age, occupation, income, vehicle ownership, and household location.
- The second part is the travel behavior of the respondents; such as, trip frequency, trip purpose, travel distance, travel mode choice, travel cost, and travel time.
- The last part is the opinion of the respondents concerning to factors affecting the choice of travel mode and the use of public transport in urban areas, as well as the selection of future public transport modes in urban areas.

The future urban public transportation modes in this study were taken from the past study projects of public transit system in Chiang Mai city. Light rail transit (LRT) with the track on and under the ground were taken from the studies of Expressway Authority of Thailand in 1994-1996 and the Office of Transport and Traffic Policy and Planning in 2016-2017. Bus rapid transit (BRT) which has its own exclusive lane was taken from the study of the Office of Transport and Traffic Policy and Planning in 2005-2007. Tram and BRT which share the lane with private vehicle were taken from the study of the Office of Pingkanakorn development (Public organization) in 2014-2015. Even though, sky train was not in any past study project in Chiang Mai city, it was added to this study as an alternative.

Content validity of the questionnaire was evaluated by using the index of item-objective congruence (IOC), which more than 0.5 is considered to indicate good content validity. Five experts in civil engineering and transportation engineering: three experts from the Department of Highway (DOH) and two experts from Chiang Mai university (CMU), were invited to evaluate the IOC. The IOC value of all questions ranged from 0.6 to 1.0; therefore, they were considered appropriate.

The reliability was determined by using Cronbach’s alpha coefficient, which equal or above 0.7 is considered satisfactory. The pilot test with 30 samples was conducted. The alpha coefficient was 0.892; therefore, the questionnaire was acceptable.

The SPSS statistical software was used to analyze the data. Data were analyzed using descriptive statistics: percentages, means, and standard deviations (Albayati, Sipe, Alizadeh, & Tomerini, 2015; Madhuwanthi et al., 2016).

**Results and discussions**

The results of this study are comprised into two parts, the relationship of socio-economic characteristics and urban form with travel behaviors and the factors influencing travel mode choice in Chiang Mai city.

**The relationship of socio-economic characteristics and urban form with travel behaviors**

Socio-economic characteristics data of the respondents in this study included age, occupation, education level, income, car ownership and motorcycle ownership. Since travel behaviors on transport mode choice was selected for analyzed the relationship with socio-economic characteristic variables, the results which revealed the relationship of socio-economic characteristics with travel behavior of the respondents was shown in Table 1.

As shown in Table 1, the results indicated that occupation, education level, income, car ownership are related to travel mode choice of the respondents. The most important and straightforward socio-economic characteristic variable that describes the travel behaviors is car ownership: almost of
households owning a car travel by car. In addition, car ownership is also the result of other socio-economic variables, particularly income (Van Acker & Witlox, 2009).

For analyzed the relationship of urban form with travel behavior of the respondents, household location was selected as an urban form variable with travel behavior variables included travel distances, travel mode, travel time, and travel cost. As shown in Table 2, the resulted shown that household location was related to all of travel behavior variables. Most of the respondents whom livings in zone A have a short travel distance and are used both personal car and personal motorcycle. However, most of the respondents whom livings in zone D have a long travel distance and are used more personal car than a personal motorcycle.

Table 1 Relationship of travel mode with socio-economic characteristics of the respondents

<table>
<thead>
<tr>
<th>Socio-economic characteristic variables</th>
<th>Personal car</th>
<th>Personal motorcycle</th>
<th>Bus</th>
<th>Songteaw (red car taxi)</th>
<th>Walking</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 – 20</td>
<td>3.9</td>
<td>6.3</td>
<td>0.0</td>
<td>0.4</td>
<td>0.2</td>
<td>11.0</td>
</tr>
<tr>
<td>21 – 30</td>
<td>25.1</td>
<td>28.0</td>
<td>0.5</td>
<td>0.7</td>
<td>1.0</td>
<td>55.4</td>
</tr>
<tr>
<td>31 – 40</td>
<td>11.7</td>
<td>9.0</td>
<td>0.5</td>
<td>0.9</td>
<td>0.7</td>
<td>22.9</td>
</tr>
<tr>
<td>41 – 50</td>
<td>3.7</td>
<td>3.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>8.0</td>
</tr>
<tr>
<td>51 – 60</td>
<td>1.5</td>
<td>0.7</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>2.7</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.117)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td>2. Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government officer</td>
<td>4.6</td>
<td>2.4</td>
<td>0.2</td>
<td>0.2</td>
<td>0.0</td>
<td>7.6</td>
</tr>
<tr>
<td>State enterprise officer</td>
<td>5.9</td>
<td>3.7</td>
<td>0.0</td>
<td>0.2</td>
<td>0.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Company employee</td>
<td>11.5</td>
<td>15.6</td>
<td>0.0</td>
<td>0.7</td>
<td>0.0</td>
<td>27.8</td>
</tr>
<tr>
<td>Self-employed</td>
<td>6.1</td>
<td>3.4</td>
<td>0.2</td>
<td>0.0</td>
<td>1.5</td>
<td>11.2</td>
</tr>
<tr>
<td>Employee</td>
<td>9.5</td>
<td>10.7</td>
<td>0.5</td>
<td>0.4</td>
<td>0.5</td>
<td>21.7</td>
</tr>
<tr>
<td>Student</td>
<td>8.3</td>
<td>12.2</td>
<td>0.0</td>
<td>0.4</td>
<td>0.7</td>
<td>21.7</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.009)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td>3. Education level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergrad</td>
<td>11.7</td>
<td>17.1</td>
<td>0.5</td>
<td>0.4</td>
<td>1.5</td>
<td>31.2</td>
</tr>
<tr>
<td>Bachelor</td>
<td>32.4</td>
<td>30.7</td>
<td>0.2</td>
<td>1.7</td>
<td>1.5</td>
<td>66.6</td>
</tr>
<tr>
<td>Master or higher</td>
<td>1.7</td>
<td>0.2</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>2.2</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.015)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td>4. Income (Baht)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 15,000</td>
<td>21.5</td>
<td>29.0</td>
<td>0.5</td>
<td>1.5</td>
<td>2.0</td>
<td>54.4</td>
</tr>
<tr>
<td>15,001 – 30,000</td>
<td>21.0</td>
<td>16.1</td>
<td>0.5</td>
<td>0.7</td>
<td>1.0</td>
<td>39.3</td>
</tr>
<tr>
<td>30,001 – 45,000</td>
<td>2.4</td>
<td>2.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>4.9</td>
</tr>
<tr>
<td>≥ 45,000</td>
<td>1.0</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.5</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.021)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0</td>
</tr>
<tr>
<td>5. Car ownership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0.0</td>
<td>2.9</td>
<td>0.0</td>
<td>0.5</td>
<td>1.0</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Table 2 Relationship of urban form with travel behaviors of the respondents

<table>
<thead>
<tr>
<th>Travel behavior variables</th>
<th>Household location (%)</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Travel distance (kilometers)</td>
<td></td>
<td>2.2</td>
<td>10.2</td>
<td>6.3</td>
<td>4.9</td>
<td>23.7</td>
</tr>
<tr>
<td>1 – 3</td>
<td></td>
<td>2.2</td>
<td>10.2</td>
<td>6.3</td>
<td>4.9</td>
<td>23.7</td>
</tr>
<tr>
<td>3 – 6</td>
<td></td>
<td>1.2</td>
<td>6.3</td>
<td>6.8</td>
<td>4.9</td>
<td>19.3</td>
</tr>
<tr>
<td>6 – 9</td>
<td></td>
<td>0.7</td>
<td>3.4</td>
<td>2.0</td>
<td>2.2</td>
<td>8.3</td>
</tr>
<tr>
<td>9 – 12</td>
<td></td>
<td>2.2</td>
<td>5.6</td>
<td>6.1</td>
<td>10.2</td>
<td>24.1</td>
</tr>
<tr>
<td>12 – 15</td>
<td></td>
<td>0.7</td>
<td>2.0</td>
<td>6.6</td>
<td>15.4</td>
<td>24.6</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.000)</td>
<td></td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Travel mode

<table>
<thead>
<tr>
<th>Travel mode</th>
<th>Household location (%)</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal car</td>
<td></td>
<td>3.2</td>
<td>9.8</td>
<td>9.8</td>
<td>23.2</td>
<td>45.9</td>
</tr>
<tr>
<td>Personal motorcycle</td>
<td></td>
<td>3.9</td>
<td>15.6</td>
<td>15.6</td>
<td>12.9</td>
<td>48.0</td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Songteaw (red car taxi)</td>
<td></td>
<td>0.0</td>
<td>0.7</td>
<td>1.0</td>
<td>0.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Walking</td>
<td></td>
<td>2.7</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>2.9</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.000)</td>
<td></td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Travel time (min.)

<table>
<thead>
<tr>
<th>Travel time (min.)</th>
<th>Household location (%)</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 10</td>
<td></td>
<td>5.4</td>
<td>12.7</td>
<td>10.0</td>
<td>8.8</td>
<td>36.8</td>
</tr>
<tr>
<td>11 – 20</td>
<td></td>
<td>2.7</td>
<td>6.6</td>
<td>7.6</td>
<td>12.2</td>
<td>29.0</td>
</tr>
<tr>
<td>21 – 30</td>
<td></td>
<td>1.7</td>
<td>7.1</td>
<td>7.1</td>
<td>10.7</td>
<td>26.6</td>
</tr>
<tr>
<td>&gt; 30</td>
<td></td>
<td>0.0</td>
<td>0.0</td>
<td>2.0</td>
<td>5.6</td>
<td>7.6</td>
</tr>
<tr>
<td>(Chi-square Asymp.Sig. (2-sided) = 0.000)</td>
<td></td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Travel cost (Baht)

<table>
<thead>
<tr>
<th>Travel cost (Baht)</th>
<th>Household location (%)</th>
<th>Zone A</th>
<th>Zone B</th>
<th>Zone C</th>
<th>Zone D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 20</td>
<td></td>
<td>2.7</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>2.9</td>
</tr>
<tr>
<td>21 – 40</td>
<td></td>
<td>2.0</td>
<td>11.5</td>
<td>11.0</td>
<td>3.9</td>
<td>28.3</td>
</tr>
<tr>
<td>41 – 60</td>
<td></td>
<td>2.4</td>
<td>8.3</td>
<td>8.0</td>
<td>11.5</td>
<td>30.2</td>
</tr>
</tbody>
</table>

(Chi-square Asymp.Sig. (2-sided) = 0.675)
The factors influencing travel mode choice in Chiang Mai city

The results of the study of factors influencing the selection of travel mode and urban public transportation system in the Chiang Mai urban area shown in Table 3 and Table 4, respectively. As shown in Table 3, comfort and convenience was the first factor affecting to transport mode selection of the respondents. Travel cost, travel time, safety, accessibility, trip frequency, and connectivity to other mode were the next prioritize with close value.

The factors influencing the selection of urban public transportation system of the respondents was shown in Table 4. The first three reasons of the respondents in order to use public transport system are traffic congestion, comfort and convenience, and travel cost.

Table 3. Factors affecting on transport mode choice decision of the respondents

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level of importance (%)</th>
<th>Very important</th>
<th>Fairly important</th>
<th>Slightly important</th>
<th>Not important</th>
<th>( \bar{x} )</th>
<th>S.D.</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort and convenience</td>
<td></td>
<td>46.3</td>
<td>38.0</td>
<td>15.4</td>
<td>0.2</td>
<td>4.30</td>
<td>0.714</td>
<td>1</td>
</tr>
<tr>
<td>Travel cost</td>
<td></td>
<td>32.0</td>
<td>50.0</td>
<td>17.1</td>
<td>0.7</td>
<td>4.13</td>
<td>0.726</td>
<td>2</td>
</tr>
<tr>
<td>Travel time</td>
<td></td>
<td>37.1</td>
<td>38.5</td>
<td>22.0</td>
<td>1.7</td>
<td>4.10</td>
<td>0.847</td>
<td>3</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td>37.3</td>
<td>37.3</td>
<td>23.2</td>
<td>1.7</td>
<td>4.09</td>
<td>0.843</td>
<td>4</td>
</tr>
<tr>
<td>Accessibility</td>
<td></td>
<td>34.9</td>
<td>38.3</td>
<td>22.9</td>
<td>3.9</td>
<td>4.04</td>
<td>0.857</td>
<td>5</td>
</tr>
<tr>
<td>Connectivity to other mode</td>
<td></td>
<td>31.2</td>
<td>37.8</td>
<td>26.1</td>
<td>4.1</td>
<td>3.94</td>
<td>0.897</td>
<td>7</td>
</tr>
<tr>
<td>Trip frequency</td>
<td></td>
<td>28.0</td>
<td>42.4</td>
<td>26.3</td>
<td>2.9</td>
<td>3.95</td>
<td>0.826</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 4 Factors affecting on urban public transport choice decision of the respondents

<table>
<thead>
<tr>
<th>Factor</th>
<th>Level of importance (%)</th>
<th>Very important</th>
<th>Fairly important</th>
<th>Slightly important</th>
<th>Not important</th>
<th>( \bar{x} )</th>
<th>S.D.</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort and convenience</td>
<td></td>
<td>39.3</td>
<td>38.8</td>
<td>17.6</td>
<td>3.2</td>
<td>4.12</td>
<td>0.891</td>
<td>2</td>
</tr>
<tr>
<td>Travel cost</td>
<td></td>
<td>33.2</td>
<td>38.5</td>
<td>23.7</td>
<td>3.4</td>
<td>3.99</td>
<td>0.904</td>
<td>3</td>
</tr>
<tr>
<td>Travel time</td>
<td></td>
<td>27.6</td>
<td>30.2</td>
<td>30.1</td>
<td>7.1</td>
<td>3.70</td>
<td>1.074</td>
<td>9</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td>31.7</td>
<td>34.9</td>
<td>29.5</td>
<td>2.9</td>
<td>3.93</td>
<td>0.903</td>
<td>4</td>
</tr>
<tr>
<td>Accessibility</td>
<td></td>
<td>25.9</td>
<td>32.9</td>
<td>34.4</td>
<td>6.1</td>
<td>3.77</td>
<td>0.928</td>
<td>6</td>
</tr>
<tr>
<td>Connectivity to other mode</td>
<td></td>
<td>23.2</td>
<td>35.6</td>
<td>35.9</td>
<td>4.6</td>
<td>3.76</td>
<td>0.886</td>
<td>7</td>
</tr>
<tr>
<td>Traffic congestion</td>
<td></td>
<td>48.0</td>
<td>27.8</td>
<td>20.0</td>
<td>3.7</td>
<td>4.19</td>
<td>0.914</td>
<td>1</td>
</tr>
<tr>
<td>Available and cost of parking</td>
<td></td>
<td>32.4</td>
<td>32.4</td>
<td>29.0</td>
<td>5.9</td>
<td>3.91</td>
<td>0.930</td>
<td>5</td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td>23.7</td>
<td>37.3</td>
<td>28.5</td>
<td>7.8</td>
<td>3.72</td>
<td>0.998</td>
<td>8</td>
</tr>
<tr>
<td>Do not have any choice</td>
<td></td>
<td>11.7</td>
<td>27.8</td>
<td>36.6</td>
<td>14.4</td>
<td>3.18</td>
<td>1.114</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 5 Urban public transportation mode choice of the respondents

<table>
<thead>
<tr>
<th>Urban public transportation mode</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>X</th>
<th>S.D.</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>18.8</td>
<td>26.3</td>
<td>34.9</td>
<td>14.1</td>
<td>5.9</td>
<td>3.38</td>
<td>1.117</td>
<td>5</td>
</tr>
<tr>
<td>Agree</td>
<td>21.2</td>
<td>30.6</td>
<td>37.5</td>
<td>15.4</td>
<td>3.1</td>
<td>3.63</td>
<td>1.069</td>
<td>4</td>
</tr>
<tr>
<td>Neutral</td>
<td>19.8</td>
<td>31.0</td>
<td>31.0</td>
<td>8.3</td>
<td>1.7</td>
<td>4.10</td>
<td>0.948</td>
<td>3</td>
</tr>
<tr>
<td>Disagree</td>
<td>36.6</td>
<td>42.2</td>
<td>17.1</td>
<td>2.9</td>
<td>1.2</td>
<td>4.10</td>
<td>0.869</td>
<td>2</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>50.0</td>
<td>31.0</td>
<td>14.9</td>
<td>2.7</td>
<td>1.5</td>
<td>4.26</td>
<td>0.909</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5 represents the choices of urban public transportation mode of the respondents. The first two choices are underground train and sky train with highly agreement and mean scores 4.26 and 4.10, respectively. On the other hand, urban public transportation modes which sharing traffic lanes; such as, tram, bus rapid transit, and bus, got a lower scored because they think it increase traffic congestion. Songthaew or red car taxi was the lowest scored because the respondents think it could not reduce traffic congestion, not comfort and convenience, and they cannot plan for a travel cost when use it.

Conclusions and implications

In this paper, influence of socio-economic characteristics and urban form on travel behaviors in Chiang Mai city was studied. The results of this study revealed that socio-economic characteristics were related to travel behaviors in Chiang Mai city. Car ownership and income were important variables influencing to transportation mode choice. Most people in Chiang Mai urban area use personal vehicle, car and motorcycle, with the reason of comfort and convenience. In addition, urban form influence to travel behaviors on travel distance, transport mode choice, travel time, and travel cost. The most people whom live in urban area which located far from center business district were used personal vehicle. The study indicated that the demand in using of urban public transportation is low, because of high travel cost and not comfort and convenience. The results of this study could be applied to assist planners and policy makers, as an important information which needed to use in the urban transportation modeling system, to evaluate and prioritize urban public transport projects in Chiang Mai city.

References


Cellulose Degradation by White Fungus Isolated from Pig Manure

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Abstract

The purpose of this research was to investigate the cellulose degradation potency of white fungus isolated from pig manure and to identify the fungus by molecular technique. Cellulase production assay of white fungus using congo red test showed that the hydrolysis capacity (HC) value was 1.03. The cellulose degradability of white fungus was examined on filter paper and it gained weight of 31.43%. The isolated fungus produced total protein and cellulase with concentration of 8.80 mg/ml and 3.46 U/ml, respectively and its cellulase activity was 1.62 U/mg. Internal transcribed spacer sequence-based identification revealed that the white fungus was similar to Lecanicillium aphanoecladii with 93.50%. This cellulolytic fungus could be used for biodegradation of cellulosic wastes.

Keywords: white fungus, cellulose degradation, cellulase activity

Introduction

Corn is an important industrial crop since it is a staple food for people and animals. The continued demand for corn consumption causes more crops cultivation and also results in agricultural waste increasing. Plenty of agricultural cellulosic wastes has been accumulating and discarded improperly such as burning, one of many sources of air pollution. Burning of agricultural crop residue also causes severe pollution of land and water and threatens to human health since it contributes towards the emission of greenhouse gases (CO₂, N₂O, CH₄), air pollutants (CO, NH₃, NOₓ, SO₂, NMHC, volatile organic compounds), particulates matter and smoke (Kumar & Joshi, 2013; Jain et al., 2014).

The domestic waste material from agriculture is cellulose, a major structural component of the plant cell wall. Cellulose is the most abundant biomass and a renewable natural product in biosphere. It is a polymer of β-1,4 linked glucose units and degraded by cellulase enzyme which is commonly produced by fungi and bacteria (Islam & Roy, 2018; Bekele et al., 2015; Ram et al., 2014). Due to the high cost of crop residue utilization processes, cellulase enzyme provide the effective treatment and utilization of cellulosic waste as inexpensive carbon sources. The cellulase-producing microorganisms includes various strains of bacteria and filamentous fungi. Among them, fungi in the genera Aspergillus, Penicillium, Rhizopus and Trichoderma (Kale & Zanwar, 2016; Meena et al., 2018; Bekele et al., 2015; Nathan et al., 2014; Kupski et al., 2014) are commonly reported as cellulase producer. The main sources for isolation of cellulase-degrading fungi are soil, compost and agricultural waste (Srivastava et al., 2018; Rathnan et al., 2012).

The aim of this research was to isolate and identify the white fungus responsible for fermentation of corncobs from pig manure and to investigate its capability to produce cellulase enzyme and degrade the cellulosic substrate.

Materials and methods

White fungus isolation from corncobs and pig manure fermentation

After fermentation of corncobs with pig manure for 3 months the white fungus grown in fermentation container was isolated. It was cultured on potato dextrose agar (PDA) medium and incubated at 25°C for 5 days. A slide culture technique was applied to observe and identify of fungal mycelium and spores.
Identification of white fungus based on the ITS sequence analysis

White fungus DNA was extracted using a modified protocol according to Doyle & Doyle (1987). PCR amplification of the internal transcribed spacer (ITS) of fungal DNA was carried out using Excel Taq 5X PCR Master Dye Mix (SMOBIO) and the primers ITS3 (5'-GCATCGATGAAACGCAGC-3') and ITS4 (5'-TCCTCGCTTATTGATATGC-3'). PCR conditions were 2 minutes at 94 ºC for the initial denaturation of template DNA, 30 amplification cycles (30 seconds at 94 ºC, 30 seconds at 55 ºC, and 30 seconds at 72 ºC), and 1 minute at 72 ºC for the final extension. Sequencing of PCR product was performed by Macrogen Inc. and the obtained sequences were used to perform BLAST searches using the NCBI GenBank database.

Cellulase production assay by congo red test

Cellulase production capability of fungal isolate was examined by congo red test based on Gupta et al. (2015) with slight modification. Pure culture was spot inoculated on carboxymethyl cellulose agar (0.1 g of carboxymethyl cellulose, 0.1 g of yeast extract, 0.4 g of K2HPO4, 0.02 g of KCl, 0.1 g of MgSO4.7H2O, 0.002 g of FeSO4.7H2O and 1.5 g of agar in 100 ml of sterilized water; pH 5.0) and incubated at 25°C for 48 hr. After incubation time, the mycelium grown in petri-dish was poured with 0.1% congo red (w/v) for 15 minutes followed by washing with 1 N NaCl for 15 minutes. Then fungal colony and clear zone diameter were measured and used to calculate the hydrolysis capacity (HC) value, that is, the ratio of diameter of clearing zone and colony as described by Sreeja et al. (2013). The experiments were done in triplicate.

Cellulose degradation assay by filter paper

Filter paper with 7 cm diameter was used as cellulosic substrate, according to Watanabe et al. (2012) with some modification. It was sterilized and dried for at least one hour at 80°C using hot air oven before placing in a PDA plate. The agar plugs of fungal isolate prepared by using a sterile cork borer was put on the filter paper and incubated at 25°C. After incubating for 30 days, the filter paper was removed and dried at 80°C until a constant weight was obtained. The assays were performed in triplicate. The dry weight of the filter paper measured both before and after the experiment was calculated for the average.

Analysis of protein concentration and cellulase activity

The protein assay was performed using biuret test. The fungal isolate was cultured in CMB medium at 25°C for 72 hours before transferring of one ml of culture suspension into the Eppendorf. The suspension was centrifuged at 5000 rpm for 15 min and then 900 μl of the supernatant was mixed with 100 μl of biuret. The mixture was 2-fold serial diluted with distilled water before measurement the absorbance at 540 nm by spectrophotometer. The protein concentration was determined based on the bovine serum albumin (BSA) standard curve. Cellulase activity was determined by evaluating the reducing sugar produced during the enzymatic reaction by dinitrosalicylic acid (DNS) based on Gupta et al. (2015). The reaction mixture composed of 0.5 ml of culture filtrate and 0.5 ml of 2% (w/v) CMC in 0.05 M sodium citrate buffer (pH 4.8) was incubated at 50°C for 30 min. Three ml of DNS reagent was added before the mixture was boiled for 5 min to obtain a colored reaction mixture. The sample was measured the absorbance at 540 nm.

Results and discussions

The white fungus isolated from corncobs and pig manure fermentation had the circular, white and cottony colony with septate hypha. Conidia was ellipsoidal shaped. ITS region from fungal isolate was an approximately 400 bp sized fragment. It showed in BLAST analysis a high percentage of homology (93.5%) with Lecanicillium aphanocladii (Table 1) The morphological characteristics of the fungal isolate corresponded the species classified by ITS sequencing and agreed the description recorded by El-Debaiky (2017).
The isolated fungus had capability to degrade CMC. It showed the cellulase hydrolysis capacity value with 1.03 when screened by congo red method (Table 2). The HC value obtained was lower than the range from *Aspergillus* sp. and Actinomycetes reported by Chobbun et al. (2016) whereas Khianngam et al. (2014) found the HC value between 1.56 to 4.14 of cellulase producing bacteria isolated from oil palm meal.

Assays of cellulose-degrading fungi using filter paper showed that the dry weight of filter paper in the isolated fungus experiment was higher than of the control with 31.43% after 30 days of culture (Figure 1). The result did not indicate cellulose degradation ability of this fungi. However, some research reported that the assays based on the dry weight reduction of cellulosic substrates required at least 40 days of incubation (Watanabe et al., 2003; Tanesaka et al., 1993). *L. aphanocladii* in this research may require more than 30 days to measure enzymatic reaction using filter paper test.

### Table 2 Analytical results related to cellulose degradation of white fungus

<table>
<thead>
<tr>
<th>HC value</th>
<th>Weight of filter paper</th>
<th>Total protein concentration (mg/ml)</th>
<th>Cellulase concentration (U/ml)</th>
<th>Cellulase activity (U/mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.03</td>
<td>+31.43%</td>
<td>8.80</td>
<td>3.46</td>
<td>1.62</td>
</tr>
</tbody>
</table>

Total protein and cellulase concentration derived from *L. aphanocladii* using biuret test was 8.80 mg/ml and 3.46 U/ml, respectively. *L. aphanocladii* exhibited 1.62 U/mg of cellulase activity. Its activity to degrade cellulosic substrate was different from other fungi such as *A. fumigatus* ABK9 (826.2 U/g; Das et al., 2013), *Myceliophthora thermophila* JCP 1-4 (357.51 U/g; Pereira et al., 2015), *Cladosporium* sp. (106.78 U/g; Meena et al., 2018), *Penicillium* sp. (37.32 U/ml; Ire et al., 2018), *T. viride* (33 U/g; Nathan et al., 2014) and a fungal strain isolated from soil (29.04 U/g; Gupta et al., 2015). Cellulolytic enzymes produced by several microorganisms, commonly in fungi including the genera Aspergillus, Penicillium, Rhizopus and Trichoderma (Kale & Zanwar, 2016; Meena et al., 2018; Bekele et al., 2015; Nathan et al., 2014; Kupski et al., 2014). The entomopathogenic fungus in genera Lecanicillium recently reported by Senthil Kumar et al. (2018) had a cellulase production capability. *L. psalliotae* strain IISR-EPF-02 could promote plant growth directly by production of indole-3-acetic acid and also indirectly by production of siderophores and cell wall-degrading enzymes like, α-amylases, cellulases and proteases.
Figure 1 The growth of white fungus on the filter paper after incubation for 1 day (A), 10 days (B), 30 days (C) and after drying at 80°C (D) in triplicate compared with control (without the fungus).

Conclusions

One strain of white fungus isolated from the pig manure was *L. aphanocladii*. It had capability to degrade cellulosic substrate with the HC value of 1.03. The cellulase concentration and cellulase activity of *L. aphanocladii* were 3.46 U/ml and 1.62 U/mg, respectively. *L. aphanocladii* obtained from this study may be considered as a cellulose-degrading fungi and could be used for biodegradation of cellulosic wastes. Further study for this isolate including optimization of cellulase production, enhancing the cellulolytic ability or extraction of cellulase enzyme are required for agricultural and industrial application.

References


Diversity of Freshwater Algae and Aquatic Insects Community in Paddy Field Areas, Chom Thong, Chiang Mai

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Abstract

The diversity of freshwater algae and aquatic insects in the lotic ecosystem at Chom Thong in Chiang Mai Province were investigated on March 2018. Samples were collected from two streams including Hauk and Yang Kham which passing through the area of chemical and organic paddy fields, respectively. At each streams, some physical and chemical factors of water quality were analyzed at field sites and laboratory. A total of two species of macroalgae, 53 species of benthic diatoms and 7 orders 29 families of aquatic insects were found in chemical paddy fields and total of 7 species of macroalgae, 61 species of benthic diatoms and 7 orders 32 families of aquatic insects were found in organic paddy fields. The study on diversity index, evenness and richness showed that the organic paddy fields areas had higher value than chemical paddy fields areas. In addition, nitrogen-fixing algae were found only in organic paddy field areas.

Keywords: Hauk stream, Yang Kham stream, water quality, organic paddy fields

Introduction

Rice cultivation is the main occupation of farmers in the Northern Thailand. Chiang Mai province has many areas of rice cultivation with a total area of approximately 68,000 hectares (Rice Department, 2018). Chom Thong district is a one district, where total rice cultivation area are approximately 2,300 hectares (Chiangmai Provincial Agricultural Extension Office, 2018). At present, Chom Thong district has cultivated organic riceberry, especially at Tambon Doi Kaeo which certified by the United States Department of Agriculture (USDA). The areas and water resources are clearly divided into chemical and organic paddy fields. As a result, the physical and chemical quality of the water resources is different. Moreover, this activity has effect to the organisms, especially the groups of freshwater algae and aquatic insects which they respond directly and rapidly to the environmental changes. In Asia, there are a few studies on the freshwater algae and aquatic insects in paddy fields such as India (Vijayan & Ray, 2015a,b, 2016), Japan (Ueno, 2013), Pakistan (Asghar et al., 2013) and Indonesia (Che Salmah et al., 2018) which most of them studied in chemical paddy fields. The aim of the study were as follows: (i) to determine the diversity of freshwater algae and aquatic insects in streams which pass through the chemical and organic paddy fields in Hauk and Yang Kham stream and (ii) to study the physico-chemical properties of stream water.

Method

The samples were collected from Hauk stream (chemical paddy fields areas) and Yang Kham stream (organic paddy fields areas) which located in Tambon Doi Kaeo, Chom Thong
District, Chiang Mai Province in March 2018. The details of each sampling site are shown in Table 1 and Figure 1.

**Table 1 Sampling sites and their topography**

<table>
<thead>
<tr>
<th>Sampling site</th>
<th>GPS (Lat-Long)</th>
<th>Altitude (m)</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hauk stream</td>
<td>18°40'5399&quot; N</td>
<td>315</td>
<td>Areas of chemical paddy fields</td>
</tr>
<tr>
<td></td>
<td>98°64'1204&quot; E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yang Kham stream</td>
<td>18°40'5423&quot; N</td>
<td>299</td>
<td>Areas of organic paddy fields</td>
</tr>
<tr>
<td></td>
<td>98°64'3334&quot; E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1 Map showing location of Hauk and Yang Kham stream at Tambon Doi Kaeo, Chom Thong District, Chiang Mai Province.*

The three replicate of water samples, freshwater algae and aquatic insects were collected from three sampling sites of each stream. The freshwater algae collection, processing and identification were done following Thiamdao et al. (2012), Leelahakriengkrai (2013) and Asmida et al. (2015). Aquatic insects were collected by the kick sampling method with a D-frame net (Kunpradid et al., 2016). Water samples were collected with polyethylene bottles and kept in a cooler box (5-7 °C). Measurement of some physico-chemical properties of water was done at each sampling site. Conductivity and pH were measured in the field using portable meters. Dissolved oxygen (DO), Biochemical oxygen demand (BOD₅), ammonium nitrogen (NH₄⁺-N), nitrate nitrogen (NO₃-N) and soluble reactive phosphorus (SRP) were determined in the laboratory using azide modification, nesslerization, cadmium reduction and ascorbic acid methods, respectively (Eaton et al. 2005).

The analysis of variance (ANOVA) and Least Significant Difference (LSD) of water qualities were analyzed for significant differences between sites in each sampling sites. The species diversity index (H') and evenness (E) were calculated following Shannon Diversity Index (Odum & Barrett, 2004).
Results and Discussions

Freshwater algae diversity

A total of two species of macroalgae such as *Oscillatoria* sp. and *Phormidium* sp. were found at the Hauk stream which were classified into Cyanophyta (Blue green algae). A total of seven species of macroalgae were found at the Yang Kham stream. These were classified into two divisions, Chlorophyta (Green algae) and Cyanophyta. The abundant genera found of Chlorophyta were *Oedogonium*, *Microspora*, *Spirogyra* and *Hydrodictyon* and Cyanophyta were *Oscillatoria*, *Nostoc* and *Cylindrospermum*. The results show that the organic paddy fields area shown a higher diversity of macroalgae than chemical paddy fields area. In addition, only Yang Kham stream (organic paddy fields areas) were found heterocystous nitrogen-fixing blue green algae such as *Nostoc* sp. and *Cylindrospermum* sp. which have an important role in the nitrogen a cycle in the agricultural area (Pereira et al., 2005). However, in this study were found low abundant of macroalgae (less than 20% per square meter) that is not suitable for agricultural value-added. The distribution and species list were classified systematically into categories and is shown in Table 2.

<table>
<thead>
<tr>
<th>Species list of freshwater algae</th>
<th>Hauk1</th>
<th>Hauk2</th>
<th>Hauk3</th>
<th>YangKham1</th>
<th>YangKham2</th>
<th>YangKham3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division Cyanophyta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Oscillatoria</em> sp.</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>√</td>
</tr>
<tr>
<td><em>Phormidium</em> sp.</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Nostoc</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
</tr>
<tr>
<td><em>Cylindrospermum</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Division Chlorophyta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hydrodictyon</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Microspora</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>-</td>
</tr>
<tr>
<td><em>Oedogonium</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><em>Spirogyra</em> sp.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>√</td>
<td>√</td>
<td>-</td>
</tr>
</tbody>
</table>

* √ = presented, - = absent

Fifty-three species of benthic diatoms were found from the Hauk stream. The most abundant species were *Achnanthidium minutissimum* and *Cocconeis placenta*. The diversity index of benthic diatoms ranged from 1.00-2.05 and the evenness ranged from 0.08-0.25 (Table 3). Sixty-one species of benthic diatoms were found from the Yang Kham stream. The most abundant species were *Gomphonema lagenula*, *Cocconeis placenta* *Rhopalodia giberula*, *Achnanthidium minutissimum*, *Achnanthes oblongella* and *Achnanthes exigua*. The diversity index of benthic diatoms ranged from 2.10-2.39 and the evenness ranged from 0.20-0.23 (Table 3). The distribution and species list were classified systematically into categories and is shown in Table 4. The results show that the organic paddy fields area shown a higher diversity index than chemical paddy fields area. However, *Cocconeis placenta* was found to be present in the highest abundant in all sampling sites which this species were acknowledged as a common species in Thailand (Leelahakriengkrai & Peerapornpisal, 2011). Moreover, Jahn et al., (2009) who found these species in the alkaline environments which was similar to this research due to Hauk and Yang Kham stream flow through a limestone mountains and had a high conductivity value.
**Table 3** Shannon’s diversity index, evenness and richness of benthic diatoms and aquatic insects in the Hauk and Yang Kham streams in March 2018

<table>
<thead>
<tr>
<th>Sampling</th>
<th>Diversity index</th>
<th>Evenness</th>
<th>Richness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benthic diatoms</td>
<td>Aquatic insects</td>
<td>Benthic diatoms</td>
</tr>
<tr>
<td>Hauk1</td>
<td>1.00</td>
<td>1.53</td>
<td>0.08</td>
</tr>
<tr>
<td>Hauk2</td>
<td>1.92</td>
<td>1.41</td>
<td>0.25</td>
</tr>
<tr>
<td>Hauk3</td>
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**Table 4** Species list and relative abundance of each taxon of benthic diatoms in Hauk and Yang Kham streams

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Table 5 Families list and relative abundance of each taxon of aquatic insects in Hauk and Yang Kham streams

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<td>Psychodidae</td>
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</tbody>
</table>
Aquatic insects diversity

A total of 29 families (805 individuals) and 32 families (2,022 individuals) of aquatic insects from the Hauk and Yang Kham stream, respectively were classified into 7 orders; Coleoptera, Ephemeroptera, Diptera, Trichoptera, Odonata, Lepidoptera and Hemiptera (Table 5). Hauk stream, the diversity index of aquatic insects were ranged from 1.38-1.53 and the evenness were ranged from 0.22-0.26 (Table 3). The most abundant families were Chironomidae, Baetidae and Ceratopogonidae. Yang Kham stream, the diversity index of aquatic insects were ranged from 1.72-2.57 and the evenness were ranged from 0.27-0.54 (Table 3). The most abundant families were Chironomidae, Baetidae, Hydroptilidae, Simuliidae and Caenidae. In this study, aquatic insects were found as a common families in Thailand (Mustow, 2002; Prommi & Payakka, 2015; Maneechan & Prommi, 2015). The results show that the organic paddy fields area clearly shown a higher diversity index than chemical paddy fields area. Moreover, in the area of organic paddy fields were found dominant families of Simuliidae, Caenidae and Hydroptilidae which could be used to indicate the oxygen rich condition which was similar to Ciadamidaro et al. (2016) who found that families disappearance due to water pollution and land use changes.

Physico-chemical properties

The some physico-chemical properties in Hauk and Yang Kham stream are shown in Table 6. The pH values were in the range of neutral. Conductivity values were significantly different during each stream that depended on the presence of dissolved ions in the water which Hauk stream show a higher value of conductivity than Yang Kham stream. The DO levels were significantly different during each stream which Yang Kham stream show a higher value of dissolved oxygen than Hauk stream. The BOD₅ and inorganic nutrients values were not significantly different within each streams but were significantly different during each sampling site. However, the results show high conductivity values due to the calcium carbonate dissolved from the mountain to the water bodies, similar to Leelahakriengkrai and Peerapornpisal (2010) which studied the water properties in the upstream of Ping river.

Table 6 Physico-chemical factors of Hauk and Yang Kham streams in March 2018 (n=3).

<table>
<thead>
<tr>
<th>Sampling sites</th>
<th>pH</th>
<th>Conductivity (µs/cm⁻¹)</th>
<th>DO (mg/l)</th>
<th>BOD₅ (mg/l)</th>
<th>NO₃ (mg/l)</th>
<th>NH₄⁺ (mg/l)</th>
<th>SRP (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hauk1</td>
<td>7.86±0.09ᵇ</td>
<td>310.8±3.87ᵇ</td>
<td>6.00±0.00ᵃ</td>
<td>1.53±0.12ᵇ</td>
<td>0.00±0.00ᵃ</td>
<td>0.09±0.00ᵇ</td>
<td>0.04±0.01ᵇ</td>
</tr>
<tr>
<td>Hauk2</td>
<td>7.40±0.39ᵃ</td>
<td>318.6±3.82ᶜ</td>
<td>6.00±0.00ᵃ</td>
<td>0.73±0.12ᵃ</td>
<td>0.00±0.00ᵃ</td>
<td>0.09±0.01ᵃ</td>
<td>0.05±0.01ᵇ</td>
</tr>
<tr>
<td>Hauk3</td>
<td>7.58±0.04ᵃ</td>
<td>317.2±3.79ᶜ</td>
<td>6.00±0.00ᵃ</td>
<td>1.53±0.12ᵇ</td>
<td>0.00±0.00ᵃ</td>
<td>0.13±0.01ᵇ</td>
<td>0.03±0.00ᵇ</td>
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<tr>
<td>YangKham1</td>
<td>7.65±0.15ᵃ</td>
<td>285.3±3.27ᵃ</td>
<td>7.40±0.00ᵇ</td>
<td>2.20±0.00ᵇ</td>
<td>0.30±0.00ᵇ</td>
<td>0.08±0.00ᵇ</td>
<td>0.12±0.01ᵇ</td>
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<tr>
<td>YangKham2</td>
<td>7.60±0.14ᵇ</td>
<td>286.1±0.91ᵇ</td>
<td>7.20±0.00ᵇ</td>
<td>2.80±0.00ᵇ</td>
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<td>0.09±0.00ᵇ</td>
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<td>YangKham3</td>
<td>7.73±0.09ᵇ</td>
<td>286.1±0.99ᵇ</td>
<td>7.13±0.12ᵇ</td>
<td>1.53±0.12ᵇ</td>
<td>0.00±0.00ᵇ</td>
<td>0.09±0.00ᵇ</td>
<td>0.00±0.00ᵇ</td>
</tr>
</tbody>
</table>

Notes: Values expressing the Mean±SD followed by similar letters in a column do not differ significantly at p<0.05

Conclusions

From this research, the diversity of freshwater algae and aquatic insects were indicated the presence of common species that can be found in Thailand. The organic paddy fields area show a higher diversity of freshwater algae and aquatic insects than chemical paddy fields area. In addition, only organic paddy fields areas found heterocystous nitrogen-fixing blue green algae. The physico-chemical properties of each stream were found significantly different. Finally, this study reflected that paddy field activity and landuse has affected to diversity of these organisms. However, this investigation was focus only in normal crop season therefore, the knowledge by this research need the fill the gap in order to find out the complexity of rice field ecosystem in term of annual sampling and the riparian zone.
Acknowledgements
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References


Analysis of Nutritional Value of *Ventilago denticulata* Willd.

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Abstract

The purpose of this research was to study the nutritional value of *Ventilago denticulata* Willd. The leaves and stem of *V. denticulata* were collected from Ban Pa Sak Ngam, Doi Saket district, Chiang Mai province. The nutritional values of leaves and stem were analyzed by AOAC method. It was found that the 100 g dry weight of leaves contain 4.36 g moisture, 10.30 g ash, 17.57 g fiber, 16.94 g protein, 3.02 g fat and 47.81 g carbohydrate. While, the 100 g dry weight of stem had 4.16 g moisture, 6.32 g ash, 41.63 g fiber, 2.73 g protein, 0.79 g fat and 44.37 g carbohydrate. In addition, the content of vitamin C in leaves and stems was also studied by High Performance Liquid Chromatography – Ultraviolet (HPLC-UV). The results showed that the content of vitamin C was found only in leaves as 47.27 mg/100 g fresh weight.

Keywords: AOAC, HPLC, nutritional analysis, vitamin C, *Ventilago denticulata*

Introduction

*Ventilago denticulata* Willd. or “Rang Daeng” (Figure 1) is one of the Thai medicinal plants in the family Rhamnaceae (Pooma & Suddee, 2014). The habit of this plant is woody climber which is widely distributed in the northern region of Thailand such as Chiang Mai, Nan, Phrae, Mae Hong Son and Phayao (BGO Plant Database, The Botanical Garden Organization, 2013). In Chiang Mai province, this plant is mostly found in the deciduous forest such as the community forest of Ban Pa Sak Ngam, Doi Saket district (Palee et al., 2017). The extracts of *V. denticulata* have been found to have biological activities e.g. phosphodiesterase inhibitory activity (Temkitthawon et al., 2008), anti – herpes simplex virus type 1 (HSV-1) activity (Lipipun et al., 2003) and anti – microbial activity (Palee et al., 2017). Pongjanta et al. (2016) reported that the ethanolic leaves extract of *V. denticulata* had strong antioxidant activity and cytotoxic effect on cancer cells. While, Das et al. (2011) found that the stem bark extract of *V. denticulata* showed strong antimicrobial activity against four bacterial strains namely *Bacillus cereus*, *Escherichia coli*, *Klebsiella pneumoniae* and *Vibrio cholerae*.

As the advantages of *V. denticulata*, the products from leaves and stem of this plant were created by the folks of Ban Pa Sak Ngam especially “Rang Daeng Tea”. However, no previous studies have examined the nutritional value of *V. denticulata*. Thus, the objective of this research was to study the nutritional value such as moisture, ash, fiber, protein, fat, carbohydrate and vitamin C in the leaves and stem of *V. denticulata*. It was also hope that the nutritional value of *V. denticulata* from the present endeavor could lead to the database of the products which were made from leaves and stem of *V. denticulata* Willd.
Methods

Plant Materials and Nutrient Analysis
The leaves and stem of *V. denticulata* (Figure 2), which were used as plant materials for the product of “Rang Daeng Tea”, were collected from the deciduous forest of Ban Pa Sak Ngam, Doi Saket district, Chiang Mai province in Thailand. The leaves and stem were excised and washed with running tap water. Then, both of two explants were cut into the small pieces and dried in an oven at 40 °C. The nutritional values including moisture, ash, fiber, protein, lipid, and carbohydrate were analyzed by AOAC (2005) method. In addition, the content of vitamin C was also studied in the fresh sample of leaves and stem by High Performance Liquid Chromatography – Ultraviolet (HPLC-UV).

Results and Discussion
The nutritional values of *V. denticulata* leaves and stem are shown in Table 1. It was found that the 100 g dry weight of leaves contain 4.36 g moisture, 10.30 g ash, 17.57 g fiber, 16.94 g protein, 3.02 g fat and 47.81 g carbohydrate. While, the 100 g dry weight of stem had 4.16 g moisture, 6.32 g ash, 41.63 g fiber, 2.73 g protein, 0.79 g fat and 44.37 g carbohydrate. According to the result, the amounts of protein and fat in the leaves were higher than in the stem, which were 6.2 and 3.8 folds, respectively.
When compared to the other plants, the leaves of *V. denticulata* contain more protein than rice (FAO, 2004), *Eleusine coracana* seeds (Chaichana and Panyamaneesorn, 2017) and *Canthium parvifolium* fruits (Rakitikul and Palee, 2018), which were 6.80 – 8.50 g, 7.30 g and 1.5 g, respectively. However, the content of protein in the *V. denticulata* leaves was less than in the *Tupistra albiflora* flowers. Chaichana (2018) reported that *T. albiflora* flowers had high amounts of protein. The protein content of *T. albiflora* flowers was 26.00 - 29.60 g in which white flower had the highest content.

**Table 1** The Nutrient Composition of *V. denticulata* Leaves and Stem

<table>
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<tr>
<th>Nutrient compositions</th>
<th>Leaves</th>
<th>Stem</th>
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<tbody>
<tr>
<td>Protein (%)</td>
<td>16.94</td>
<td>2.73</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>3.02</td>
<td>0.79</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>47.81</td>
<td>44.37</td>
</tr>
<tr>
<td>Fiber (%)</td>
<td>17.57</td>
<td>41.63</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>10.30</td>
<td>6.32</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>4.36</td>
<td>4.16</td>
</tr>
<tr>
<td>Vitamin C (mg/100g)</td>
<td>47.27</td>
<td>Not Detected</td>
</tr>
</tbody>
</table>

Furthermore, the content of vitamin C in leaves and stem was also analyzed by HPLC-UV. The results revealed that the content of vitamin C was detected only in the leaves, which was 47.27 mg/100 g fresh weight. On the other hand, it was not found vitamin C in the stem. The quantity of vitamin C in *V. denticulata* leaves was more than the other plants. Uawonggul et al. (2017) analyzed the concentration of vitamin C in 77 species of traditional vegetables and 27 species of traditional fruits in Nakhon Phanom Province. It was found that the highest concentration of vitamin C in traditional vegetables was found in *Calamus caesius* as 20.86 mg/100 g, followed by *Azadirachta indica* var. *siamensis* and *Lagenaria siceraria* as 20.81 mg/100 g and 20.18 mg/100 g, respectively. While, the highest concentration of vitamin C in traditional fruits was showed in *Elaeocarpus lanceolatus* as 29.58 mg/100 g, followed by *Musa acuminate × Musa balbisiana* and *Terminalia chebula* as 23.12 mg/100 g and 21.44 mg/100 g, respectively. Hence, this result demonstrated that the leaves of *V. denticulata* had high content of vitamin C.

**Conclusions**

The analysis of nutrient composition in leaves and stem of *V. denticulata* by AOAC (2005) revealed that the leaves had more the contents of protein, fat and carbohydrate than the stem. The nutrient values of leaves (100 g dry weight) comprised 16.94 g protein, 3.02 g fat and 47.81 g carbohydrate. Also, the detection of vitamin C by HPLC-UV was found only in the leaves, which was 47.27 mg/100 g fresh weight. While, the nutrient values of stem (100 g dry weight) included 2.73 g protein, 0.79 g fat and 44.37 g carbohydrate.

**Acknowledgements**

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**References**


Fatty Acid Analysis of *Horsfieldia glabra* Warb. Seeds

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Abstract

This research was purposed to study fatty acid composition of *Horsfieldia glabra* Warb. seeds. Seeds of *H. glabra* Warb, usually found in Chiang Rai province, Thailand, were harvested, dried, extracted and analyzed based on AOAC method. The result indicated that the seed consisted of several 15 types of fatty acids. The most composition was saturated fatty acid (19.55 g/100gDW) which was composed of lauric acid and myristic acid (10.19 and 8.52 g/100gDW, respectively). Both fatty acids were categorized as medium chain fatty acids. The research revealed that *H. glabra* Warb. seeds contained essential fatty acids and probably had medicinal or herbal potential.

**Keywords:** *Horsfieldia glabra* Warb, fatty acid, lauric acid, myristic acid

Introduction

There were many interesting plants in the recent era for their therapeutic potential. For example, sesame (*Sesamum indicum* L.) was investigated for food, industrial, nutraceutical, and pharmaceutical activity (Morris, 2002). Several useful plants contained essential fatty acids. The nutritional profile and antioxidant potential of black cumin (*Nigella sativa* L.) seeds was earlier examined. Nutritional analysis revealed that it contains carbohydrates, proteins, fats and minerals (potassium, calcium, phosphorous, magnesium, sodium, iron, manganese, zinc and copper). It was found that essential oils from the seeds also provided antioxidant properties (Sultan et al., 2009).

*Horsfieldia glabra* Warb. (Myristicaceae family) is usually found in Chiang Rai province, Thailand (Figure 1). The characteristic of *H. glabra* Warb. was previously described. The nutritional analysis of *H. glabra* Warb. seed was investigated, indicating that the *H. glabra* Warb. seed extract contained the highest level of lipid composition of 68.24 g per 100 g dry weight (Chaichana, 2016). This research was purposed to further investigate fatty acid composition of *H. glabra* Warb. seeds.

![Figure 1](image1.png)

**Figure 1** *H. glabra* Warb fruit (a) and seed (b)

Materials and Methods

*H. glabra* Warb. seeds were harvested from Chiang Rai province, Thailand. The sample was weighed (100g dry weight) and added with pyrogallic acid, internal standard, ethanol and 8.3 M HCl into the Mojonnier flask. Then, the sample was hydrolysed at 70 - 80 °C and cooled to room temperature.
Ethanol and ether used as solvent was added to sample and then shook. The ether layer of the centrifuged sample was decanted into a tube and was evaporated on water bath using nitrogen stream. The residue was dissolved in chloroform and evaporated to dryness before adding with 7% BF$_3$ reagent and toluene. The sample was heated at 100 °C, added with water (5 ml), hexane (1 ml), Na$_2$SO$_4$ (1 g) and shaken. The separated layer was transferred to another vial containing Na$_2$SO$_4$ (1 g). The top layer that should contain fatty acid methyl esters (FAMEs) and triglyceride internal standard solution was transferred to autosampler vial for GC analysis procedure by in house method TE-CH-208 based on AOAC (2012) 996.06.

Results and Discussion

_H. glabra_ Warb. seeds were composed of 15 fatty acids (Table 1) including lauric acid, myristic acid, palmitic acid, behenic acid, lignoceric acid, saturated fat, cis-9-oleic acid, monounsaturated fatty acid, cis-9,12-linoleic acid, cis-8,11,14-eicosatrienoic acid, polyunsaturated fatty acid, unsaturated fat, omega-3, omega-6 and omega-9. Majority was saturated fat (19.55 g/100g DW) whereas unsaturated fat yield was 1.09 g/100g DW. The earlier study examining antimicrobial activity of _Anethum graveolens_ (Umbelliferae) seed oil revealed that it was composed of essential fatty acids such as capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, oleaic acid, linoleic acid, linolenic acid and arachidoic acid and the oil showed 100% antimicrobial activity against _Escherichia coli_, _Salmonella typhi_, _Bacillus subtilis_ and _Staphylococcus aureus_, respectively (Badar et al., 2008).

Table 1 Fatty acid composition of _H. glabra_ Warb. seeds

<table>
<thead>
<tr>
<th>Type of fatty acid</th>
<th>Composition (g/100g DW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lauric acid</td>
<td>10.19</td>
</tr>
<tr>
<td>Myristic acid</td>
<td>8.52</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>0.76</td>
</tr>
<tr>
<td>Behenic acid</td>
<td>0.01</td>
</tr>
<tr>
<td>Lignoceric acid</td>
<td>0.02</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>19.55</td>
</tr>
<tr>
<td>Cis-9-Oleic acid</td>
<td>0.67</td>
</tr>
<tr>
<td>Monounsaturated fatty acid</td>
<td>0.68</td>
</tr>
<tr>
<td>Cis-9,12-Linoleic acid</td>
<td>0.15</td>
</tr>
<tr>
<td>Cis-8,11,14-Eicosatrienoic acid</td>
<td>0.25</td>
</tr>
<tr>
<td>Polyunsaturated fatty acid</td>
<td>0.41</td>
</tr>
<tr>
<td>unsaturated fat</td>
<td>1.09</td>
</tr>
<tr>
<td>Omega-3</td>
<td>14.69 (mg/100g)</td>
</tr>
<tr>
<td>Omega-6</td>
<td>393.55 (mg/100g)</td>
</tr>
<tr>
<td>Omega-9</td>
<td>674.49 (mg/100g)</td>
</tr>
</tbody>
</table>

Lauric acid was found to be highest ratio (10.19 g/100g DW). It is a primary fatty acid in coconut oil. The previous experiment that investigated isolation of lauric acid from crude coconut oil presented that 5% concentration of lauric acid could inhibit the growth of all tested bacteria (S. aureus, _B. cereus_, _Salmonella thyphimurium_ and _E. coli_) (Nitbani et al., 2016). Moreover, it was found that lauric acid had demonstrable significant antimicrobial activities against gram positive bacteria and a number of fungi and viruses (Dayrit, 2015). Lauric acid was also evaluated for its antimicrobial property against bacterial skin infection caused by _Propionibacterium acnes_, _S. aureus_ and _S. epidermidis_. The result revealed that lauric acid provided minimal inhibitory concentration (MIC) values against the bacterial growth over 15 times lower than those of benzoyl peroxide (Nakatsuji et al., 2009). Furthermore, lauric acid could enhance the innate immune defense of human sebocytes by upregulating β-defensin-2 expression (Nakatsuji et al., 2010). In addition, lauric acid from palm kernel (_Elaeis guineensis_) oil could inhibit _S. aureus_ and _Streptococcus_ sp. (Ubgogu et al., 2006). Lauric acid was characterized to be a high content (38.08%) in _Laurus nobilis_ seed oil. Antioxidant properties of _Laurus nobilis_ seed oil was examined to have IC50 value of 94.655 mg/ml (Ozcan et al., 2010).

_H. glabra_ Warb. seeds contained high amount of myristic acid (8.52 g/100g DW) which was reported to be the main constituent of several plants and had antimicrobial activity. It was found that _Euphrasia rostkoviana_ Hayne essential oil was composed of myristic acid (4.71%) and presented
antimicrobial effect against Enterococcus faecalis, E. coli, Klebsiella pneumoniae, S. aureus, S. epidermidis and Candida albicans with the minimum inhibitory concentration of 512 µg/ml (Novy et al., 2015). The result was related with the study of antimicrobial activity of Trichodesmium erythraeum (Ehr). The major component of the extract was fatty acid, such as myristic acid, palmitic acid and oleic acid. The extract exhibited antimicrobial activity against several organisms (Thillairajasekar et al., 2009). Curcumin-loaded myristic acid microemulsions could inhibit skin bacterium S. epidermidis (Liu & Huang, 2012). Moreover, myristic acid was also used for cancer prevention and cosmetics industry (Morris, 2002).

Conclusions

H. glabra Warb. seeds contained essential 15 fatty acids, including high amount of lauric acid and myristic acid. Both fatty acids could exhibit therapeutic potential through their antimicrobial, antioxidant and cancer preventive activity.

Acknowledgements

We gratefully acknowledge the grant support from the Plant Genetic Conservation Project under the Royal Initiative of Her Royal Highness Princess Maha Chaki Sirindhorn, The Institute of Biodiversity and Environment for Local and Asean Development, Chiang Rai Rajabhat University and the Research and Development Institute, Chiang Rai Rajabhat University, Chiang Rai, Thailand.

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Developing an Optimal Hydroponic Fertilizer Formula to Increase Growth Rate and Chlorophyll Quantity of *Wolffia globosa*

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Abstract

The research aim was to study the effects of hydroponic fertilizers to develop an optimal formula for the growth of *Wolffia globosa*. The ratios of formula AB per water in the nutrient solutions used were 0:1000 (control), 1:1000, 2:1000 and 3:1000. The plant was cultivated for 14 days at pH 5.0 - 6.0 in an open system. The growth of plant was recorded every 7 days. The result showed that the maximum dry weight of *Wolffia globosa* was obtained (38.08 g) in the treatment of ratio 1:1000. Also, chlorophyll a (40.81 mg/L) and chlorophyll b (8.40 mg/L) in plant was detected most when it was cultivated in hydroponic fertilizer formula AB at a concentration of 1:1000.

Keywords: hydroponic fertilizer, *Wolffia globosa*, chlorophyll

Introduction

*Wolffia globosa* (Rootless duckweed or Khai-nam) is the smallest aquatic flowering plant, belonging to the Araceae family. It normally floats on water or a little below water surface. Thalli is present either single or in pairs with inflatable spherical or oval shape, but with a flat top, no root. The size is around 0.1 centimeter wide. Imperfect flowers were produced at the edge of thallus, each contains one stamen or one pistil. It is a tiny plant that can be eaten by human and served as nutritious food. According to the previous study, it has high content of protein (17.88%), fat (0.20%), ash (23.50%), carbohydrate (38.2%) and calcium (0.09%) (Appenro et al., 2018). In addition, chlorophyll extract from *Wolffia globosa* is also used as a food supplement (Sripen, 1999). It is generally used as an ingredient in local Northern or Northeastern food. The plant is derived from a natural water source; so, it is difficult to continuously obtain. It may also be contaminated by chemicals that are flushed into water sources, such as pesticides and herbicides. Therefore, it is a better choice to make a self-watering system for rootless duckweed cultivation. Apart from the need of clear and clean water, which is the main factor, it requires suitable nutrients for growth and productivity. Typically, farmers use chemical fertilizer derived from inorganic and organic synthetic elements containing N – P – K with a mixture of kaolin (white clay). The fertilizer pellet is, however, not a good option to use as it is not completely soluble and it is hard to define the right amount to prevent sedimentation which interrupts plant nutrient use efficiencies.

Hydroponic fertilizers AB is a synthetic fertilizer formula in liquid form that contains the same nutrients as found in fertilizer pellets and manure. Nutrient Formula AB is composed of stock A and B separately. Stock A contains calcium oxide 2.0% (CaO) and iron supplement (Fe) 0.05% for the strength of cell wall structure, increasing protein content, expanding size, supporting the respiratory system as well as synthesis of enzymes. Stock B contains the secondary nutrients including 1.0% magnesium (MgO), 1.0%, 0.5% sulfer (S) and micronutrients including 0.05% iron (Fe), 0.05% manganese (Mn), 0.20% copper (Cu), 0.05% zinc (Zn), and 0.05% boron (B) which are components of chlorophyll, green pigments that is necessary for plant’s photosynthesis. It assists in plant growth, helps transporting phosphorus and supporting protein synthesis. In addition, it increases the rate of photosynthesis and is a component element of many important enzymes in cellular respiration. In addition, it is immediately dissolved when mixed with water due to its polarization property and it does not cause fungal or microbial spoilage when compared with the use of manure. In order to increase the yield, it is important to address the right formula ratio and to optimize the amount of fertilizer used.
One of the most noticeable pigments in *Wolffia globosa* that can be used as the indicator for the growth of plant is chlorophyll. Therefore, an additional study of chlorophylls obtained from different optimization of formulas should be conducted as well in order to determine the optimal concentration of the fertilizer. Chlorophyll is a pigment that appears in chloroplast and captures energy from light. Chlorophyll a is a substance that absorbs energy from sunlight for reactions in the process of photosynthesis while chlorophyll b also helps in the process (İnanç, 2011). Chlorophyll a is considered as a primary pigment which is responsible for photosynthesis. Other pigments are called accessory pigments as they help forward the energy to chlorophyll a. Generally, plants have about 2-3 times more chlorophyll a than chlorophyll b. Molecules of chlorophyll a and b are similar and contain different functional groups in the porphyrin ring (a methyl group and carbonyl group respectively), resulting in different properties such as light absorption and reflection properties due to their structural differences (Bjorn et al., 2009; Xu et al., 2011).

**Objectives**

This research was aimed to address an optimized hydroponic fertilizer formula ratio for cultivation of *Wolffia globosa* in order to get maximum yield and higher amount of chlorophyll. *Wolffia globosa* collected from natural lake in Bandu district, Chiang Rai were used in the study during June-October, 2017.

**Effect of different fertilizer treatments on yield of Wolffia globosa.**

The AB fertilizer with various concentrations was added to 50 liter plastic buckets of 54.5 cm diameter, 30 cm in height that contained 25 g *Wolffia globosa* in 10 L of water that was left sitting overnight to dissipate chlorine. The buckets were covered by nets to prevent mosquitoes and insects from spawning in the water. The 4 group samples (3 replicates) were grown for two weeks. Group I: no fertilizer added (control group). Group II: 1000 ppm fertilizer. Group III: 2000 ppm fertilizer: Group IV 3,000 ppm fertilizer. The wet weight of samples from each group was measured every 7 days. The solution in each group was changed every 7 days (as well and the hydroponic fertilizer was added to the water again and adjusted) to maintain the concentration and the pH was adjusted to 5-6.0 by sulphuric acid and sodium hydroxide. On the last day, each group was collected and measured for wet weight and dry weight. In order to measure dry weight, the plant was kept in a hot air oven at 105 °Celsius for 3 hours, then left in a moisture-suction jar for 30 minutes at room temperature. The procedure was repeated until the measured dry weight was stable.

Air and water temperature and light intensity was measured every day using a measuring light intensity (Lux Meter) to calculate an average value. The solution samples were also collected for measurement of pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) every 7 days by Sension + EC71 GLP Conductivity Laboratory meter.

**Determination of chlorophyll a and chlorophyll b contents**

Chlorophyll a and chlorophyll b from 100 mg *Wolffia globosa* was extracted by 20 ml ethanol. The filtered solution was adjusted to 30 ml by ethanol and kept in a container covered with aluminium foil to prevent chlorophylls from exposure. The absorption at the wavelength of 663 and 645 nm was measured using a spectrophotometer to determine the quantity of chlorophyll a chlorophyll b and total chlorophylls in the sample (Laongsri, 2008).

**Results**

**Effect of different concentration of hydroponic fertilizer AB on the yield of Wolffia globosa.**

Four groups of sample were treated with different concentrations of fertilizer formula AB. The average light intensity was approximately 7,400 Lux. The mean and standard deviation (SD) of wet weight (every 7 days) and dry weight (on the harvest day) are shown in Table 1. The results indicated that *Wolffia globosa* grown in 1000 ppm fertilizer formula AB (group II) had the highest average value of total yield both at day 7 and day 14, The yields of group I and III (0 ppm and 2000 ppm respectively) were not significantly different. The lowest yield was from group IV (3000 ppm).
Table 1 Effect of different fertilizer concentrations on average wet weight of *Wolffia globosa* yield

<table>
<thead>
<tr>
<th>Group</th>
<th>Yield (g)</th>
<th>Day0</th>
<th>Day7</th>
<th>Day14</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>25±0.0</td>
<td>34.23±6.82&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.28±2.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>25±0.0</td>
<td>43.83±2.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>50.14±4.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>25±0.0</td>
<td>35.58±5.41&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.12±4.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>25±0.0</td>
<td>31.21±2.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.76±5.56&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

The average dry weights after a period of 14 days from each sample group were shown in Table 2. The results indicated that the highest average total dry weight of *Wolffia globosa* was the yield from group II (38.08±4.67 g) while group III, IV showed no significant difference from the control group.

Table 2 Effect of different fertilizer concentrations on dry weight of *Wolffia globosa* yield

<table>
<thead>
<tr>
<th>Group</th>
<th>Dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>24.59±3.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>II</td>
<td>38.08±4.67&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>III</td>
<td>24.87±5.08&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>IV</td>
<td>24.20±4.80&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Effect of different concentrations of hydroponic fertilizer formula AB on quantity of chlorophyll a, chlorophyll b contents

The quantity of chlorophyll a and chlorophyll b extracted from *Wolffia globosa* from each treatment group was shown in Table 3. The measurement was taken on the first day, day 7 and day 14. It showed that the highest chlorophyll a content after 14 days was 40.81 ± 1.91 mg/L (group II) while the significant highest chlorophyll b content was 13.54±0.95 mg/L (group II) on day 7. Group I, III and IV did not show significant difference. The comparisons of chlorophyll a and chlorophyll b quantity among 4 sample groups were also shown in Fig 1 and Fig 2 respectively.

Table 3 Effects of different concentrations of fertilizer AB on the quantity of chlorophyll a and b

<table>
<thead>
<tr>
<th>Group</th>
<th>Chlorophyll a (mg)</th>
<th>Day 0</th>
<th>Day7</th>
<th>Day14</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11.68±0.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19.28±4.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.66±1.96&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>11.18±0.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.38±1.80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.81±1.65&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>11.58±0.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.66±4.20&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>36.59±1.94&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>11.97±0.88&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.41±4.94&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>35.78±3.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Chlorophyll b (mg)</th>
<th>Day 0</th>
<th>Day7</th>
<th>Day14</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>9.15±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.91±2.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.09±1.71&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>9.31±0.14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.54±0.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.40±1.91&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>9.03±0.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.30±4.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.15±2.09&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>8.78±0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.33±2.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.02±1.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>
The quantity of chlorophyll a from *Wolffia globosa* after 14 days

The quantity of chlorophyll b from *Wolffia globosa* after 14 days

Discussion

All 4 treatments were set to contain different concentrations of fertilizer formula AB while all the rest of physical and chemical conditions were the same. The average water temperature was 25 °Celsius. The pH range was between 5.0 and 6.0. The average light intensity during the experiment was 7400 Lux. In comparison, the result collected from 4 sample groups cultured with 4 different ratios of hydroponic fertilizer formula AB (0, 1000, 2000, 3000 ppm) for a period of 14 days showed that the highest average total yield of *Wolffia globosa* was from group II (1000 ppm) which was equal to 50.14±4.23 g of wet weight. The lowest average total yield was from group 4 (3000 ppm) which was equal to 34.76 ± 5.56 g, significantly lower that the control group. For dry weight, the highest yield from group 2 was 38.08 ± 4.67 g (54.86% higher than the control group).

This research studied yield quantity of *Wolffia globosa* in a sample treated with different concentrations of hydroponic fertilizer formula AB. The highest average dry weight was obtained when treated with 1000 ppm fertilizer, therefore it was supposed that the treatment contained most suitable chemical environments for plant growth. Among 4 groups, the average EC value measured from group II (457.89 μS/cm) was the closest to the EC value of natural water resources (around 580.78, μS /cm). From the experiment, the concentration of hydroponic fertilizer affected the growth rate of *Wolffia globosa*. Since the nutrients for plant were derived from fertilizer, the concentration of 1000 ppm fertilizer was likely to be the right amount of nutrient. The growth of group III, IV was slow due to an excess amount of fertilizer. Apart from chemical factors, the physical environment was also a factor affecting the growth of plant. Aqua plants grew well in fresh water with a temperature of 25-30 °Celsius (Daengsawat, 2011). In addition, the optimal light intensity was required to be between 4000-15000 Lux (the average value during the experiment was of 7400 Lux).

Generally, the main factors that affect the growth of aquatic plants are nutrients or fertilizers in the water. Plants need nitrogen, phosphorus and potassium to grow and to help maintaining all life activities. For *Wolffia globosa*, nitrogen (approximately 18%) is a component of proteins, nucleic acid, enzymes, vitamins, and chlorophyll. Lack of nitrogen causes an inhibitory effect on cell division and a decrease in growth and size. Phosphorus is a component of nucleic acids, proteins, phospholipids,
important for synthesis of fats and carbohydrates, and respiration. Lacking phosphorus affects plant’s growth, causing leaves to stop growing. Potassium plays a role in controlling osmosis and shape of cells, accelerates metabolism of proteins and carbohydrates, increases disease resistance. Potassium deficiency in plants results in reduction of photosynthetic rate and sugar’s transport (Abdulrahman, 2014; Daengsawat, 2011).

According to the report from Kruasanit et al. (2014), the suitable condition of natural water sources for plants belonging to the Lemnaceae family, including *Wolffia globosa*, was found to be within the range of temperature 22.08 - 31.55 °C, pH 5.0-6.5 and turbidity 7.90 - 30.07 NTU. Containers used for cultivation of *Wolffia globosa* should not be less than 30 cm in height. It must be able to contain water and a drainage system is needed as well. It is better to avoid the location with too much sunlight as high temperature would affect the growth, especially if the containers were plastic. The proper location is under the shade or the net that can filter around 50% of heat and sunlight, so that it will allow plants to grow fresh and contain more protein. Raising the plant outdoor results in faster growth, however its color becomes paler. Moreover, water quality is very important for growing *Wolffia globosa*. It should not be alkaline water.

The pH value (pH) is one of important environmental factors that affect the growth of *Wolffia globosa*. It is the value that represents concentration in the form of the logarithm of hydrogen ions (H⁺) or hydronium ions (H₃O⁺) which is used to tell the acidity of the aqueous solution. The pH value of natural water depends on several environmental aspects such as characteristics of stone and soil, usage of land, the influence of living organisms in water, such as phytoplankton and microorganisms. It is an extremely critical factor for the plant to use nutrients in water (Petra, S. K. and Proctor, J., 2001). For water plants, the pH value is very important for chemical reaction of fertilizers that feed the plants. Nutrients dissolve well in water with acidity so that plants were well assimilation. If the water is high in pH, it causes nutrients to sediment and cannot be absorbed. Normally, the pH value of the plant should be in the range of 5.5-7.0 (McKenzie, 2003).

Hydroponic fertilizer is the element for plant hydroponic cultivation. It is important to optimize the amount of stock A and B fertilizer prior use as too high-concentrations will cause sedimentation. An inappropriate quantities of fertilizer that exceeds the proper proportion will result in accumulation of chemicals. Therefore, the concentration of aqueous mixed solution should be controlled with an EC meter in order to grow non-toxic hydroponic plants.

The report from Kongrak (2006) revealed that the electrical conductivity (EC) of water from natural sources are generally varied according to the distance from the origin as when water traveled to lower area it dissolves more substances along the way. If the EC value is higher than 3,000 μS/cm it will cause a tremendous problem for plant’s water absorption. Therefore, water used for water plants should be set to not exceed 300 μS/cm before adding fertilizers. Too high EC affects root permeability to obtain nutrients, causing deficiencies in plants. Total dissolved solids (TDS) is the quantity of soluble solids in water, referring to salts, minerals, metals, soluble anions, etc. For the growth of plants, the total concentration of the nutrient solution should be between 1,000 and 1,500 ppm in order to obtain optimum osmotic pressure for the plant’s roots.

Both chlorophyll a and b were important pigments that converted light energy to be used in the process of photosynthesis. It was revealed that chlorophyll a and chlorophyll b content of *Wolffia globosa* was highest when treated with 1000 ppm fertilizer. The fertilizer contained nitrogen, a mineral nutrient that was a key element of chlorophyll. It played a role in the photosynthesis process, resulting in increasing growth. Other minerals, such as iron and magnesium, were vital for chlorophyll synthesis as well. A deficiency of these minerals could affect chlorophyll synthesis, photosynthesis and growth rate (Aro, & Andersson, 2001).

**Conclusion**

It could be concluded that culturing with hydroponic fertilizer formula AB at a concentration of 1000 ppm was the best condition as it gave the highest amount of *Wolffia globosa* yield. When compared with the amount of chlorophyll content from 4 samples over a period of 14 days, the highest level of chlorophyll a and chlorophyll b, which was from group II which was equal to 40.81±1.65 and 8.40±1.91 mg/L respectively.
References
 Isotherm, Kinetic and Thermodynamic Adsorption of Methylene Blue Dye onto Shrimp Shell  
Suchada Sawasdee, Disorn Kaewkanha, Sawitra Tonsaree, Prachart Watcharabundit  
Department of Chemistry, Faculty of Science and Technology  
Thepsatri Rajabhat University, Lopburi THAILAND  
E-mail: ps_neng@hotmail.com  

Abstract  
The objective of this work was to investigate the methylene blue adsorption onto shrimp shell in the batch experiments. The effects of adsorption such as pH, contact time, adsorbent dose, initial dye concentration, and temperature were investigated. The shrimp shell used as an adsorbent was characterized by FTIR, and its surface area was evaluated. The experimental results showed that the optimum adsorption occurred at pH 7 and equilibrium time at 30 min. The equilibrium adsorption data were analyzed by Langmuir and Freundlich isotherms. The data were fitted well with Langmuir isotherm, and the maximum adsorption capacity was found to be 11.36 mg/g. Adsorption kinetic data can be described by pseudo-second order for all different concentrations. From thermodynamic study, the adsorption process was endothermic and spontaneous in nature. In conclusion, the shrimp shell could be an efficient sorbent for dye removal from aqueous solution.  

Keywords: isotherm, kinetic, thermodynamic, methylene blue, shrimp shell  

Introduction  
Synthetic dyes are most widely used in many industries. The removal of dyes from textile effluent is a major problem in many textile industries due to difficulty of treatment. Dyes are complex aromatic molecular structures, are inert and difficult to biodegrade when discharged into water streams. Methylene blue is a cationic dye, and it is difficult to remove completely because of its stable aromatic structure consisting of a chromophore and polar groups (Liu et al., 2012; Zhang et al., 2015).  
Several methods have been developed for the dye wastewater treatment such as adsorption, membrane process, coagulation, advanced oxidation process and electrochemical process, etc. (Das & Charumathi, 2012). Adsorption methods provide the advantages of low cost, simple operation, and low secondary environmental pollution.  
The waste materials are the most popular for dye treatment because of their economic and eco–friendly traits, availability in abundance and low cost (Chowdhury et al., 2011). The waste shrimp shell compositions are mainly calcium carbonate and chitin along with some proteins. The functional groups of shrimp shell are hydroxyl (OH) and N-acetyl groups forming negatively charged adsorption sites. Shrimp shell has been widely used for the removal of various pollutants (Daneshvar et al., 2014; An et al., 2001). In this work, the methylene blue dye adsorption onto shrimp shell was evaluated. The effects of adsorption such as pH, contact time, adsorbent dose, initial dye concentration, and temperature were studied. The isotherm, kinetic and thermodynamic parameters were determined. Also, the shrimp shell used as an adsorbent was characterized by FTIR and surface area.  

Methods  
Preparation of adsorbate  
The methylene blue dye (C.I.52015, C_{16}H_{18}ClN_{3}S: M.W. = 319.98 g/mol), was supplied by Finechem, Australia. It was dried at 80°C for 2 hr before using.  
Preparation of adsorbent  
The river shrimp shell (Macrobrachium rosenbergii) used as the adsorbent in the present investigation was obtained from a restaurant in Lopburi city, Thailand. The collected shrimp shell was washed with tap water for several times to remove all the dirt particles and dried in a hot air oven at 80°C. It was sieved to 50–100 mesh and stored in desiccator until used.
Characterization of adsorbent

The surface functional groups of the shrimp shell before and after methylene blue adsorption were analyzed by FTIR (Perkin Elmer, model two).

The specific surface area (Vilar et al., 2007) as in the equation (1) was determined from $q_{\text{max}}$ of methylene blue adsorption. The $q_{\text{max}}$ value obtained from the Langmuir isotherm was the maximum monolayer adsorption.

\[
S_{\text{MB}} = \frac{q_{\text{max}} \times a_{\text{MB}} \times N}{MW_{\text{MB}}} \quad \ldots (1)
\]

where $S_{\text{MB}}$ is specific surface area ($\text{m}^2/\text{g}$), $a_{\text{MB}}$ is the area occupied by one methylene blue molecule ($\text{m}^2/\text{molecule} = 130 \text{ Angstrom}^2$), $N$ is the Avogadro’s number ($6.02 \times 10^{23}$ molecule/mol), and $MW_{\text{MB}}$ is the methylene blue molar mass (319.98 g/mol).

Batch Adsorption process

The experiments were conducted in 250-ml flasks with 50 ml of methylene blue solution of different pH (2–10), initial methylene blue concentration (25–300 mg/L), and the known amount of shrimp shell (0.1 g). The flasks were kept in an isothermal shaker at different temperatures (20–40°C) and agitation speed 200 rpm at different contact time (1–180 min). The initial pH values of the solutions were previous adjusted with 0.1 M HCl or 0.1 M NaOH. Then, the suspension in each sample was filtered and supernatant was measured for methylene blue concentration by a double beam UV–Vis spectrophotometer at the wavelength 665 nm. The percentage of adsorption and amount of adsorption capacity ($q_t$) were calculated as follows:

\[
\% \text{ adsorption} = \frac{(C - C_o)V}{C_o} \times 100 \quad \ldots (2)
\]

\[
q_t = \frac{(C - C_t)V}{W} \quad \ldots (3)
\]

where $C_o$ (mg/L) is initial dye concentration, $C_t$ (mg/L) is the concentration at any time, $q_t$ (mg/g) is the amount adsorbed at any time, $V$(L) is the volume of the solution and $W$(g) is the mass of adsorbent.

Adsorption Isotherm

The Langmuir isotherm in a linear form is represented as follows:

\[
\frac{C_e}{q_e} = \frac{1}{q_m} + \frac{1}{K_L q_m} C_e \quad \ldots (4)
\]

where $C_e$ (mg/L) is the equilibrium concentration, $q_e$ (mg/g) is the amount adsorbed at equilibrium, $K_L$ is the Langmuir constant, and $q_{\text{max}}$ (mg/g) is the maximum adsorption capacity. The essential characteristics of a Langmuir isotherm can be expressed in terms of a dimensionless separation factor or equilibrium parameter ($R_L$) which is defined by
The Freundlich isotherm in a linear form is represented as follows:

\[
\log q_e = \log K_F + \frac{1}{n} \log C_e \quad \ldots \ldots (6)
\]

where \( K_F \) (L/g) is the adsorption capacity and \( \frac{1}{n} \) is the adsorption intensity.

### Adsorption Kinetics

The pseudo-first order and pseudo-second order kinetic in a linear form are written as follows:

\[
\log \left( q_e - q_t \right) = \log q_e - \frac{k_1 t}{2.303} \quad \ldots \ldots (7)
\]

\[
t = \frac{1}{k_2 q_e^2} + \frac{1}{t} \quad \ldots \ldots (8)
\]

where \( k_1 \) (min\(^{-1}\)) and \( k_2 \) (g.mg\(^{-1}\).min\(^{-1}\)) is the rate constant of pseudo-first order and pseudo-second order. The initial adsorption rate was defined by the following equation:

\[
h = k_3 q_e^2 \quad \ldots \ldots (9)
\]

The intraparticle diffusion model is expressed as:

\[
q_t = k_{id}(t)^{1/2} + C \quad \ldots \ldots (10)
\]

where \( q_t \) is the amount of adsorbate (t), \( k_{id} \) is the rate constant (mg/g min\(^{-1/2}\)) and C is the intercept.

### Error analysis

The Chi-square test statistic is the sum of the squares of the differences between the experimental data and calculated values. It was calculated as follows:

\[
\chi^2 = \sum \frac{(q_{e,exp} - q_{e,cal})^2}{q_{e,exp}} \quad \ldots \ldots (11)
\]

where \( q_{e,exp} \) is the experimental data of the equilibrium capacity (mg/g) and \( q_{e,cal} \) is the equilibrium capacity obtained by calculating from the model (mg/g).

### Thermodynamic parameters

Thermodynamic parameters such as the Gibbs free energy change (\( \Delta G \)), enthalpy change (\( \Delta H \)), and enthalpy change (\( \Delta S \)) were determined. The Gibbs free energy change (\( \Delta G \)) can be expressed as follows:

\[
\Delta G = -RT \ln K \quad \ldots \ldots (12)
\]

where \( K = \frac{q_e}{C_e} \) is the equilibrium constant, \( R \) is the gas constant and \( T \) is the absolute temperature. Also, enthalpy (\( \Delta H \)) and entropy (\( \Delta S \)) changes can be estimated by the following equation:
Results and discussion

FTIR spectrometer was used to identify spectra of shrimp shell at 4000–750 cm\(^{-1}\). The spectrum of before and after the methylene blue dye adsorption were shown in Figure 1. The peak at 1010.27 cm\(^{-1}\) indicated C–O stretching and after adsorption it shifted to 1010.16 cm\(^{-1}\). The peak at 1622.00 cm\(^{-1}\) was due to NHCO stretching of amide group (Jeon et al., 2014), and the peak at 1531.97 cm\(^{-1}\) was due to N–H stretching of amino group. As seen in Figure 1, the intensities of after adsorption spectrum decreased as it was compared to before adsorption spectrum.

\[
2.303 \log K = \frac{\Delta S}{R} - \frac{\Delta H}{RT} \quad \ldots \ldots (13)
\]

\[
\log K = \frac{\Delta S}{2.303R} - \frac{\Delta H}{2.303RT} \quad \ldots \ldots (14)
\]

Figure 1  FTIR spectra of before and after methylene blue adsorption onto shrimp shell

The specific surface area of shrimp shell was determined by methylene blue method. The results showed that the methylene blue adsorption onto shrimp shell formed a monolayer and its \(q_{\text{max}}\) was obtained from the Langmuir isotherm plot. The specific surface area calculated as the Equation (1) was 27.78 m\(^2\)/g.

Effect of pH

The experiments of the effect of pH (2–10) for methylene blue adsorption were studied at initial dye concentration of 50 mg/L and 30\(^{\circ}\)C. The percent of adsorption were shown in Figure 2. As seen in Figure 2, the percent of adsorption increased as the pH of dye solution increased from 2 to 7 and the maximum of adsorption occurred at pH 7. Therefore, the pH 7 was selected for further experiments.
Effect of contact time at different initial dye concentration

The experiments of effect of contact time (1–180 min) at different initial dye concentrations (25–75 mg/L) were studied and the results were shown in Figure 3. As seen in Figure 3, the adsorption was very rapid at 1–5 min and gradually decreased with time until reached the equilibrium at 30 min. The adsorption capacity at equilibrium time valued 1.20, 2.44 and 3.40 mg/g for 25, 50 and 75 mg/g, respectively.

Effect of adsorbent dose at different initial dye concentrations

The experiments of effect of adsorbent dose from 0.2 to 1.0 g at different initial dye concentration from 25 to 75 mg/L were studied, and the results were shown in Figure 4. As seen in Figure 4, the adsorption capacity decreased with increased initial dye concentration, but the percent adsorption increased with increased adsorbent dose.
Effect of initial concentration
The equilibrium adsorption of methylene blue onto shrimp shell was investigated to study the effect of initial dye concentration at 30°C as shown in Figure 5. The results showed that the adsorption capacity increased from 1.206–10.987 mg/g with increasing initial dye concentration in the range of 25–300 mg/L.

Adsorption isotherm
For isotherm study, the adsorption experiments were carried out at the equilibrium time and constant temperature. The adsorption experiments of the effect of concentration between 25 to 300 mg/L at 30°C were evaluated. The adsorption isotherm models such as Langmuir and Freundlich isotherm were used to test the equilibrium adsorption data. The linear plots of isotherms and the calculated parameters were shown in Figure 6 and Table 1, respectively.
Table 1 Isotherm Parameters of Methylene blue Adsorption onto Shrimp Shell

<table>
<thead>
<tr>
<th></th>
<th>Langmuir isotherm</th>
<th>Freundlich isotherm</th>
</tr>
</thead>
<tbody>
<tr>
<td>( q_{\text{max}} ) (mg/g)</td>
<td>( K_L )</td>
<td>( R_L )</td>
</tr>
<tr>
<td>11.36</td>
<td>0.12</td>
<td>0.24–0.02</td>
</tr>
</tbody>
</table>

By considering of relative coefficient \( (R^2) \) in Table 1, the experimental data were better described by the Langmuir isotherm than Freundlich isotherm, and the maximum adsorption capacity \( q_{\text{max}} \) valued 11.36 mg/g. The value of \( R_L \) were 0.24–0.02. For the Freundlich isotherm, the value of \( 1/n \) was 0.40. Moreover, the Chi-square, \( \chi^2 \) of the Langmuir isotherm (0.89) was lower than of the Freundlich isotherm (0.94).

Kinetics of adsorption

The kinetic experiments of methylene blue adsorption onto shrimp shell at different initial dye concentrations from 25–75 mg/L at 30°C were investigated. The results of pseudo-first order, pseudo-second order and intraparticle kinetic models were plotted in Figure 7.
Table 2 Adsorption Kinetics of Methylene blue Adsorption onto Shrimp Shell

<table>
<thead>
<tr>
<th>Adsorption kinetics</th>
<th>initial dye concentration (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>$q_e$ (exp) (mg/g)</td>
<td>1.20</td>
</tr>
<tr>
<td>pseudo first order</td>
<td></td>
</tr>
<tr>
<td>$q_e$ (cal) (mg/g)</td>
<td>1.73</td>
</tr>
<tr>
<td>$k_1$ (min$^{-1}$)</td>
<td>0.17</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.88</td>
</tr>
<tr>
<td>pseudo second order</td>
<td></td>
</tr>
<tr>
<td>$q_e$ (cal) (mg/g)</td>
<td>1.21</td>
</tr>
<tr>
<td>$k_2$ (g.mg$^{-1}$.min$^{-1}$)</td>
<td>1.12</td>
</tr>
<tr>
<td>$h$ (mg.g$^{-1}$.min$^{-1}$)</td>
<td>1.64</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.99</td>
</tr>
<tr>
<td>intraparticle diffusion</td>
<td></td>
</tr>
<tr>
<td>$k_{id}$ (mg/g min$^{1/2}$)</td>
<td>0.04</td>
</tr>
<tr>
<td>$C$</td>
<td>1.01</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.94</td>
</tr>
</tbody>
</table>

The values of kinetic parameters were determined as shown in Table 2. Based on the correlation coefficients ($R^2$), the kinetic data were best fitted by pseudo–second order model at all initial dye concentrations. Besides, the $q_e$ values calculated from pseudo–second order model agreed very well with the experimental data. At higher concentration, the initial rate constant (h) was higher.

For the intraparticle diffusion, the linear lines did not pass through the origin indicating that it was not the only–rate controlling step.

**Thermodynamic study**

Thermodynamic parameters of methylene blue adsorption onto shrimp shell such as the Gibbs free energy change ($\Delta G$), enthalpy change ($\Delta H$) and entropy change ($\Delta S$) were evaluated at equilibrium...
time using initial dye concentration of 50 mg/L at different temperatures (20–40°C). The values of ΔG, ΔH, and ΔS were shown in Table 3.

Table 3  Thermodynamic Parameters for Methylene blue Adsorption onto Shrimp Shell

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>ΔG (kJ/mol)</th>
<th>ΔH (kJ/mol)</th>
<th>ΔS (J/mol.K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>−0.95</td>
<td>20.59</td>
<td>73.66</td>
</tr>
<tr>
<td>30</td>
<td>−1.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>−2.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As seen in Table 3, the free energy of adsorption (ΔG) were estimated to be −0.95, −1.78, and −2.42 kJ/mol at 20, 30, and 40°C, respectively. The enthalpy (ΔH) and entropy (ΔS) values of adsorption were 20.59 kJ/mol and 73.66 J/mol.K, respectively.

Discussion
In this work, the adsorption of methylene blue dye by shrimp shell was investigated in the batch process. The effects of adsorption such as pH (2–10), contact time (1–180 min), adsorbent dose (0.2–1.0 g), initial dye concentration (25–300 mg/L), and temperature (20–40°C) were evaluated.

For the characterization of adsorbent, the FTIR spectrum confirmed the existing of the groups of C−O, N−H, and NHCO at the peak of 1010.27, 1531.97, and 1622.0 cm$^{-1}$, respectively. For after adsorption, the peak at 1010.27 cm$^{-1}$ shifted to 1010.16 cm$^{-1}$ and the intensities decreased as it was compared to before adsorption.

For the effect of pH (2–10), the results showed that the dye adsorbed increased as the pH was increased from 2 to 7 and maximum of adsorption was at pH 7. At low pH (pH = 2), the electrostatic repulsion between the protonated dye and positively charged adsorbent sites resulted in decreased adsorption. However, at higher pH, more negatively charged surface sites were available, which facilitated the adsorption of dye cations.

For the study of the effect of contact time (1–180 min), the results showed that the initial stage adsorption was very rapid at 1–5 min and a gradually decreased with time until reach the equilibrium at 30 min. The initial adsorption was rapid due to the fact that in the initial stage there was the high availability of the adsorption sites (Vilar et al., 2007). And, it might involve physical adsorption or ion exchange at the adsorbent surface and the subsequently slower phase might involve other mechanisms such as complexation, micro-precipitation or saturation of binding sites (Gupta and Rastogi, 2009). The adsorption capacities of contact time 1–5 min were found to be 0.56–1.07, 0.87–2.15 and 1.43–3.05 mg/g for initial dye concentration at 25, 50 and 75 mg/L, respectively. The adsorption capacity at equilibrium time valued at 1.20, 2.44 and 3.40 mg/g for 25, 50 and 75 mg/g, respectively.

For the effect of adsorbent dose from 0.2–1.0 g, the percentage of adsorption at a concentration increased with increased adsorbent dose. This can be explained by the fact that the number of adsorption sites increases when the amount of adsorbent increases and more adsorbent surface and pores volume will be available for the adsorption (Amrhar et al., 2015). However, the adsorption capacity (mg/g) decreased with increased adsorbent dose, due to some adsorption sites remained empty during the adsorption process (Yang and Cui, 2013; Bailey et al., 1999).

For the effect of concentration, the results showed that the adsorption capacity increased with increased initial concentration of dye solution. This was due to the increase in driving force of concentration gradient for mass transfer with the increase in initial dye concentration. However, at higher concentration, the trend of adsorption became less and would be constant further. This was due to the saturation of adsorption sites on the adsorbent as the dye concentration increased (Aksu and Tezer, 2005).

For the adsorption isotherm, the experimental data were described using Langmuir and Freundlich isotherms. The better fit of experimental data in the Langmuir isotherm indicated the monolayer coverage of sorbed molecules on the adsorbent surface. The maximum adsorption capacity valued 11.36 mg/g. The values of $R_L$ were in the range of 0.24–0.02, indicating that the adsorption
process was favorable. For the Freundlich isotherm, the value of 1/n was 0.40. The value of 1/n was in the range between 0–1, indicating that the adsorption was a favorable process.

For the Chi-square test of error analysis, $\chi^2$ value of Langmuir isotherm (0.89) was lower than of Freundlich isotherm (0.94). Therefore, the methylene blue adsorption onto shrimp shell was described better by the Langmuir isotherm.

The kinetic adsorption data were analyzed by linear plots of pseudo–first order, pseudo–second order, and intraparticle diffusion models. Based on the correlation coefficient ($R^2$), the experimental data were best fitted by the pseudo–second order model. The increase in values of the initial adsorption rate ($h$) with an increase in the initial dye concentration could be attributed to the increase in the driving force for mass transfer. The similar observation has been reported by Chio et al (2009) for the removal of arsenic (As) from aqueous solutions using shrimp shell. For the intraparticle diffusion, the linear lines did not pass through the origin indicating that film diffusion and intraparticle diffusion occurred simultaneously.

For thermodynamic study, the free energy of adsorption ($\Delta G$) was estimated to be $-0.95$, $-1.78$ and $-2.42$ kJ/mol at 20, 30 and 40°C, respectively. The negative values of $\Delta G$ indicated that the dye adsorption onto activated carbon was feasibility and spontaneous. The $\Delta G$ decreased with increasing temperature, suggesting that the adsorption process was more favorable at the higher temperature, probably as a result of the increased mobility of dye molecules in aqueous solution. The Gibbs free energy changes for physical and chemical adsorption are usually in the range of 0 to $-20$ kJ/mol and $-80$ to $-400$ kJ/mol, respectively (Suteu and Malutan, 2001). Therefore, in this study, the adsorption of methylene blue adsorption onto shrimp shell could be considered to physisorption which is the predominant mechanism in the adsorption process. The enthalpy ($\Delta H$) and entropy ($\Delta S$) of adsorption were $20.59$ kJ/mol and $73.66$ J/mol.K, respectively. The positive value of $\Delta H$ indicated that the adsorption was endothermic in nature. The positive value of $\Delta S$ suggested an increase in entropy with adsorption. This occurred as a result of an increase in the randomness at the solid–solution interface during the adsorption of methylene blue on shrimp shell.

Conclusions

The aim this work was to determine the potential of shrimp shell for the methylene blue dye removal in the batch adsorption process. Various experimental conditions such as pH (2–10), contact time (1–180 min), adsorbent dose (0.2–1.0 g), initial dye concentration (25–300 mg/L), and temperature (20–40°C) were investigated. It was observed that the optimized adsorption occurred at pH 7 and equilibrium time at 30 min. The adsorption data were fitted well to Langmuir isotherm model. The kinetic results showed that the process can be described by the pseudo–second order model. Furthermore, thermodynamic studies had confirmed that the adsorption process was spontaneous, endothermic, and physical.

References


Using Raspberry Pi in Teaching and Learning Python: Case of Matthayomsuksa 3 Students of Wat Nongyao School, Ladyao District, Nakhon Sawan Province

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Abstract

This study of using Raspberry Pi in teaching and learning Python: case of Matthayomsuksa 3 Students of Wat Nongyao School, Ladyao District, Nakhon Sawan Province was aimed to 1) design the lesson plan of teaching and learning in Python programing based on Problem-based Learning (PBL) approach, 2) study the learning achievement of using lesson plan of teaching and learning in Python programing based on Problem-based Learning (PBL) approach, and 3) study the students’ satisfaction towards the learning activities. This experimental research methods consisted of 6 steps: step 1 was to study the core curriculum and indicators in which used it to develop the school curriculum, step 2 was to study the Raspberry Pi as the learning technology, develop PBL lesson plans, and design and develop the learning achievement test, step 3 was to verified the learning achievement test and lesson plans which included the pilot test, step 4 was to modified the result of step 3, step 5 was to do the actual experiment, and lastly step 6 was to summarise and discuss the results. Used of Mean, Standard Deviation (S.D.), and T-Test as the statistics methods to interpret the data. The results show that, 1) the quality of PBL lesson plans were at good level which included 10 weeks lesson plans and it starts from basic to intermediate level of Python programm and also it is matching to the Core curriculum in studying Computing subject. 2) There was difference between pretest and posttest score of students’ learning achievement learned by Raspberry Pi and PBL lesson plans at .05 level of significant. 3) There was high satisfaction towards the learning activities.

Keywords: Raspberry Pi, Problem-Based Learning (PBL), Python programming

Introduction

In this age, the Information and Communication Technology (ICT) has grown steadily in the daily life of human beings everywhere which people spend their time on computer or smartphone such as reading news, buying something they want, and communicate to their friends. It has played an important role in the life includes the study and research in the current business, politics, and more. With the advancement of computer technology, many organizations adopt these technologies in helping to make the organization more efficient, which is skills needed to develop these skills to students. To have knowledge and readiness of ICT skills in using information technology to solve problems and to live, schools should encourage and develop the activities to students. According to Udomsinn (2016) who questioned that why should anyone study programming? Looking back in 2012, nonprofit organization named code.org was founded with supported from technology entrepreneurs such as Bill Gates of Microsoft and Mark Elliot Zuckerberg of Facebook to address the shortage of people, computer science. Code.org has a mission to push the subject such as introduce the program to the Code.org school in Thailand. Over the past two years, Good Factory has had the opportunity to help drive this issue which supported by Microsoft.

Teaching students how to write the computer programming, students should learn some code and phase and teachers should teach student in order to write computer programming in step by step. There are 2 types of teaching student in computer programming which is essential: 1) teach students the structured programming, and 2) teach students the basic of Object Oriented Programming (OOP). In the case of teaching programming to students, teachers should teach the introduction of programming to students by let them practice the thinking skills and work in systematic way. Moreover, if teacher use
the instructional materials and appropriated language so that students could learn well. The use of Raspberry Pi has been used in many countries to provide a variety of programs for students and also, developers are most commonly used and the Raspberry Pi used Python in coding (Developer Survey Results, 2017). Therefore, the teaching and learning of the Python language, which is using in Raspberry Pi in the subject as the foundation course in Computing Science is benefit to students because it let students to practice thinking skills, creates project work and experience for students to learn new things. To be knowledgeable and having skills in the ways to use technology, learning programming will make the understanding of the computer system and think that how computer work. This lead to the conceptual framework below.

![Figure 1 Conceptual Framework](image)

**Methodology**

Population and Sampling, this study used Matthayomsuksa 3 Students of Wat Nongyao School, Lad Sao District, Nakhon Sawan Province as sample group. This sample group came from the purposive technique.

There were pretest, posttest, and students’ satisfaction evaluation forms used as materials for collecting data, and Website as learning resource, lesson plans and Raspberry Pi used for experiment.

The analysis used Mean, Percentage, Standard Deviation, and compare Mean by t-test.

The development of lesson plans was based on documents synthesis and analysis followed the practices in normal classes. The Science core curriculum of basic education which revised on 2017 was to scope and detail the teaching of computer programming such as using the Python in development of project works. In classroom, students were asked to learn the basic of Python, how to code Python, and using Python to control the relay for instance to achieve the learning outcomes or objectives. Lesson plans consisted of 8 plans for 8 weeks of actual experiments, and the outline or draft plans were viewed and confirmed by experts.

**Results**

1) Based on the core curriculum of basic education and school curriculum on teaching and learning Computing Science subject.

According to the core curriculum of basic education in 2017, the Computer subject has moved from Career and Technology core subject area to Science core subject area. This indicates that students have to study as a foundation subject and must be able to solve problems, think critically, have systematic thinking, and think creativity. Students can define problems or needs and to gather information methodology which can design the convey ideas to solve the problem systematically related to the indicators in the Mathayomsuksa 3. There were 8 lesson plans as below,

- Lesson Plan 1: Raspberry Pi Operating Systems and how to install.
- Lesson Plan 2: Using Raspberry Pi and GPIO.
- Lesson Plan 4: Hello World.
- Lesson Plan 5: How to coding GPIO of Raspberry Pi by Python.
- Lesson Plan 6: Coding the Python to lighting.
- Lesson Plan 7: Coding Python to Manage the Relay.
- Lesson Plan 8: Switch on/ off by Using Relay.

Website as learning resource as bellw.
2) The results of learning achievement in Python programming based on Problem-based Learning (PBL) approach.
There were three learning achievement test used to measure students in knowledge about using Raspberry Pi.

Table 1 T-Test of learning achievement on Principle of Python Programming

<table>
<thead>
<tr>
<th></th>
<th>$\bar{x}$ (S.D.)</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (n=16)</td>
<td>7.62 (1.14)</td>
<td>19.28</td>
<td>.000*</td>
</tr>
<tr>
<td>Posttest (n=16)</td>
<td>16.75 (1.61)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P< .05, t >= 1.7459

Table 1 shows that there was posttest ($\bar{x}$ =16.75, S.D. = 1.61) score higher than pretest score ($\bar{x}$ = 7.62, S.D. = 1.14) which is has significant at .05 level. This mean that lesson plans in the topic of Principle of Python Programming encourage students learned best in this topic.

Table 2 T-Test of learning achievement on Using Raspberry Pi.

<table>
<thead>
<tr>
<th></th>
<th>$\bar{x}$ (S.D.)</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (n=16)</td>
<td>8.87 (1.78)</td>
<td>12.38</td>
<td>.000*</td>
</tr>
<tr>
<td>Posttest (n=16)</td>
<td>17.25 (2.81)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P< .05, t >= 1.7459

Table 2 shows that there was posttest ($\bar{x}$ =17.25, S.D. = 2.81) score higher than pretest score ($\bar{x}$ = 8.87, S.D. = 1.78) which is has significant at .05 level. This mean that lesson plans in the topic of Using Raspberry Pi encourage students learned best in this topic.

Table 3 T-Test of learning achievement on Using Technology and Communication.

<table>
<thead>
<tr>
<th></th>
<th>$\bar{x}$ (S.D.)</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (n=16)</td>
<td>9.31 (1.50)</td>
<td>17.29</td>
<td>.000*</td>
</tr>
<tr>
<td>Posttest (n=16)</td>
<td>20.50 (2.46)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**P< .05, t >= 1.7459

Table 3 shows that there was posttest ($\bar{x}$ =20.50, S.D. = 2.46) score higher than pretest score ($\bar{x}$ = 9.31, S.D. = 1.50) which is has significant at .05 level. This mean that lesson plans in the topic of Using Technology and Communication encourage students learned best in this topic.
Table 4 The results of students’ satisfactions toward learning and teaching by using Raspberry Pi and Problem-based Learning (PBL) approach.

<table>
<thead>
<tr>
<th>Lists</th>
<th>(\bar{x})</th>
<th>S.D.</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teacher gives clearly feedback to students</td>
<td>4.19</td>
<td>0.75</td>
<td>High level</td>
</tr>
<tr>
<td>2. Funny activates and motivated</td>
<td>4.00</td>
<td>0.82</td>
<td>High level</td>
</tr>
<tr>
<td>3. Modern topics</td>
<td>4.13</td>
<td>0.81</td>
<td>High level</td>
</tr>
<tr>
<td>4. Teachers used appropriated instructional media.</td>
<td>4.00</td>
<td>0.82</td>
<td>High level</td>
</tr>
<tr>
<td>5. Teachers used questions to encourage students’ learning</td>
<td>4.19</td>
<td>0.75</td>
<td>High level</td>
</tr>
<tr>
<td>6. Teachers integrated other disciplines in class activities</td>
<td>4.63</td>
<td>0.50</td>
<td>Highest level</td>
</tr>
<tr>
<td>7. Teachers encourage students’ creative and critical thinking</td>
<td>4.56</td>
<td>0.73</td>
<td>Highest level</td>
</tr>
<tr>
<td>8. Teacher accepted students feedbacks and comments</td>
<td>4.44</td>
<td>0.73</td>
<td>High level</td>
</tr>
<tr>
<td>9. Teachers encourage students learning in group and also in individual.</td>
<td>3.94</td>
<td>0.93</td>
<td>High level</td>
</tr>
<tr>
<td>10. Teachers encourage student gathering information seeking</td>
<td>4.50</td>
<td>0.63</td>
<td>Highest level</td>
</tr>
<tr>
<td>11. Teachers allows students to ask</td>
<td>4.50</td>
<td>0.63</td>
<td>Highest level</td>
</tr>
<tr>
<td>12. Teachers away maintain students in learning</td>
<td>4.19</td>
<td>0.83</td>
<td>High level</td>
</tr>
<tr>
<td>13. Teachers pay attention to students while teaching everyone</td>
<td>4.56</td>
<td>0.73</td>
<td>Highest level</td>
</tr>
<tr>
<td>14. Teachers provide support or assistance to students</td>
<td>4.25</td>
<td>0.86</td>
<td>High level</td>
</tr>
<tr>
<td>15. Students know the measurement and evaluation criteria in advance</td>
<td>3.88</td>
<td>0.89</td>
<td>High level</td>
</tr>
<tr>
<td>16. Students participate in the measurement and evaluation in advance</td>
<td>4.25</td>
<td>0.77</td>
<td>High level</td>
</tr>
<tr>
<td>17. The teacher assesses the study in a fair way</td>
<td>4.13</td>
<td>0.81</td>
<td>High level</td>
</tr>
<tr>
<td>18. Teachers have the intention of teaching</td>
<td>4.31</td>
<td>0.79</td>
<td>High level</td>
</tr>
<tr>
<td>19. Personality, dress, and speaking of the teacher</td>
<td>4.25</td>
<td>0.77</td>
<td>High level</td>
</tr>
<tr>
<td>20. Teachers teach and leave on time</td>
<td>4.00</td>
<td>0.97</td>
<td>High level</td>
</tr>
<tr>
<td>Total</td>
<td>4.22</td>
<td>0.80</td>
<td>High level</td>
</tr>
</tbody>
</table>

Table 4 shows that the overall of students’ satisfaction toward the lesson plans and learning activities is in the high level (\(\bar{x} = 4.22,\) S.D. = 0.80). Students felt that “Teachers integrated other disciplines in class activities” (\(\bar{x} = 4.63,\) S.D. = 0.50) was highest level followed by “Teachers encourage students’ creative and critical thinking” (\(\bar{x} = 4.56,\) S.D. = 0.73), “Teachers pay attention to students while teaching everyone” (\(\bar{x} = 4.56,\) S.D. = 0.73), “Teachers encourage student gathering information seeking” (\(\bar{x} = 4.50,\) S.D. = 0.63), and “Teachers allows students to ask” (\(\bar{x} = 4.56,\) S.D. = 0.73) respectively.

Discussions

The results show that 8 lesson plans were created. The design of lesson plans for Python programming learning and teaching through Raspberry Pi for the Mathayomsuksa 3 students was came from the analysis of core curriculum and the school’s curriculum based on Computing Science subject. The Problem-Based Learning method was used in this study as the learning activities. The advantage of Problem-Based Learning is that students who participate in Problem-Based Learning activities can improve their abilities to retain and recall information. Moreover, Problem-Based Learning allow student working in small group. Small group discussion can be especially benefit because each student will get chances to participate (Guido, 2016).

The results of learning achievement in Python programing based on Problem-based Learning (PBL) approach. There were three learning achievement test used to measure students in knowledge about using Raspberry Pi. The results of three test show that there were posttest higher than pretest with .05 level of statistically significant. This may be because, students learn Python programing through
Problem-Based Learning and real materials (Raspberry P). When students met the problem they discussed the possibility to solve that problem which is same as Guido (2016) who claimed that real-life issues are require real-life solutions and students will have more effectively engaging in the classroom. Moreover, Problem-Based Learning are an effective way to create motivation to learn programming (Nuutila, To’rma and Malmi, 2005)

In overall score of students’ satisfaction toward the lesson plans and learning activities is in the high level (̅= 4.22, S.D. = 0.80). Students felt that “Teachers integrated other disciplines in class activities” (̅= 4.63, S.D. = 0.50) in the most satisfaction followed by “Teachers encourage students’ creative and critical thinking” (̅=4.56, S.D. = 0.73), “Teachers pay attention to students while teaching everyone” (̅= 4.56, S.D. = 0.73), “Teachers encourage student gathering information seeking” (̅ = 4.50, S.D. = 0.63), and “Teachers allows students to ask” (̅ = 4.56, S.D. = 0.73) respectively which were related to Problem-Based Learning teaching method. The Problem-Based Learning is characterized by open-ended, authentic, substantial problems which drive the learning, explicit teaching and assessment of generic and metacognitive skills, and collaborative learning in groups (Boud and Feletti, 1991). In this study, teachers allowed students to participate with their peers and always facilitated students to solve the problem. Moreover, teachers also motivated students and available to answer indirectly way because students should not get any direct answer.

References
Social Science
Chinese Female Characters’ Identity and Chinese Consumer Culture and Globalization in the Novel of Shanghai Baby

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Abstract

This research explores the search for female characters’ identity through consumption and globalization. Consumer culture is used as a tool to be socially accepted. Unfortunately, they, especially, the heroine, Coco only gain the temporary identity since it cannot spiritually fulfill their hollow mind. Next, western art and philosophy is employed as the tool to inspire oneself. Consuming western art and philosophy play the crucial role in the female protagonist’s life. It mentally teaches her how to live her life and boost up her spirit which is the significant step to strengthen oneself. Thirdly, western modern thoughts are used as the tool to liberate Chinese women from the social constraints. Western thoughts particularly about feminism release Chinese women from the social confinement. They give them the new experience to the gender equality that they have never had. Consequently, both consumer culture and globalization render both positive and negative sides to Chinese women.

Keywords: Chinese female identity, Chinese consumer culture, globalization, westernization, feminism, Shanghai Baby

Introduction

Chinese women have long known for encountering the difficult time in struggling with gender inequality and seeking for their own identity. They did not even have the chance to show their femininity. In Mao’s Cultural Revolution era, women were not allowed to fully express their “feminine beautification through cosmetics and fashion” (Johansson, 2001, para1; Zheng, 2016, p.72). Yet, the degree of Mao ideology’s hostility about women’s beautification had substantially reduced especially after the Cultural Revolution had ended. After the Culture Revolution era, consumer culture and globalization arrived in China and gave the brand new perceptions on the world and new lifestyle that totally contrasted from the traditional Chinese lifestyle. Chinese women had a lot more freedom after the open door policy. With the open door policy, People’s Republic of China (PRC) completely transferred from the close country to the open one which allows the foreign countries especially the western to freely trade or invest in China. The emergence of western products, commodities, new knowledge and thoughts bring the new way of thinking and way of life to Chinese people particularly the young ones (Xia, 2016, p.66). With the economic reform and people’s success is measured from their wealth. The arrival of consumer culture and globalization give the opportunity for women to find what can identify them as a person and also find the suitable way of life for them. After the long repression of identifying feminine beautification, Chinese women look for the ways to address themselves with their beauty in the consumer culture.

Women were permitted to express their feminine beautification again in the 1980s: they were able to decide what kind of clothes to wear, what hairstyle to have, and the right to wear or not to wear makeup (Johansson, 2001, para1). According to Zheng (2016, p.72), the Chinese youth were the majority who benefited from the consumer culture. After the Cultural Revolution period when gender were ignored, not clearly identified and followed by the economic reform, the issue of gender identification was raised again especially the question of what was really constructed women’s being or identity (Johansson, 2001, para3).

Reykowski (as cited in Weber, 2002, p.351) suggests that self-identity is not associated only with the individual but it is also connected to the environment one lives in. Self-identity constitutes two
contrast facets: individualism and collectivism. Individualism is the sense that one separates oneself from his/her surrounding; collectivism is the correlation between one and the society they are embedded. Self-identity, therefore, progresses differently depending on where one inhabits and “on how they are fostered culturally. Actually, Chinese people immensely concern about the “collective needs” more than the individualism. They, thus, rely on the historical Chinese culture which is based on the Confucian teaching including “the myths and narratives of society, the grammar of the language, the disciplinary power of the state, and the role of the family”. On the contrary, for the individualistic, they focus more on the personal achievement, “has right to his or her own private property, thoughts and opinions” (Samovar et al as cited in Weber, 2002, p. 352).

*Shanghai Baby* was written by the Chinese female author. It was banned right after its publication. It is the story of a Chinese woman in the late 1990 named Coco. The female protagonist is a self-confident girl who lives in Shanghai. She wants to be a famous writer but all she does is working in the café. She has an impotent boyfriend named Tian Tian. Although Tian Tian cannot fulfill Coco’s sexual satisfaction, he fulfills her spiritual desire. He encourages her to start writing the manuscript for her first novel again. So she decides to quit a job as a waitress and devotes her time to writing. She, however, struggles with her identity crisis during her writing journey. She lives in the materialistic world where famous brands and objects possessions are the important part in her lifestyle. She has the affair with the German man named Mark who comes to work in Shanghai. She feels disgusted with herself for cheating on her boyfriend but she cannot stop doing it. While Coco confronts with the hardship, Tian Tian also has the troubles. He takes drugs and finally dies. Coco is devastated but she keeps on writing because she thinks that writing is the only way that can connect her to Tian Tian. She eventually finishes her first novel but still does not know the outcome of it and she still asks herself at the end of the story who she is.

Chinese women perceive the consumer culture as the way to gain power through the luxurious products, elegant appearance and western lifestyles. Women, thus, identify themselves as the individual with the consumption in the patriarchal society (Zheng, 2016, p.78). Yet, the proper manner for Chinese women was discussed. *Chinese Women* (cited in Johansson, 2001, para3) states that they should conserve “their Chinese characteristics and, compared to Western women, be more reserved and shy”. Chinese women were still restrained by the patriarchy. They were told to act properly by being “gentle and soft”. In addition, women can show their beauty in the certain degree but they should pay more attention to the motherly duties: provide the comfort and take a good care of their husbands and children. Women thus, did not need to be too self-assured (Johansson, 2001, para3).

Consumer culture was bombarded worldwide in the last decade of the twentieth century. It is referred to “economies built on mass consumptions, as well as to a commodified symbolic universe where individual and collective identities are structured by products and advertising” (Lury as cited in Johansson, 2001, para1). Lury (as cited in Johansson, 2001, para1), also remarks that consumer culture allows people to focus on their identity rather than the social concern. Women are major factor in consumer culture because they can defy their femininity, beauty, wealth, social status through the object possession. As seen above, Chinese women enthusiastically welcome the consumer culture into their lives because they realize that being a part of consuming activities can give them the social status without knowing whether this position it gives will last long or will be the true one. With the new advert of consumer culture and the prolonged subordination under the male dominance, the subject of identity is new and therefore is the thing they want to possess as it will bring them the sense of self-esteem, of being visible and accepted.

**Related Literature**

China is well known for the male dominated country. Chinese women, however, attempt to find their place in the patriarchal society. Kuoshu (2005, p.85) states that *Shanghai Baby*, written by Wei Hui, presents Mainland China in the late twentieth century when the western culture had the great influence in Chinese society especially in the urban China. This novel, therefore, reinforces “fashion, lifestyle, taste, and emotion in the leisure of everyday life”. Some western readers do not find this story intriguing but it is nothing different from the Western literature. It is, however, not initially written for the western audience. It aims to reflect the urban life of Chinese youth. Such rapid changes in Post Mao period, the youth are torn between the old traditions and the new Western way of life. Barber (as cited in Kuoshu, 2005, pp.95-96), declares that China embraces the “McWorld” which is “the commercial
culture, ideology, and lifestyle embodied by the material and cultural products of the West”. Kuoshu(2005, p. 96), adds that the flush of Hollywood films and pirate DVDs of foreign films shape the Chinese youth’s lifestyle.

Koetse (2012, p.18) announces that “idolization for (Western) brands and the modern city-life are recurring themes” in this novel. She adds that the heroine is associated with the western brands since the beginning of the story: Coco tells the readers that she gets her names from the famous fashion influencer, Coco Chanel. Furthermore, “the world famous brand” and movie such as IKEA furniture, Christian Dior’s lipstick, Yves Saint-Laurent, Esprit and Tarantino films are mentioned in the story. Additionally, Shanghai is a combination of “Chinese tradition and Western modernity” that causes Chinese youth to indulge in materialism. Since Post Mao era had significant changes with how the society should be liked, China attempted to find its position and existence in the world outside China. At the same time, Chinese youth also look for their own place in society. Post Mao era encountered the social conflict between its Communist control and the emergence of capitalism.

Koetse (2012, pp.19-21) also indicates that Coco ironically describes the effect of harmful “Shanghai material wealth” throughout the story but the obsession of materialism is still raised for the entire narration. It demonstrates that all the Chinese characters try to gain “Western (capitalist) identity” through the material possession. Koetse states that Chinese youth rebels against Chinese Communism and Chinese tradition through “westernized lifestyle and consumer behavior” Koetse also remarks that it is the transformation from Communism to Capitalism. After the Cultural Revolution (1966-1976), Chinese youth which was called Generation X had never experienced Mao’s rules. They, therefore, did not find themselves related to Maoism. Koetse insists that although Chinese youth in this novel cherish the western culture, they still want to maintain Chinese identity. The Generation X did not want to be “colonized” by the West, but they wanted to see the modern version of China.

In addition, in Shanghai Baby, Chen (2016, p.73) proposes that women perceive their sexual confidence as “a source of female power” through consuming the luxurious or international products. Female characters, Coco, the protagonist, Zhu Sha, and Madonna tend to identify themselves with the products they buy and the extravagant lifestyle. The purchasing power and consuming behavior renders them the female authority since they are free to make choices and more independent. The “female self” constituted in this novel is equivalent to “a confident consumer”. Moreover, those female characters are presented to be “a modern, confident and sexually attractive woman in the new age”. This novel is outstanding for Chinese women’s self-identity journey and the power of consumer culture and globalization. These two topics, thus, will be analyzed whether consumer culture can give them the genuine identity. To illustrate this assumption, the analysis will be categorized in three types: consumer culture and globalization as the way to present women’s existence; consumer culture and globalization as the way to fulfill the emptiness; and western and philosophy as the way to spiritually lift up.

**Theoretical Framework**

**Personal Identity and Social Identity**

Identity is attributed to the self that separates its “existence on its own apart from relations with others”. Nevertheless, self-identity is quite complex and affected by the surrounding and social roles. The society, therefore, has the impact on the inner self (Ryan, 2012, p. 47). According to Hazel Rose Markus (as cited in Ferguson, 2016, p.148), a psychologist, she categorizes identity into two parts: “the self or our self-definition” and “the perception of how others see us”. In other words, those two types of identity are personal identity and social identity. Ferguson (2016, p.147) claims that identity is not fixed since we were born. In fact, it is changeable throughout one’s life depending on the experiences one learns through each stage of life and the certain circumstances they face. The factors that can have the great impact on one’s identity are “gender, race ethnicity, sexuality, disability and social class”. One’s identity is “fluid, contextual, and unique”. Moreover, personal identity and social identity often have conflicts with each other.

For personal identity, Erik H. Erikson’s theory is undeniable to be the one to refer to. He claims that personal identity development can be seen clearly during the teenagers. He, however, states that identity and identity problems can happen throughout one’s life. It is the lifelong process that can be changeable all the time depending on “individual life lessons and experiences” (Menard, 2009, p.19). Personal identity is the sense of knowing who one is and being able to describe oneself as a person (“Personal Identity”, 2015).
For social identity, it focuses on “the causes and consequences of identifying with the social group or category” (Burke and Stets (2000, p.3). Social identity also intermingles with self-esteem. It is important factor for social identity. People who belong to the group as the members will have self-esteem for belonging to the particular group and for being accepted from the group members (Brown and Lohr and Ellison as cited in Burke and Stets (2000, p.5).

Methodology

The entire novel is read to get the whole picture of what the story is about. Next, the previous study, relevant theory and topics such as identity theory and consumer culture are investigated. After that, search through the text that is relevant to consumer culture and identity of each female character to see what each female character has done to identify herself with consumer culture. Furthermore, this research will examine whether consumer culture can give the true identity to those female characters. This exploration only focuses on the topic of identity of the female characters and consumer culture in the novel of Shanghai Baby. Other irrelevant topics in this book are not interpreted here.

Results

Consumer Culture and Globalization as the Way to Present Women’s Existence

Chinese women and the invisibility are inevitably related to each other. The arrival of consumer culture from the west brings them the opportunity to identify themselves through the materials they possess and make them stand out from the crowd. People, however, cannot completely stand out from the crowd through their material consuming since they want to be accepted by people who also adore materialism. They cannot avoid identifying to the collective identity which is the group of people who have the same characteristics. Nevertheless, the consumption make women look better and have more charming personalities. It is thus, the easiest way for Chinese women to be visible under the male control by making themselves attractive so that people especially men will recognize them and give them some spaces in the patriarchal society. As a woman, attracting one’s attention from her physical appearance is the first way she can do and it will hardly harm her because people particularly men will be trapped in admiring her prettiness and charm so that they will not realize that women try to gain power through her beauty image. Unlike protesting the male dominance with the radical actions, most men would think beautiful women are brainless and harmless. Actually, Chinese women are treated as the object in the patriarchy. Reversely, in the consumer culture, Chinese women attempt not to be the object themselves but to possess the objects instead. This way they take control over the objects. They have freedom to choose the right products that suit them and when they find them, their self-confidence, self-esteem and self-determination will be boosted up.

Possessing materials and consuming the luxurious products to get attention and social recognition is still disputable if the authentic identity is formed since some people perceive this social identity as the uncertain, fake, instable one. And this kind of identity will not be long lasting social identity. If one day women do not have the purchasing power, their social status defining by their beauty, attraction, charm and wealth will be disappeared and ignored in the society as nobody again. As a result, this consumer culture and globalization cannot give one the true identity. Women are, however, unaware of this illusion. Women’s first concern is to be beautiful and socially recognized so that there will be somebody in the society. The three female characters of this novel, Coco, Zhu Sha and Madonna, are the eminent examples who are influenced by consumer culture and globalization. To elaborate how each female character states her existence, they will be analyzed separately. Additionally, consumer culture and globalization can be seen in different aspects including capitalism, mass media, commercialism the advert and popularity of foreign brands, fashion, materialism, the new values of beautification, and westernization.

The foreign brands, fashion, extravagant materials are promoted by the mass media and commercialism so that their repetition of being appeared in public can lure women to worship and give them some values. It also brings Coco self-esteem which leads to self-identification, the sense of belonging in the big city like Shanghai and lead her to the existence, eventually. According to Coco, Shanghai is referred to as women in this story:

It is because Shanghai is home to so many women like Shu Sha that it’s become the city whose vibrancy is
tempered by feminine elegance. The aimless ennui of Eileen Chang’s unmarried women and the refined melancholy of Chen Dan-Yan’s writing are rooted here. Some people called Shanghai the Women’s City, but that’s probably in comparison to the macho cities of northern China.

(Hui, 2001, p.116)

Coco assumes that Shanghai is referred to women’s city because most women in this city cherish their affluence and enjoy their materialistic life. Coco claims there are many Shanghainese women like her cousin, Zhu Sha who adore and relish lavish style of living. Meanwhile Coco refers to northern China as the “macho cities”. It is implied that other northern cities do not fully transform to consumer culture like Shanghai. So the patriarchy in other northern cities is still not threatened by women’s power obtaining through the western consumption. Some phallic symbols, however, are shown in Shanghai city like the skyscraper which underlined that no matter how much women’s power has grown, men’s power is still over them like the tall building embracing over the Shanghai city. Men’s authority is still haunting those sophisticated Shanghainese women:

Standing on the roof, we looked at the silhouettes of the building lit up by the streetlights on both sides of the Huangpu River, specially the Oriental Pearl TV tower, Asia’s tallest. Its long, long steel column pierces the sky, proof the city’s phallic worship. The ferries, the waves, the night-dark grass, the dazzling neon lights, and incredible structures—all these signs of material prosperity are aphrodisiacs the city uses to intoxicate itself. They have nothing to do with us, the people who live among them. A car accident or a disease can kill us, but the city’s prosperous, invincible silhouette is like a planet, in perpetual motion, eternal.

(Hui,2001, p.14-15)

The foreign brands appear throughout the novel through the Coco’s narration: describing about the western goods she uses in daily life; the city’s prosperity, her female friends’ lifestyle. Coco’s existence can be explained in two main aspects: through Coco’s beauty and her sense of social acceptance. Coco uses the famous foreign brands to stand out from the crowd and to make herself socially accepted at the same time. With the impeccable clothes and makeup makes Coco outstanding. This can be assured by her narration that she attracts men’s attention: “…I was repeatedly eyed by the northern men at a nearby table. That typical northern perusal can thoroughly reassure a single Shanghainese woman in Beijing for Christmas. At least it tells her she’s attractive” (Hui,2001, p.107). Male gaze makes her proud of herself for being visible. As a result, she believes to gain power by her beauty since she can gain attention from men which means she overcomes the patriarchal society.

The subject of beauty image will be discussed here. All of the three female characters use beauty image to gain the social acceptance. Women consume materials to create the beauty of themselves because they believe that they can gain authority through beauty. The image of beauty, however, is defined by men since it is viewed by men. Beautification, thus, does not give women real authority because it is still under male dominance (Jeffreys,2005,p.1). Coco has to dress up and wear makeup before she goes to have dinner with Mark and his friend:

Having dinner with a lover and a journalist is not a bad thing. Before I went out, I dressed carefully. I love that vain pleasure when I pencil my eyebrow, apply blusher, and roll on my lipstick; for this alone I’d choose to be reborn as a woman. A careful, understated toilette, a reserved elegance nonetheless capable of stunning onlookers-Shanghainese women are innately
This shows that she is not confident with her bare face. She needs to make herself beautiful with cosmetics. However, this is not entirely true that Coco obtains the complete female empowerment from the male dominated world since she has to look beautiful to please men. Although she thinks she enjoys making herself attractive. Ironically, if she really wants to look pretty for her own sake, she would dress up and wear makeup at home as well. On the contrary, she does this on purpose. Moreover, she confesses that she feels better writing at home without worrying if anyone would see her without makeup and with the messy hair: “I stayed in my room writing for a week, not even bothering to comb my hair.” (Hui, 2002, p.167) and “Actually, in the middle of this reclusive life, I discovered the tao and attained a state of grace. To my mind, heaven is no more than this: being at ease and completely free of worry. There are no men to notice your hairstyle and clothes, no one to fuss about whether you’re full breasted or your eyes are sufficiently elegant…” (Hui, 2002, p.167). Apparently, Coco feels better when she is writing without worrying about her appearance. That way she can fully concentrate and use all her imagination on her works. She does not realize that she dress up and wear makeup to serve male gaze which leads her to be objectified. According to Kant (as cited in Malik, 2014, p.88), objectification is the way to “[dehumanize] a person and [reduce] him or her to only a thing”. Superficially, Coco has more freedom than her mother’s generation that allows her to have more choices in life: careers, belief, clothes, lifestyle but the choices here do not mean that she will have her full freedom and away from male superiority. With a lot more freedom than the previous generations, it lures Coco and other female characters into the fake liberation. Apart from Coco, Madonna and Zhu Sha also see beauty image as the way to gain attention and be socially accepted. Both of them are described as the elegant and full dress up women as well.

Madonna has the difficult childhood and also suffers from sexual abuse early in her life and becomes the consort later on. The wealth she gets from her passed away husband, however, asserts her of her self-confidence and a social position in Shanghai since she is one of the affluent women. She gains the social acceptance by holding the party to show her wealth: “Come over to my place when you have time. You’ll find singing, dancing, card games, drinking, and all sorts of weird people. I just redecorated my apartment. I spend half a million Hong Kong dollars on the lighting and sound system alone. More fucking awesome than some Shanghai nightclubs” (Hui, 2002, pp.11-12) and also hanging out in the public places. She thinks her life has changed from being nobody to being somebody in society. She also cares about her beauty image. Coco often describes her elegant appearance whenever she sees Madonna: “Madonna’s effervescent face looked like a phosphorescent deep-sea creature as she walked toward us, radiating a thousand watt glow” (Hui, 2002, p.28). Madonna concerns about her physical appearance as well. She asks Coco if her body is attractive: “What do you think of my figure? Still attractive?” (Hui, 2002, p.119). In addition, she thinks she can overcome the patriarchy since she is no more in the prostitution business and her husband is dead. Actually, she is still trapped in it since she tries to be visible through the materials.

Zhu Sha, Coco’s cousin is also concerned about the social status. She is stated as one of the modern and wealthy Shanghai women. She has a stable job and good amount of salary. She also wears elegant clothes and lives the luxurious life like other youth in Shanghai city.

...Zhu Sha is a lady through and through. In the morning takes an air-conditioned bus or taxi to the office, wearing impeccably applied makeup. At noon she orders and Executive Set Lunch in western-style café or restaurant. And in the evening, when the colorful lights have just begun to glow, you’ll find Zhu Sha among the women parading past the windows of Maison Mode department store on Huaihai Road, where the latest world-class brands are displayed in quiet glory, then on to the Changshu Road escalator down to the subway, their recently refreshed faces showing a hint of satisfied fatigue.

(Hui, 2001, p.115)
Consumer Culture and Globalization as the Way to Fulfill the Emptiness

Superficially, it seems like the commodities consumption can fulfill the hollowness in the female characters’ lives. In reality, they are still lost, discontented and confused. The city of Shanghai also well represents the consumer culture and westernization. Nevertheless, Coco and Madonna unconsciously mention that this city is full of chaos:

This city is so claustrophobic. Just a handful of people are on the circuit. The circuit she meant is composed of artists, real and phony, foreigners, vagabonds, greater and lesser performers, private entrepreneurs of industries that are currently fashionable, true and fake linglei, and Generation X types. Members of this circle move in and out of the public eye, now visible, then hidden, but ultimately dominating most of the city’s trendsetting scene. They are like beautiful insects whose bellies give off a blue light, existing secretly and subsisting on desire.

(Hui, 2002, p.39)

It is paradox that Coco love extravagant lifestyle. Yet, she feels lost and invisible living in the big city like Shanghai as she describes the city: “When I thought about that, I felt as insignificant as an ant on the ground” (Hui, 2002, p.15).

Commodities consuming cannot give those female characters real happiness since those luxurious products they own or the expensive makeup they wear do not help them to find the true answer of who they really are, what they really want. Materials are the non-living thing. They cannot give the wise advice to them whenever they encounter the problems and want somebody to guide them the ways. Consequently, no matter how many extravagant commodities they own or how elegant they look outside cannot heal the wounds they have inside. The psychological wound needs to be healed from the understanding of oneself: trying to learn their life lesson and face the problem and try to solve them or consult people who can enlighten you instead of hanging around with those people who live the same shallow life like oneself.

Consumer culture comes with the hedonistic lifestyle since those commodities can give one’s comfort, convenience, fake happiness, self-confidence and the sense of owning and belonging. The female characters are lured into the hedonistic lifestyle that is tightly knotted with the consumerism. They, however, cannot escape reality that this hedonistic lifestyle risen from consumption cannot give them the real identity and cannot fulfill their spiritual desire. The emptiness and confusion in the female characters’ lives are often unconsciously demonstrated through the city’s description. Shanghai city is often mentioned throughout the story through the eyes of the female protagonists by comparing to the feeling of loneliness, insecure, insincere, and worthless. They are unaware of the influence Shanghai city has on them. Shanghai is referred to the city of consumer culture where the materials are attached to most of Shanghainese new generation. With the arrival of consumer culture, globalization and westernization render the Shanghainess confusion with the completely contrast culture: Western culture and Eastern culture. This city does not only give the happiness to them but it also makes them feel unconsciously alienated. Their alienation will be discussed through each female character.

Although they seem to enjoy living there, they unconsciously describe how chaotic and hollow the Shanghai city is. Living in the high civilization in Shanghai gives Coco the confusion. She does not seem to be fully happy. On the contrary, she unconsciously confess that the thought of living in the material world like Shanghai makes her feel worthless:

Standing on the roof, we looked at the silhouettes of the buildings lit up by the streetlights on both sides of the Huangpu River, specially the Oriental Pearl TV Tower, Asia’s tallest. Its long, long steel column pierces the sky, proof of the city’s phallic worship. The ferries, the waves, the night-dark grass, the dazzling neon lights, and incredible structures—all these signs of material prosperity are aphrodisiac the city uses to intoxicate itself. They have nothing to do with us,
the people who live among them. A car accident or a disease can kill us, but the city’s prosperous, invincible silhouette is like a planet, in perpetual motion, eternal”.

“When I thought about that, I felt as insignificant as an ant on the ground” (Hui, 2001, p.15)

As seen, the hedonistic lifestyle she has by consuming those commodities or being visible in the society cannot fulfill her hollowness. This hedonism cannot rescue her from the problems she encounters in her life: Tian Tian is still impotent. He still cannot sexually satisfy her. He is also a drug addict and seems to lose hope in life which tremendously upset Coco. Moreover, the guilty of cheating on Tian Tian cannot be solved by the consumption. Those problems are caused by the inner conflicts, dark side and interpersonal conflicts. Using the materials to eliminate the trauma she has is not the right way to do. The material she consumes finally cannot solve her crisis. For example, in Christmas Eve’s night, Coco is devastated. She is very upset and feels down and feels that there is nothing to heal her wound:

“I’m in Beijing”, I said, as my heart was seized by a sharp wave of Tired tenderness. I didn’t even know why I was in Beijing at this moment. I was so agitated, a heart that never knew where it belonged, floating here and there, just sleeplessness night after night. Neither music nor drink nor sex could save me. I just lay there in the heart of darkness…”

(Hui, 2001, p.111)

For Madonna, the materials she possesses cannot give her the entire self-confidence. Material possessions can give her self-esteem and self-confidence on the surface but it cannot heal her spiritual wound. This is obviously seen when Ah Dick, her younger boyfriend, deserts her to be with Coco’s cousin, Zhu Sha. She feels lost and very upset. At first she thinks she has enough power by her wealth to make Ah Dick stay with her for a long period of time. Unfortunately, things do not turn out the way she expects: she does not have power over Ah Dick anymore which makes her lose her self-confidence and feel empty. That is why she reaches for Coco to spend time with her so that she would feel better. She even feels that Coco’s place is cozier than hers despite all the luxurious materials she decorates her room. Those luxurious commodities she own cannot heal her broken heart.

Furthermore, Madonna thinks that Shanghai is confined and people live in the same routine and the same circle of life everyday and those people who live in it are strangers to one another. That is why she compares the living of Shanghainese as living in the circuit. It also shows that she feels uncomfortable living in this crowded city with strangers. It seems that she is lost among strangers. It seems that she herself often interact with these kinds of people. Yet, she still invites people both friends and strangers to her place to gain the sense of being socially accepted. However, it seems like being accepted by the society is not enough for her. Actually, not only those people who live their lives on the surface but she does as well. Ironically, her appearance according to Coco’s description is highly sophisticated that the audience might think she lives the happy life: “Madonna’s effervescent face looked like a phosphorescent deep-sea creature as she walked toward us, radiating a thousand watt glow” (Hui, 2001, p.28). This situation demonstrates the superficial lives that the Shanghainese people take as the true happiness but when the time passes, they start to realize that the happiness from materials world are not genuine. Their mind is still empty.

According to Coco, Zhu Sha, Coco’s cousin seems to be a perfect woman who becomes successful in career and lives. In fact, she is nothing different from the other materialistic Shanghainese women. She just follows the trends and do what most Shanghainese women do so that she will belong to the same position with them which will make her feel secure and happy because she is not left out from the group. Despite her perfect physical appearance, she still suffers from her problems with her husband. She is not really content being with her husband so she decides to get divorced. This is another example showing that being materialistic still cannot be the solutions to Zhu Sha’s problem.
Western Art and Philosophy as the Way to Spiritually Lift up

Western philosophy and new theories introduce the concept of feminism to the Chinese patriarchal society. It opens the whole new world to Chinese women to gain more knowledge of women’s right. The female characters in this novel are the conspicuous examples who espouse the new aspects of women power in male dominance. Coco presents her liberation in many facets. She no longer conforms to the Chinese old tradition: moving in with her boyfriend despite her parents’ disagreement, wearing revealing clothes, expressing her sexual desire freely, cheating on her impotent boyfriend, and trying to be a writer which once was the career belonged to men only. It is good that Chinese women have the freedom to show their sexual expression but Coco goes beyond the moral limitation: she has the secret affair with the German man to release her sexual repression since she cannot have sex with her impotent boyfriend.

Apart from Coco, her cousin, Zhu Sha dares to get divorced and has the new boyfriend which violates the Chinese tradition that women have to live with one husband only. However, the advantage for women’s liberation is women have the chance to express their ability: Coco can demonstrate her writing talent and Zhu Sha can work in the international bank and have high salary.

Besides the aesthetic appreciation, the western art, songs, movies, novels, artists, and writers all give the wisdom and intellect to Chinese women. This case is obviously seen from Coco. She often mentions the titles of the books, songs, the artists, the authors and the philosophers in her narration. Those western arts and philosophy brighten the world and inspire Coco.

However, the westernization also has the negative side to Chinese people. Westernization comes with the western power over the Chinese people. Some of them think that they have more authority than the local people because of the power of their money and culture. In this story, the western couple who rent a house in Shanghai looks down on Coco and her friends who are relaxing on the yard and ask them to leave because they destroy the view. Actually, this western couple does not have the right to dismiss anyone from somebody else’s yard just for the sake of their own viewing pleasure and just because they pay the great amount of the renting. They do not realize that it is not their country. They dare to do such thing because it is the power of westernization. It spreads all over the world so they feel superior for those people who receive the western culture. This scene also implies advert of western culture in general that probably threatens the old Chinese culture. However, it seems like the female characters do not totally forget the old Chinese culture. For instance, Madonna provides the party with the retro theme that gives the feeling of nostalgia. The guests have to wear the traditional Chinese clothes to attend the party. It shows that the youth or the new Chinese generation do not completely ignore the traditional Chinese culture. However, this mixture of culture: East meets West, leads the new generation to the confusion. They do not know exactly what the proper behavior or appropriate action is. For example, Coco admires the old Shanghainese way of life which does not depend on money and materials:

Everyone in that district shares a warmheartedness unique to the older Shanghainese. Almost none of them have any money to speak of. These laid-off housewives arrange their daily lives meticulously. Small, air-dried fish and pickled turnips hang from kitchen windows, and smoke from a coal stove drifts over from time to time. Kids in green school uniforms and red bandannas play ever-popular games. Old people gather in a corner of a small park playing Big Ghost (a card game played between two teams or three), the wind occasionally ruffling their snowy beards.

To the majority of older Shanghainese, this kind of neighborhood is what they know best, and it has a nostalgic air. To the new generation, it’s the place that’s been rejected and will eventually be replaced, a lowly corner devoid of hope. But when you lived here for a while, you can appreciate its simplicity and vigor.

(Hui, 2002, p.56)
Here the sharp contrast is shown between the old Shanghai neighborhood and the Westernized Shanghai city. In the old neighborhood, people connect to one another and live the simple life without relying on the luxurious materials that are not necessary for them. They can be happy in their own way. On the contrary, people in the city of Shanghai are mostly the slave to the commodities. Coco feels bad that the old tradition will be eliminated soon. Despite her appreciation, she cannot desert her luxurious and hedonistic lifestyle that she is acquainted to.

In addition, westernization gives Chinese women the night job as the prostitutes which will make the westerners look down on the Chinese women even more. Here, they are still treated as the object of desire or the slave to the westerners.

Discussion

I agree with the previous study that consumer culture has the great impact on Chinese youth’s identity. Nevertheless, the previous research does not mention about personal identity. Those authors, Kuoshu and Koetse do not seem to categorize identity in this story. They only refer to identity. So in my investigation, I deeply explore the two different kinds of identity and show both the good and negative sides of consumer culture that related to the characters especially the protagonist’s identity. In my opinion, consumer culture that offers social identity cannot give the female characters true happiness. What is more crucial for them is having personal identity because it can fulfill the hollowness in one’s mind. The physical attractiveness from owning the objects superficially gives them the fake happiness and self-worth. The real happiness and self-worth comes from the spiritual quest instead. Moreover, possessing materials cannot give women the true power because they need those materials to make them look beautiful so that they will be self-confident. On the contrary, material possession takes away their genuine self. They have to depend on the objects to feel secure.

Conclusions and Implications

It is undeniable that material possession in the consumer culture gives the female characters in this story the happiness with all the comfort and convenience they receive from the hedonistic lifestyle. Nevertheless, it cannot give them the complete sense of personal identity. It can only give them the sense of social identity: the sense of being recognized, accepted and belonging to the wealthy social class which does not seem to be the identity that these characters especially the protagonist are looking for. They all face the identity crisis and search for the way for their real happiness in life. Unfortunately, they are on the wrong path. The path they take do not take them to discover the true identity or the true pleasure. That is why they are lost. On the contrary, consumer culture, globalization and westernization reinforce the hollowness in their mind. Actually, personal identity is what they are looking for. They want something to fulfill their mind which the materials they own cannot serve their need. As a result, their lives are still full of crisis especially the heroine, Coco.

References


A Hierarchical Stimulus-Organism-Response Framework of Tourist Perceptions of Community as Brand and Its Implication for Business Model

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Abstract

This research treats community as a brand and adapts the stimulus-organism-response (SOR) concept in consumer behavior to suggest how communities can chart their marketing, marketing communications and brand strategies forward. Three layers of the SOR form the basis of the contribution. While the first layer describes how the CBT stimuli lead to the formation of tourist perceived value, which further induces tourists to engage in learning, the second layer involves how the stimuli, in particular the destination personality and tour guide roles, play in establishing the identity-fit linkage between the tourists and the CBT experiences. The third layer involves combining the previous two layers of brand efforts in impacting tourist satisfaction and influencing brand ambassadorship. The data were collected based on convenience-based sampling method, which involved tourists participated in the CBT to the communities located in Chiang Rai that offer coffee and tea-based agritourism and CBT experiences.

Keywords: Community-Based Tourism (CBT), brand, Stimulus-Organism-Response (SOR) theory, business model

Introduction

Community is a form of place filled with living heritages, cultures and unique livelihood means, and can be considered as a sum of the products, services and activities offered for generating memorable tourist experiences that offer multi-faceted tourist values. In order to transform community as a destination for tourism, known as community-based tourism (CBT), it would need creative and value-oriented strategies and investments to build community as a brand that tourists can form knowledge of the community’s differentiated characteristics and induce favorable positive words-of-mouth. Although there are available publications to help the academicians and practitioners understand how tourists form, store and make use of images and representations of destinations (Crompton, 1979) to understand their intentions for visiting and revisiting (Kock, Josiassen, and Assaf, 2016), there are still important knowledge gaps in the domain of CBT especially relating to brand efforts of the communities. Branding and marketing are significant value-added strategic tools, as shown in the smiling curve concept (Shih, 1992), which has direct contribution to customer retention (Herremans, Ryans, and Aggarwal, 2000). Community as a brand is a valid definition of brand, particularly a community possesses unique natural or designed characteristics that can potentially generate differentiation and memorable identity (Dibb, Simkin, Pride and Ferrell, 1997).

To contribute to fill parts of the academic and empirical gaps in the domain of CBT’s brand management, this research exploits a stimulus-organism-response (SOR) framework to establish a bridge between community’s branding strategies and tourists’ perceptions and attitudes. In view of psychology and by relating to brand domain, tourists form attitudes as a result of summative evaluation (Ajzen, 2001) of the stimuli (Aung & Tan, 2016; Tan, 2017) relating to the services rendered, activities provided and the resources and capabilities associated with the community as a brand, such as unique landscapes and sustainability differentiated cultivations. The stimuli could be in the form of visual, auditory, olfactory, gustatory and tactile experiences (Tan, Kantabutra, Nakeeree, & Pongsata, 2015) for the formation of the visitors’ perceptions, attitudes and belief systems (Tan & Kantabutra, 2015; Tan, 2016). According to Dubois, Cawley and Schitzm (2017, p.300), common activities in a rural community that stress on agritourism are often presented in the forms of green and natural experiences,
gastronomy, rural ways of life or heritage preservation. To be exact, the following research objective is formed:

The purpose of the research is to justify a conceptual base for adapting the hierarchical structure of stimulus-organism-response (SOR) model to study tourist perceptions and behaviors towards the community as a brand, which can also be used for implying in the design of business model for community-based tourism (CBT).

Literature review

As there are many types of activities and experiences offered by the different types of communities for tourism purposes, one way to sustain the community’s uniqueness and differentiation from the many others is by offering a systematic set of stimuli that can memorably influence the mental-psychological states of the visitors or tourists. By favorable psychological state or organism (Tan and Patthracolakorn, 2018), which is a result of stimulus, it indicates that the tourists have developed reasonable knowledge of the products and services offered by the community and the relationships with the community, and this is where fundamental root of strong community-as-brand is situated (Hoeffler & Keller, 2003).

Tourists can either actively or passively involved in a CBT context (Pine and Gilmore, 1998), through respectively, ecotour experiences (nature-oriented experiences in pristine natural environment (Eagles, 1992, p.3) and tour-guided interaction with the arranged activities, such as relating to how coffees and teas are cultivated, processed and value-added. In short, stimuli-organism-response (SOR) theory of tourist behavior is a suitable theoretical concept for addressing the research objective. As it is stated in Nooteboom (2009, p.43), “by interacting with the physical and social environment, the epistemological subject constructs mental entities that form the basis for virtual, internalized action and speech, which somehow form the basis for further action in the world.” The literature review is arranged in sequential order explaining stimuli, organism, and response, leading to integrating the hypotheses in a conceptual framework depicted in Figure 1. The literature review is guided by the following hypothetical direction:

1) Appropriate stimuli of CBT can positively influence the organism of tourists.
2) Organism is a significant predictor of tourists’ responses to CBT, representing the extent to which the tourists become the community advocacy and community ambassador.

Stimuli

The stimuli should be carefully designed in order to provide the tourists with “the sensory order” (Hayek, 1976) to form favorable cognition (customer value) and tourist learning. The stimuli are the touch points (Ditoiu & Caruntu, 2014), constitutive of CBT destination (represented by its quality), brand image, brand personality, and tour guide. If stimuli are appropriately leveraged, the tourists can form positive and favorable perceptions and attitudes towards the community, leading to positive arising of organism and response of tourists. This is how the SOR framework is considered appropriate to be used as a platform to develop and manage community as brand.

Brand Image

Brand image is defined as the conceptions or perceptions formed as a result of tourists exposing to a set of stimuli, or “the expression of all knowledge, impressions, prejudices and emotional thoughts” formed of a place (Sun, Chi and Xu, 2013, p.559). The different facets of stimuli lead to a set of associations linked in the tourists’ memory (Aaker, 1996). Through stimuli arrangement of the community in its community-based tourism (CBT) program, tourists would be able to integrate the various facets of exposures, through sensory experiences and cognitive “mental conception” (Crompton, 1979, p.19), in forming perceptions about the community as a brand that is held in tourist memory (Keller, 1993). In other words, tourists form brand image through brand associations that are enabled by the stimuli. Each stimulus can be reckoned as an informational node linked to the brand node in memory and contains the meaning of the brand for tourists (Hoeffler & Keller, 2003). As

84
illuminated in Morgan, Pritchard and Pride (2002), two elements go to form an overall brand image, namely “a physical (cognitive) dimension which relates to what is known about a destination such as location and activities and an emotional (affective) dimension which includes feelings towards the location” (cited in Dubois, Cawley, & Schmitz, 2017, p.299).

**Destination Brand personality**

Brand personality is even more important for a community as it is alive when compared to material objects. There is a difference between brand personality and brand image. While the former is primarily the result of the community’s communication that reflects the unique identity of the community, destination brand image is merely the tourist perception of what the brand offers (Plummer, 1985), which may relate to infrastructure, accessibility, services, nature of engagement, and information. Destination brand personality is operationalized to characterize certain trait dispositions such as competence, sacredness, vibrancy, femininity and excitement. Based on these metaphorical analogies, Aaker (1996, p.150) believe that the brand strategists can enrich the understanding of people’s perceptions of and attitude toward the brand, and thus, can contribute to differentiating brand identity and guiding the communication effort in creating brand equity.

**CBT Destination Quality**

Destination quality can be defined differently when the term is viewed in different contexts, expectations or performance requirements (Cong, 2016). For this research, CBT destination quality adapts the technical service quality (refers to as outcome that is unique, educational and valuable) and functional service quality in terms of time and activity assortments provided by the community as suggested in Grönroos (1984).

**Tour Guide**

Tour guide is represented by certain competencies and roles of the community members in serving the tourists, and the most significant ones are the communicative, social, instrumental, interactional and care roles (Tan, 2017). Communicative role indicates the extent to which the tour guides provides comprehensive details and interpretations of the CBT activities. Social role indicates the extent to which the tour guide creates the opportunities and initiatives for the conversation with the tourists. Instrumental role indicates the extent to which the tour guide exercises responsibilities to ensure the CBT experience is executed as scheduled and in intended manner. Care role indicates the extent to which the tour guide is attentive to tourists in terms of their dietary and psychological needs. In a typical CBT environment, tour guide is the only interactive stimulus that enables the tourists to learn and to form value perceptions of the experiences (Tan, 2017). As Weiler and Black (2016) discovered, tour guide plays a significant role in transforming tourists in the sense of tourists’ learning and value perceptions formation. The latter – value formation – is the cognitive and affective interpretations, or functional and enjoyable experiences of tourists (Holbrook & Hirschman, 1982).

In view of the above discussions, the following hypothesis is stated, which explains the role of stimuli in stimulating the tourists to process information as expected, and thus forms the perceptions that are in alignment with the positioning and differentiating strategies of the community (Souiden, Ladhari, & Chiadmi, 2017, p. 55).

H1: The stimuli will significantly influence tourists’ perceived values.

**Organism**

Organism is consisted of customer value, tourist satisfaction and tourist self-congruency, which can be reckoned at cognitive, affective and identity levels, respectively. Organism is a psychological outcome of tourist experience that is evoked by the stimuli and has the capability to establish positive memory (Tsai & Wang, 2017) and impact on repeat-loyalty (Tan, 2017).

**Tourist Self-Congruence**

Based on social learning theory (SLT) advocated in Tajfel and Turner (1986), it is hypothesized that tourists can create a meaningful connection between the community as a brand and themselves (Zenker, Braun, & Petersen, 2017) when they have identity-fit with the community in various domains,
such as relating to community’s environment, nature and tourism activities. In favorable identity-fit situation, tourists’ uncertainty perception towards the community is reduced and loyalty is established (Hogg, 2000). By defining tourist self-congruence as the identity-fit between the tourists’ personal disposition and the CBT destination personality, including the nature of tour guide involvement in the CBT context, the following hypothesis is assumed:

H2: Both community’s brand personality and tour guide are significant predictors of tourist self-congruence.

In addition, the similar finding is articulated in the self-congruency theory in that “consumers tend to select products or brands that correspond to their self-concept” (Usakli and Baloglu, 2011, p. 116), leading to the following two hypotheses raised:

H3: Tourist self-congruency is a significant predictor of CBT loyalty. CBT loyalty implies that the CBT would definitely be a major part occupying the tourists’ memorable experiences and tourism expenses in the future.

H4: Tourist self-congruency is a significant predictor of tourist satisfaction.

**Tourist Value**

Successful brand, according to de Chernatony (2006), involves a judicious balance between the functional and emotional values associated with the experiences. Values mean different things when viewed from different perspectives; for instance, customer value refers to the worth of a tourist experience for a trip expense (Zeithaml, 1988), or the benefits received (Bojanic, 1996), or a summative assessment of tourist experiences (Lee, Yoon, & Lee, 2007). Concept of customer value is borrowed in this research to study how tourists form the different aspects of value-oriented perceptions towards the CBT experiences. From the view of marketing paradigm, customer value is considered as an intangible asset, which influences attitude and willingness of consumers (Tasci, 2016). This value concept is extended to gain the knowledge of how tourists form perceptions and attitudes in the context of community as a brand.

In a broader view, customer value reflects a wide spectrum of socio-psychological and experiential benefits, represented, for instance, by hedonic value (Hirschman and Holbrook, 1982), emotional value, functional value and social value (Sweeney, Soutar, Whiteley & Johnson, 1996), and operations performance (Lapierre, 2000). Customer value formed has been shown in various empirical efforts to induce satisfaction (Parasuraman & Grewal, 2000). The value theme also highlights a RBV (Resource-based View) concept, which advocates that a community has a competitive advantage when it can leverage a value-creating strategy in CBT (Barney, 1991). The value-theme also reflects the value-adding capabilities of the community. Correspondingly, the following hypothesis is assumed:

H5: Tourist value is a significant predictor of tourist satisfaction.

**Response**

Response is constitutive of tourist learning, CBT loyalty and positive words-of-mouth (WOM). Suitable constructs in tourist behavioral studies, according to Riley (1995), include greater levels of intention to revisit the destination (representing CBT loyalty) and tourists engaging more in WOM (Word of Mouth) communication. Tourist learning is rarely discussed in the extant literature. Bandura’s (1977) social cognitive learning theory, which explains how “psychological functioning” arises in “a continuous reciprocal interaction of personal and environmental determinants,” is borrowed to operationalize the SOR concept. Sharing the social cognitive structure of tourist learning, Falk, Ballantyne, Packer and Benckendorff (2012) suggest that tourists learn when they interact with an educational environment that has novel features and attractions and can provide meaning and emotional worth to the tourists at personal level. In other words, worthwhile at the personal level can lead to tourists engage in learning. The following hypothesis is assumed for this purpose:
H6: Tourist value, constituting functional value, emotional value, educational value, experiential value and life-changing value, and stimuli, are significant predictors of tourist learning.

The value-driven learning highlights tourists learn in deliberating search for knowledge (of educational value) and practical wisdom (for life-changing value) and aim to pick up some of the competencies and skills exhibited in the agricultural practices of the communities (of functional and experiential values). These different facets of values are termed as the episteme (knowledge), techne (practical skills, functional), and phronesis (practical wisdom) domains of competencies in which tourists intend to learn through traveling (Falk et al, 2012). In view of the aforementioned empirical findings and theoretical supports, the following hypothesis is assumed:

H7: The stimuli, constituting of CBT destination quality, brand image and tour guide, will significantly contribute towards tourist learning.

In addition, when tourists perceive that they learn (a form of benefits realized), satisfaction arises, along with loyalty attitude and behavior, and positive words-of-mouth advantage, leading to the following hypotheses assumed:

H8: Tourist learning is a significant predictor of tourist satisfaction.
H9: Tourist learning is a significant predictor of CBT loyalty.
H10: Tourist learning is a significant predictor of positive words-of-mouth.

Lastly, the theory of planned behavior TPB (Ajzen, 2001) and norm activation model (NAM, Schwartz and Howard, 1981) are employed for suggesting the relationship between revisit intention as identified in CBT loyalty and positive words-of-mouth as behavioral response. Basically, both theories advocate on an intention-driven behavior, and satisfaction reflects the existence of perceived behavioral control in view of meeting the expectations of the trips (Sinsoponkit & Tan, 2018; Tungchaiwanna & Tan, 2018). Thus, the following hypotheses are assumed:

H11: CBT loyalty is a significant predictor of positive words-of-mouth.
H12: Tourist satisfaction is a significant predictor of positive words-of-mouth.
H13: Tourist satisfaction is a significant predictor of CBT loyalty.

The above-derived thirteen hypotheses can be grouped in the SOR theoretical framework shown in Figure 1, presented in hierarchical structure.
Figure 1 highlights that there are two levels, which the stimuli aim to influence, namely the business model and personal identity-association levels. The business model makes use of stimuli-induced tourists’ perceived values and their induced learning to benefit favorable responses. The personality identity-association level infers customer segmentation as reflective of self-congruency. The two levels are shown to significantly explain tourist satisfaction, which is an important organism that influences CBT loyalty and brand ambassadorship.

Methods

Although some scopes of interpretive methods such as focus group discussions, individual interviews and fieldtrip observations were employed, this paper predominantly presents the deductive and questionnaire-based outcome of the study. The data were collected based on convenience-based sampling method, which involved tourists participated in the CBT to the communities located in Chiang Rai that offer coffee and tea-based agritourism and CBT experiences, including enjoyment of nature, living heritages and cultures, gastronomy, homestays, and agricultural practices demonstrations. Only tourists staying over Doi Chang and Huai Nam Kuen villages are targeted. Doi Chang village currently has 1,224 households, with a population of 3,913, and is located 1,200-1,800 meters above sea level. The community members mainly belong to Akha, Lisu and Yunnan Chinese ethnic groups. Currently, there are eight homestays and two villages working on CBT. The area for coffee cultivation is about 5,000 rai, with income per person estimated at around 63,000 baht/person/year. Huai Nam Kuen village has a total of 151 households, located at approximately 1,178 meters above sea level, with Muang ethnicity. Currently, the village has 10 homestays to service the CBT initiative. The village prioritizes on tea cultivation, in Wiang Pa Pao district, spanned a total area of 10,269 rai. The tea species are Oolong about 42 rai, and Assam tea at around 10,254 rai. The income level is about the same as that of Doi Chang village, at 63,000 baht/person/year.

The questionnaire instrument was designed, pilot-tested and analyzed based on the scale construction guideline recommended by Hinkin, Tracey and Enz (1997). The questionnaire instrument delivers the construct validity which represents the correspondence between a construct (conceptual definition of a variable) and the operational procedure to measure the construct (Schwab, 2006, p.78-79). For model validation purpose, all the demographic variables were excluded from the statistical analysis. Due to limited opening to the tourists and lack of infrastructure, and with the community established in the goal of environmental sustainability and agricultural emphasis (i.e. cultivation and production) of the communities, there is a limitation in data collection. A total of 106 tourists participated, and to alleviate the sampling limitation, the theoretical construction is fully supported by the robust literature reviews and synthesis.

The following states the definitions and samples of the measurement operationalization.

Brand image is defined as tourist perception about the community as a brand, which is based upon the mental associations and perceptions held in tourist memory towards the stimuli. In other words, brand image represents “a simplification of a large number of associations and pieces of information connected with the place” (Kotler, Haider, & Rein, 1993, p.141), and thus is a product of the mind trying to “process, categorize, and essentialize huge amounts of data about the place” (Kock, Josiassen, & Assaf, 2016, p.32). The operationalization includes both cognitive and affective domains. The former contains the natural and man-made stimuli associated with the availability of information and accessibility to the community, pricing and crowdedness, nature attractions and empathy, sustainability image, cleanliness and security of the community. The latter addresses the extent to which the community is arousing, relaxing, exciting and entertaining.

For this research, CBT destination quality adapts the technical service quality (refers to as outcome that is unique, educational and valuable) and functional service quality in terms of time and activity assortments provided by the community as suggested in Grönroos (1984).

Community destination personality is operationalized by competence, sacredness, vibrancy, femininity and excitement (Aaker, 1996).

Tour guide is defined by the communicative, social, instrumental, interactional and care roles assumed and performed by the local community members (Tan, 2017). The operationalization contents are suggested in the literature review section.

Tourist self-congruence is defined as both the actual identity fit (“defined as how tourists see themselves” through the lens of community personality) and the ideal identity fit (“defined as how
tourists would like to see themselves” when visiting the community), by incorporating the identity-fit concept given in Sirgy, Grzeskowiak, and Su (2005).

Customer value defines the extent to which the tourists perceive the various domains of values, namely functional value, emotional or hedonic value, educational value or worth, experiential value, and life-changing value, as a summative but subjective assessment of the CBT experiences (Hirschman & Holbrook, 1982; Sweeney, Soutar, Whiteley, & Johnson, 1996). The value perceptions in the questionnaire reflect only the values-in-use aspects. Emotional value is associated with the hedonic motivation and is determined by the community’s ability to arouse certain feelings and affective states (Vigneron and Johnson, 1999). Functional value is closely related to the assortment of activities and services provided by the community. Educational value indicates the extent to which the tourists perceive the CBT experiences implanting a memorable experience of educational significance. Experiential value highlights the experiential nature of exposures. Life changing value indicates the capacity of the CBT to influence tourist attitudes towards society, career and life in general.

The value-driven learning highlights tourists learn in deliberating search for knowledge (of educational value) and practical wisdom (for life-changing value), while also learning to pick up some of the competencies and skills exhibited in the agricultural practices of the communities (of functional and experiential values).

While CBT loyalty represents that the CBT would definitely be a major part occupying the tourists’ tourism expenses in the future, and that the tourists would choose to travel to return to the community even if prices should increase somewhat, positive words-of-mouth (PWM) construct manifests that the tourists would say positive things about the CBT experiences and would also encourage friends and relatives to visit the community. CBT loyalty and positive words-of-mouth are the constructs that connotate the existence of brand value, which reflects performance of the brand and looks to the future, in comparison to profit and revenue that are past and present oriented (Wang & Tzeng, 2012).

**Results**

This section presents the results of the multivariate structural equation modelling (SEM) analysis. Prior to SEM analysis, the questionnaire instrument was validated on aspects of construct and content validities. The results were based on 106 tourists visited the communities to experience CBT during Feb 2017 to Feb 2018. The Kaiser-Meyer-Olkin provides the measure of sampling adequacy, over 0.6 as the suggested minimum, and the significance of the Barlett’s test of sphericity to support factor analysis. With the square root of the average extracted variance (AVE), displayed on the diagonal of the matrix shown to be larger than the cross-correlations coefficients of the variables as shown Table 1, discriminant validity is established (Fornell and Larckers, 1981). In addition, with reliability coefficient more than 0.70 and AVE more than 0.50 (Fornell & Larckers, 1981), it provides the foundation for convergent validity. Having the questionnaire instrument established in sound validity and reliability, statistical equation modelling (SEM) analysis can thus be meaningfully performed.
Source: 1=CBT destination quality. 2=Community Brand Image. 3=Tour Guide. 4=Competence. 5=Femininity. 6=Customer Value. 7=Tourist Learning. 8=Tourist Satisfaction. 9=Tourist Self-Congruency. 10=Positive Word-of-Mouth. 11=CBT Loyalty.

The Table 1 shows that brand personality (in terms of competence of the community and the femininity feature of the community) and CBT destination quality are two significant destination attributes the tourists have the most impressions to impact on their decision choices and post-consumption actions. While, in general, the tourists in the survey responded satisfactorily with the CBT experiences, there still possess weaker responses in positive word-of-mouth and tourist loyalty to the community-based tourism programs, partly could be owed to lower self-congruency with the community, the nature of customer (tourist) values and the extent of learning, and the overall services rendered by the tour guides, including the destination brand image, with scales below 4 of the five Likert scales (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree), as inferred by the SEM configuration given in Figure 2.

![Figure 2 The SEM (Structural Equation Model) in SOR Configuration](image)

Basically, the model-fitting structure of Figure 2 supports the hypothesized relationships between the constructs. The SEM confirms the original conceptual framework depicted in Figure 1, which integrates the 13 hypotheses stated. The satisfactoriness of the model fitting is evidenced in Table 2, which presents the structural parameters: Chi-Square at 29.276, df = 22, Chi-Square/df = 1.331, p insignificant at 0.137, NFI (Normed Fit Index) = 0.974, RFI (Relative Fit Index) = 0.934, IFI = 0.993, TLI (Tucker Lewis Index) = 0.983, CFI (Comparative Fit Index) = 0.993, and RMSEA (Root Mean Square Error of Approximation) = 0.056. The path analysis outcome supports the significant predictor roles of the stimuli consisting of CBT destination, brand image, tour guides, and brand personality (competence and femininity dispositions), in explaining 85% variance of customer value. Competence personality of the community indicates the extent to which the community demonstrates reliability and know-how of what it is good at, and thus also shows the optimistic spirit towards CBT development. Femininity personality of the community indicates the extent to which the place has the graceful touch of the nature and its poetical in the scenery sense.

Furthermore, as shown in Figure 2, as a result of the learning-facilitated roles of tour guides, such as interactional, communicative, and caring, together with the community-as-a-brand image in providing the situational stimuli background and contents for learning, tourists engage in active
learning, with 82% of its variance explained. As such, the business model-layer of the SOR model is supported, which justifies CBT stimuli-customer value-tourist learning-CBT loyalty-positive word-of-mouth structure of relationships. Having rooted in tourists forming value perceptions and engaged in activities and thus learning, satisfactions arise, with 59% of variance explanation. Besides, tour guides and destination personality are also shown to explain tourist self-congruency and thus induce CBT loyalty, at 66% of variance explanation. Loyalty is a state of intention that leads to positive words-of-mouth, together with tourist satisfaction and tourist learning, which has important implication in that tourists who have had participated in the CBT should be engaged continuously as they are the potential candidates for community-as-brand ambassadors.

The SEM path model also indicates the mediating role of customer value in leveraging the relationship between CBT destination and tourist learning. By following Baron and Kenny’s (1986) recommendation for determining mediation, it shows a direct path coefficient at 0.04 (insignificant) when compared to a mediating path with coefficient at 0.25X0.52=0.13, as shown in Figure 2. Thus, value perception is at the core of CBT branding management. Tourist satisfaction also exhibits partial mediation role in between tourist learning and positive words-of-mouth (with 0.21 in direct path, and 0.44X0.57=0.22 in mediating path). Similarly, CBT loyalty plays a partial mediating role in between tourist learning and positive words-of-mouth (0.21 in direct path versus 0.73X0.19=0.139 in mediating path).

### Table 2 The Structural Parameters of the Validated Model

<table>
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<tr>
<th>Model</th>
<th>NPAR</th>
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<th>DF</th>
<th>P</th>
<th>CMIN/DF</th>
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**Baseline Comparisons**

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<th>RFI Rho 1</th>
<th>IFI Delta 2</th>
<th>TLI Rho 2</th>
<th>CFI</th>
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<tr>
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<tr>
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<td>0.000</td>
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**RMSEA**

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<th>HI 90</th>
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<td>Independent Model</td>
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<td>0.450</td>
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</table>

**Discussion**

This paper is based on theoretical insights drawn from relevant socio-psychological theories being embraced in the SOR framework. The ability to establish linkage between the CBT offers and response as CBT ambassador grants the credibility to CBT activities and branding, and marketing efforts. Three layers of the SOR model become significantly important, as shown in the incremental and absolute fits of the structural equation model analysis. While the first layer describes how the CBT stimuli lead to the formation of customer value, which further induces tourists to engage in learning, the second layer involves how the stimuli, in particular the destination personality and tour guide roles, play in establishing the identity-fit linkage between the tourists and the CBT experiences, to further induce CBT loyalty. The third layer involves combining the previous two layers of brand efforts in impacting tourist satisfaction and positive words-of-mouth as brand ambassadorship. The combined tourist self-identification congruence and situational influences in the tourists’ psychological organism states also validate the social cognitive theory advocated in Bandura (1977).
There are various important mediating roles identified in the SEM path analysis. First, customer value played a perfect mediation role in leveraging the relationship between CBT destination quality and tourist learning, leading to a value-driven learning theme in the tourist behavior for CBT context. Thus, value perception is at the core of CBT branding effort. Value-driven tourist learning advocates that tourists put more efforts in learning (activity) that are motivated by the values (the expected returns) (Blau, 2004). Second, tourist learning exhibits a partial mediating role in leveraging the relationship between customer value perception and tourist satisfaction, with an indirect path coefficient at 0.22 versus 0.24 for the direct path. Third, CBT loyalty, represented by revisit intention, is an important partial mediator of the relationship between tourist learning and positive words-of-mouth. In other words, before tourists become channel of ambassadorship and communication, loyalty must be established.

Lastly, the “response” of the SOR has significant theoretical rooting in theory of planned behavior (TPB, Ajzen, 2001) and norm activation model (NAM, Schwartz and Howard, 1981). These theories are employed for suggesting the relationship between revisit intention as identified in CBT loyalty and positive words-of-mouth. The latter is a type of behavior. Basically, both theories advocate on behavior as a result of intention and also satisfaction as manifesting perceived behavioral control in view of meeting the expectations of the trips (Sinsoponkit & Tan, 2018; Tungchaiwanna & Tan, 2018).

Conclusions and Implications

The core assumption of this study is that community is treated as a brand. As such, a repertoire of brand-related literature can be borrowed in suggesting a hierarchical structure of stimulus-organism-response (SOR) framework to study brand-related behaviors and attitudes by the tourists and visitors to the communities in experiencing CBT. Based on rigorous multivariate statistical analysis that centralizes on the structural equation model (SEM) analysis, the thirteen hypotheses deductively proposed were supported in addressing the research objective. Significant percentage of variance can be explained in different parts of the SOR framework, with the minimum of 59% variance being explained for tourist satisfaction by customer value, tourist learning and tourist self-congruency. The SOR framework combines both the direct and indirect approaches to brand studies. It is direct by studying how tourists respond to the community-as-brand through revisit intentions and positive words-of-mouth, and it is indirect through tourists’ formation of organisms such as customer values, self-identification congruency and satisfaction.

The SOR model is a simple framework that forms a community’s brand management process emphasizing on the role of stimuli by leveraging both tangible and intangible assets and resources in order to establish favorable and positive brand attitude towards the CBT offers by the communities. With an emphasis on value, resources can tap on the concept of RBV (Barney, 1991) to leverage the effects of the available tangible asset of the community (i.e. the landscapes and sustainability image), as well as the intangible asset (destination brand image, destination quality, the value propositions), and community capabilities in order to deliver values uniquely different from the alternatives in the crowded tourism spaces. Most importantly, the value should also facilitate tourists in engaging active learning so that what is learned can be used as subjects of communication for positive experience sharing to other potential tourists.

There are many angles of implications. First of all, the SOR is a useful concept for business model design which centralizes on stimuli of resources and capabilities, in both tangible and intangible forms, of aesthetics and picturesque, of escapism nature, indigenous root, man-made and natural, to induce positive and favorable perceptions of values and attitude formation of tourists and visitors. According to the SOR theory, a right organism can lead to favorable behavioral responses of tourists and visitors that would benefit the community-based tourism and the communities visited. Most importantly, the stimuli should create the opportunities for tourists to engage in learning, and form various aspects of values, such as experiential, functional, emotional, educational and life-changing, so that affection and loyalty states can be established, leading to intended return and positive words-of-mouth. Learning provides the contents and subjects for impactful destination brand ambassadorship. In other words, the brand marketers would need to create tourist learning experiences that are memorable, and relatable in the sense of aligning with what they value the most (tourist values). These memorable and relatable experiences would eventually lead to tourists being converted to brand ambassadors.
On the segmentation aspect of business model, the valid role of tourist self-identification congruence implies a need to focus on a segment that shows favorable identity fit in the first place. Moreover, the values or benefits identified, and the significant role of community destination personality, and tourist learning as behavior, can be integrated as the bases for market segmentations (Li, Rahimi, & Stylos, 2017). Furthermore, the CBT business model should actively exploit learning theme in alignment with nature of values offered to visitors and tourists.

References


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A Balanced Scorecard Configuration of Business Model: A Case of Community-Based Tourism

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Abstract

No previous study in the discipline or topics relating to community-based tourism has shown a management-oriented approach through the lens of balanced scorecard (BSC). This paper contributes to this gap and considers the question: What is the relevant focus of each perspective in the BSC structure? Overall, the BSC has four perspectives considered, namely the growth-oriented perspective, the internal business process perspective, the customer perspective and the sustainability perspective. Structural equation modeling (SEM) fits provide the empirical supports for the BSC framework. The simplicity of the BSC structure provides a simple concept in guiding the communities to design and implement business model, which forms the theory of the business. This study deploys case research design based on questionnaire-based survey instrument. The case communities share similar ethnicity backgrounds and ecological resources and landscapes. Numerous aspects of implications are also discussed and presented in this article.

Keywords: Community-Based Tourism, balanced scorecard, sustainability, structural equation modeling.

Introduction

Community-based tourism (CBT) offers an alternative option for tourists and visitors to experience the lifestyle and the unique livelihood-oriented products and services, and agricultural activities offered by the communities, which otherwise would be difficult to experience in urban-bound tourism or city-bound tourism. CBT is attractive particularly for central and provincial government, learning institutions and private enterprises as these institutions have, at the core of their philosophies and policies, to offer innovative social responsibility and assistance to the needed, in fulfilling their social contracts and responsibilities. Thus, opportunities to offer the communities resourceful assistance could help them improve their qualities of life, and also help them maintain and better preserve the ecological diversity and environmental vitality that are also important to the downstream population. The academicians are also drawn towards the research efforts focusing on CBT.

Many significant findings that are widely shared across in the different parts of the world and livelihood contexts (i.e. different agricultural bases) are available in the extant literature; for instance, to succeed, CBT would assume co-operation between different stakeholder groups at the local level (Matilainen, Suutari, Lahesmaki, & Koski, 2018). Due to unique community locations, i.e. located in, for instance, fertile highlands, the communities can exploit the locality resources and their agricultural strengths to bring about positive socio-economic benefits or impacts (Tolkach & King, 2015).

Although a community participation approach has long been recognized and advocated as an integral part of sustainable CBT development (Okazaki, 2008), and many factors have been shown important to induce successes in CBT initiatives, the extant literature still lacks a coverage of practical management-oriented framework to help the communities learn and develop their competencies and devote their efforts in systematic manner. The author has come across this issue during some casual and formal interrogation sessions with many different stakeholders of the CBT-offered communities in northern Thailand, including Chiang Rai and Nan provinces. It is assumed that a simple but structural framework could eventually help the residents and relevant stakeholders systematically learn and improve their offers that are truly valued by tourists and visitors, while also provide a knowledge base for developing CBT that can generate positive sustainability impact. The learning attribute of a structural framework is important. For instance, in Pookaiyaudom (2013), the research indicates that an
integrated learning of CBT can lead the students to form a holistic understanding of community-based tourism at the principal level and from the angle of practice angle. To address these potential benefits and fill the gap of a management-oriented structural framework capable to help the communities managing their CBT initiatives and efforts systematically, in contributing positively to the sustainability-oriented goal, a balanced scorecard (BSC) concept is proposed. In other words, the purpose of the research objective is:

To develop a management framework convincing enough to guide the communities develop their CBT initiatives and efforts, by use of balanced scorecard (BSC) structure, and by convincing, structural equation model (SEM) fitness should be reasonably robust to provide evidential and convincing explanation to the community members and the relevant stakeholders.

More specifically, the following question is raised to address the research objective: What is the relevant focus of each perspective in the BSC structure?

**Literature Review**

In line with the requirement for a management-oriented structural framework by use of balanced scorecard (BSC) to guide the systematic development of the communities in CBT initiatives and efforts, the literature review would highlight the nature and the significant values of BSC, so as to lay the theoretical groundwork in addressing the research objective and the corresponding research question.

Although BSC is widely used as a performance measurement system (Rajesh, Pugazhendhi, Ganesh, Ducq, & Koh, 2012), its original role and intention has long been shifted towards a performance management system (Kaplan & Norton, 1996). BSC concept was awarded and recognized as “the best theoretical contribution in 1997” by the American Accounting Association (Norreklit, 2003). The core theme in BSC is the balanced perspective incorporation of strategically important commitment that, when arranged in cause-and-effect relationship structure, can provide a logic of competition. In short, the interlinked factors of commitment should form a strategy that helps the communities achieve their strategic objectives (Leung, 2015), such as sustainability. Four perspectives are considered in this research, namely the growth-oriented domain, the internal business process, customer perspective, and sustainability impact. The growth-oriented domain is used, which excludes the learning perspective, for simplicity, as the author reckons that the entire BSC structure is itself a learning mechanism and system (Tan, 2004).

The relevant growth-oriented factors are predominantly obtained from the first-hand interrogation of the author to the community, but are theoretically supported by further literature review. To grow collectively among the community members, towards insight generation and gaining the competency for problem-solving, it is important social attitude such as trust and community beliefs are considered (Arrow, 1972). As it is inferred from the theory of planned behavior (Ajzen, 1991), there are numerous growth-supportive antecedents important to cause the development of both the supply-side and demand-side activities (the internal business perspective). Besides considering the attitudes and beliefs that represent the collective synergy and intentional strengths of the community members, human capital development and appropriate resource management and resource availability are important factors that could infer the existence of perceived behavioral control of the community members. Human capital development is positively correlated to innovation, and both can help facilitate the adoption of technology and new ideas to improve both the supply-side and demand-side strategies (Danquah & Amankwah-Amoah, 2017), which can facilitate as the sources of organizational competitive advantage (de Pablos & Lytras, 2008).

Communities, who are responsible to make CBT successful, are also suggested to be service-oriented and innovation driven, so that they can bring out the authenticity and differentiation. Along this line of thought, Sanchez-Canizares and Castillo-Canelo (2014) reckon that innovation is needed because communities are often located in “small, out-of-the-way areas, far from large coastal towns” (p. 219), and thus, the ability to offer attractive products and services is important. The last factor considered for the growth-oriented management to contribute towards sustainability and tourist value attraction, through means of development in both the supply-side and demand-side activities, is the
resource exploitation and resource management, based on the assumptions that could be summarized by stating that communities are surrounded by sustainable ecological and socio-cultural resources, which should be systematically managed and organized for competitive advantages (Barrutia & Echebarria, 2015). In view of the aforementioned discussions, the following hypotheses are raised:

**H1**: The growth-oriented factors, constituting of attitude and beliefs toward CBT, human capital development, innovation, tourism resources and tourism resource management, can significantly predict tourism activities and product development (representing the supply-side activity).

**H2**: The growth-oriented factors, constituting of attitude and beliefs toward CBT, human capital development, innovation, tourism resources and tourism resource management, can significantly predict market demand identification and marketing strategy development (representing the demand-side activity).

Both H1 and H2 provide the causal linkages between the growth-oriented factors, which incorporate not only resource-advantage view, but also socio-psychological variables in terms of attitudes and belief. H1 and H2 configure the first two layers of the BSC structure.

To operationalize the customer perspective, the concept of customer value proposition (CVP), which bridges the supply-side and the demand-side activities of the business model, is advocated. Without a clear customer value proposition, the business model would lack the central theme and direction for value creation, value production and value delivery. The value propositions, together with the supply-side and the demand-side activities, constitute the so-called business model (Aung & Tan, 2016; Tan & Anomasiri, 2017), which depicts the theory of the business (Kannisto, 2017). In view of these understandings, two further hypotheses are assumed, namely:

**H3**: The growth-oriented factors, constituting of attitude and beliefs toward CBT, human capital development, innovation, tourism resources and tourism resource management, can significantly predict the values offered to tourists.

**H4**: Both the supply-side and the demand-side activities of CBT can significantly predict the values offered to tourists.

Hypotheses H3 and H4 interconnect the growth perspective and the internal business process perspective to the customer perspective, and form the structural shape of business model. When the business model is systematically developed, by taking a strong root as illustrated in hypotheses H1 to H4, business sustainability can be assumed to be established. As noted in Formentini and Taticchi (2016, p. 1921), “business sustainability is defined as the ability to conduct business with a long-term goal of maintaining the well-being of the economy, environment and society”, which is a broader management goal than the original financial performance goal advocated in Kaplan and Norton (1996). The sustainability focus in the BSC also connotes a socially responsible image to organizations (Ritala et al, 2018), which aims in designing and developing a sustainable business model. Sustainability is described by the socio-cultural, economics, and environmental impact of the business model and efforts made by the communities. At this juncture, a BSC oriented management framework is taken shape, filled by the last hypothesis H5 stated as follows.

**H5**: The business model of CBT, constituting of the values offered to tourists, and the supply-side and the demand-side activities, can significantly predict the sustainability impact.

The conceptual model is shown in Figure 1, which integrates the five stated hypotheses in the BSC framework.
Methods

In responding to the nature of the research question and the research objective, which investigate a contemporary phenomenon in which there is still a lack of clear knowledge structure presented in comprehending the dynamics of the CBT management, case study or case research method as advocated in Yin (1993) is suitable. The cases involve the highland communities who rely on either coffee or tea cultivations as the main sources of livelihoods. The case communities share some similar ethnicity backgrounds such as Aka tribes, Lahu and Lisu tribes, and ecological resources and landscapes. A valid eighty-seven set of questionnaires was collected from the community members, who are parts of the so-called Tribes ETC (Experience, Tea and Coffee) participated communities located in Chiang Rai, such as Mae Chan Tai village, Doi Chang, Huai Nam Guen village, and Ban Pha Mee village. Other Tribes ETC communities include Huai Ma Kliang village, Khiang Mae Loi village, Phayapai Litu village, Phayapao Mae Mhor village, Pang Khon village, Mae Mon village, Khun Lao village, Pang Ton Phung village, Ban Thai Smakki village, and Ban Huai Khrai village, which also offer similar insights in qualitative interrogation occasions. The data were collected in 2017-2018 period, during off-raining seasons and hot summers.

The operationalization of the questionnaires follows the definition of the given constructs within the CBT context, in order to ensure validity and reliability. Specifically, the instrumentation design guidelines follow, for instance, those recommended in Hinkin, Tracey and Enz (1997). Attitude and belief towards CBT delineate the nature of the attitude and beliefs of the community members, and are operationalized by items such as committing on CBT expansion program without diluting the identity of the community, and by accentuating on the community’s uniqueness and its livelihood, and lifestyle. Human capital development explains the extent to which the communities make efforts in developing leadership of the community members as a thrust for the CBT initiatives. Innovation measures the effort of innovation of the community towards CBT in terms of innovative services and reaching-out innovation. Tourism resources present the nature of ecological and man-made resources available to the communities, manifested, for instance, in terms of the lifestyle, abundance of fertile land, conservation measure, culture and heritages. Tourism resources management articulates the extent of efforts of the community in managing the various aspects of resources, and activities measured involve waste management, tourism carrying capacity, monitoring and continuous development, network leveraging of tribe members, and design of rules and regulations for appropriate resource management purposes. Tourism activities and product developments are the supply-side activities, which involve developing the experiential activities for the tourists, such as eco-trekking, agricultural practice learning, local culinary tasting, leisure and recreation, homestay experiences, stories and
interpretation of local attractions, enjoyment of natural landscapes, local lifestyle understanding, and exhibiting souvenir production. Market development identification and marketing strategies are the two market-side or demand-side activities which the community focuses, in the design and implementation of the business model, which focuses on the level of efforts in pricing, promotion strategies, and market development and fulfillment. The values offered to the tourists are operationalized by the degree of efforts made in the various domains or features of tourist values, such as functional value, educational value, cultural value, ecological value, which provides a bridging to brand studies in another article of the author. The sustainability impacts present the four facets of sustainability, namely (1) economic impact (i.e. family income increase, job creation, better earning, profit distribution), (2) cultural impact, which touches on cultural awareness increase of the community members, cultural maintenance, and new knowledge and valuable experiences gained as a result of open interactions with the visitors, (3) social impact, which focuses on infrastructure development, medical and educational improvement, and quality of life and sense of belonging of the community members, and (4) environmental sustainability, which includes measurement items such as systematic waste and water management benefits, and sense of love and care for the environment.

Results

This section presents the statistical analysis in justifying the discriminant and convergent validity, and reliability of the measurement instrument. While reliability, which measures dependability or consistency of the measurement in defining the construct, is acknowledged by the Cronbach Alpha presented in Table 1, overpassing the recommended threshold of 0.70 at the minimum, the construct validity is represented by the assessments of both the discriminant validity and convergent validity. As explained in Neuman (2006), convergent validity means that “multiple measures of the same construct hang together or operate in similar ways” (p. 194), and discriminant validity is the opposite, which means that “the indicators of one construct hang together or converge, but also are negatively associated with opposing constructs” (p. 194). With the square root of average variance extracted (AVE) shown exceeding the cross-correlation terms in Table 1, as highlighted by the diagonal value exceeding the off-diagonal in each column, then, as suggested in Fornell and Larker (1981), divergent validity is established. Furthermore, with each factor loading (not shown) of the measurement items exceeding the 0.70 threshold, and with AVE, over 0.5, and with reliability index beyond 0.70 threshold, the convergent validity is also established.

Table 1 Discriminant and Convergent Validity, and Reliability Assessments

| Latent Construct | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Cronbach Alpha | AVE |
|------------------|--|--|--|--|--|--|--|--|--|--|--|---|---|
| 1                | 0.853815 | | | | | | | | | | | |
| 2                | 0.354 | 0.81264 | | | | | | | | | | |
| 3                | 0.508 | 0.691 | 0.801249 | | | | | | | | | |
| 4                | 0.553 | 0.519 | 0.533 | 0.811788 | | | | | | | | |
| 5                | 0.519 | 0.364 | 0.505 | 0.899656 | 0.754 | | | | | | | |
| 6                | 0.402 | 0.612 | 0.657 | 0.471 | 0.325 | 0.842021 | | | | | | |
| 7                | 0.735 | 0.504 | 0.612 | 0.661 | 0.626 | 0.565 | 0.846759 | | | | | |
| 8                | 0.435 | 0.658 | 0.729 | 0.671 | 0.461 | 0.596 | 0.594 | 0.798749 | | | | |
| 9                | 0.514 | 0.552 | 0.603 | 0.649 | 0.333 | 0.377 | 0.567 | 0.669 | 0.87178 | | | |
| 10               | 0.758 | 0.575 | 0.763 | 0.675 | 0.593 | 0.611 | 0.754 | 0.761 | 0.719 | 0.871206 | 0.969 | 0.759 |

Discriminant Validity: OK OK OK OK OK OK OK OK OK OK

Note: All the correlations coefficient presented are significant at the 0.01 level (2-tailed), and the diagonal value represents the square root of AVE for the corresponding construct. 1 = Attitude and belief towards CBT. 2 = Human capital development. 3 = CBT management. 4 = Innovation. 5 = Tourism resources. 6 = Tourism resource management. 7 = Tourism activities and products. 8 = Market demand identification and marketing strategy development. 9 = Values to tourists. 10 = Sustainability impact.

Table 2 below is a creative combination of both the mean descriptive of the constructs and the ANOVA or t-test of important variables. Table 2 shows significant differences between the CBT head and non-head. Apparently, there is a perception gap, which highlights that the CBT heads, in general, perceive at a higher level than the non-head across the constructs studied and captured in the theoretical model. In addition, although coffee shops seem booming at an accelerated rate much higher than the
tea-based beverages in Chiang Rai, the communities who rely on tea as the main livelihood show better perceptions across the board when compared to the communities planted coffees in majority. The perceptual mean that crosses four scale (of the five Likert scale, with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) belongs to only two constructs, namely attitude and belief towards CBT, and tourism activities and product development, which highlights a more collective synergy among the members, and also shows relatively homogeneous, higher level of commitment in the production-side. In general, the communities lack the skills, competencies and knowledge in the demand-side and the sustainability domains of goals.

Table 2 Mean Descriptive and T- or ANOVA Test

<table>
<thead>
<tr>
<th>Latent Construct</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Tea</th>
<th>Coffee</th>
<th>Both</th>
<th>Levene Stat.</th>
<th>Sig.</th>
<th>F</th>
<th>Sig.</th>
<th>CBT Head (11.4%)</th>
<th>Not CBT Head (88.6%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.14</td>
<td>0.62</td>
<td>4.40</td>
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<td>4.24</td>
<td>1.494</td>
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<tr>
<td>2</td>
<td>3.44</td>
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<td>3.11</td>
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<td>1.085</td>
<td>0.36</td>
<td>5.976</td>
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<tr>
<td>3</td>
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<td>0.59</td>
<td>3.91</td>
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<td>0.337</td>
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<td>3.59</td>
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<td>3.90</td>
<td>3.60</td>
<td>3.62</td>
<td>2.47</td>
<td>0.06</td>
<td>2.909</td>
<td>0.039</td>
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<tr>
<td>5</td>
<td>3.77</td>
<td>0.52</td>
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<td>3.77</td>
<td>2.228</td>
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<td>3.62</td>
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<td>0.892</td>
<td>0.559</td>
<td>2.38</td>
<td>0.075</td>
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<tr>
<td>10</td>
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<td>3.72</td>
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<td>1.019</td>
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</tbody>
</table>

Note: 1 = Attitude and belief towards CBT. 2 = Human capital development. 3 = CBT management. 4 = Innovation. 5 = Tourism resources. 6 = Tourism resource management. 7 = Tourism activities and products. 8 = Market demand identification and marketing strategy development. 9 = Values to tourists. 10 = Sustainability impact.

The five hypotheses raised in the literature review section basically can be fundamentally confirmed by the structural equation models (SEM) shown in separate sustainability domains, namely Figure 2 for economic impact, Figure 3 for cultural impact, Figure 4 for social impact, and Figure 5 for environmental impact. There are minor additions of the direct relationship between attitude and belief towards CBT and the various facets of the sustainability achievements, signifying a significant value and role of collective socio-psychological variable.

Figure 2 Economics Impact
Figure 3 Cultural Impact

Figure 4 Social Impact
The SEM fit statistics are given below, respectively for SEM in Figures 2 to 5: (1) Chi-square/df = 1.446, NFI = 0.977, RFI = 0.897, IFI = 0.993, TLI = 0.966, CFI = 0.992, and RMSEA = 0.072 for economic impact, (2) Chi-square/df = 1.047, NFI = 0.982, RFI = 0.927, IFI = 0.999, TLI = 0.997, CFI = 0.999 and RMSEA = 0.023 for social impact, (3) Chi-square/df = 1.566, NFI = 0.972, RFI = 0.889, IFI = 0.990, TLI = 0.989, and RMSEA = 0.081 for cultural impact, and (4) Chi-square/df = 3.43, NFI = 0.945, RFI = 0.779, IFI = 0.960, TLI = 0.833, CFI = 0.958, and RMSEA = 0.167, for environmental impact. RMSEA represents the root mean square error of approximation, which indicates how well the SEM fits the population, not just a sample used for the estimation, and acceptable value should be below 0.10 (Hair et al, 2006, p. 748). A good fit is also shown in Chi-square / df (goodness of fit, GOF) in the range of 3:1 or less (Hair et al. 2006, p. 748). While RMSEA and GOF are measures of absolute fit, in quantifying the differences between the observed and the estimated covariance matrices (Hair et al. 2006), the incremental fit statistics are represented by NFI (Normed Fit Index), CFI (Comparative Fit Index), TLI (Tucker Lewis Index), and RFI (Relative Fit Index), which should exceed 0.90 threshold, or approach 1, for a good model fit.

**Discussion**

The structural equation modeling (SEM) configurations conclude good incremental and absolute model fits, highlighting that the values offered to tourists are a result of two types of activities typically understood in a business model concept (Aung & Tan, 2016; Tan & Anomasiri, 2017), namely the supply-side activities (tourism activities and product development) and the demand-side activities (market demand identification and marketing strategy development). Both human capital development and innovation are shown significantly able to impact positively on the degree of efforts made on tourist value proposition design and development. The tight interrelationship between innovation and customer value design is the central theme in the blue ocean strategy, in which Leavy (2005, p. 13) stated that “In Blue Ocean Strategy, value and innovation are inseparable. Value innovation places equal emphasis on value and innovation”. As to human capital, its role has the knowledge spillover effect, which is often regarded as the engine of sustained growth and development (Chang, Wang, & Liu, 2016), being realized through the contribution of human capital in the various aspects of CBT business model, whether in the tourism activities and products, values offered to tourists, or market demand identification and marketing strategy development.
The SEM also shows the significant linkages between the extent of efforts in tourism resources and their management, and in the developments of both the supply-side and demand-side aspects of the CBT business model. The role of resources is significantly important for communities who make use of the available natural, cultural and livelihood resources as potential sources of attractions and tourist organism stimulations. In Ryan (2010), it is noted that the multi-faceted resources, in combination, can provide the sources of stimuli in stimulating the formation of images, and could also help the tourists formulate the criteria by which they evaluate the success of otherwise of their stay (Chen, Chen, Lee, & Tsai, 2016).

The fact that a significant percentage of variance of the sustainability achievements, in the ranges between 0.58-0.73, can be explained by the business model elements of the BSC structure of CBT management, including growth-oriented factors of innovation and human capital development, is well aligned with the definition of CBT as follows: “CBT is a sustainable, community-owned and community-based tourism initiative that enhances conservation and in which the local community is fully involved throughout its development and management are the main beneficiaries through community development” (Manyara & Jones, 2007, p.637). Environmental or ecological responsibility (i.e. resource management) ensures that resources are maintained to the best productive levels possible that favor the production activities. In line with also the guidelines advocated in UNEP & UNWTO (2005, p. 11-12), “sustainable tourism should make optimal use of environmental resources that constitute a key element in tourism activities, maintaining essential ecological processes and helping to conserve natural heritage and biodiversity”.

Conclusions and Implications

The structural equation models, which indicate how growth-oriented factors provide the necessary competencies and motivational thrusts to help the communities develop and strategize their supply-side and demand-side aspects, and the tourist value propositions of the community-based tourism (CBT) business model, are framed by the conceptual concept of balanced scorecard (BSC). The aim of the BSC framework is to provide the community with a simple management structure to guide them in learning, growing, planning, designing, execution and organization of the strategically important areas, in order to succeed in the CBT initiatives and efforts, that eventually can lead to positive sustainability-oriented impacts. The successes of the BSC are partly owing to the organized valid structure that is demonstrated by the model-fit assessments through structural equation model (SEM), and the strategically important information visibility available to enhance managerial flexibility and decision-making capability, which shares the advocated concept stated in Morgan (2004). Overall, the BSC has four perspectives considered, namely the growth-oriented perspective, the internal business process perspective, the customer perspective and the sustainability perspective. The growth-oriented variables are theoretically derived from the literature, supported by first-hand interrogation of the author to the community, and are shown, through empirical data, their significant values in influencing the other elements of the BSC. The growth-oriented variables include innovation, attitude and belief towards CBT (a socio-psychological variable), human capital development, tourism resources and their management. The internal business process perspective is characterized by the supply-side and the demand-side activities of the business model. Values offered to tourists form the central commitment of the customer perspective. Sustainability perspective has four balanced commitment, namely economics, social benefit, cultural benefit and environmental impact.

The incorporation of the socio-cultural, economic and environmental aspects of sustainability provides the preventive and strategic measures to counteract the embodied weakness of sole reliance on economic monitoring of the communities. While learning is a part of the strategy in the learning and growth perspective in the BSC (Kaplan & Norton, 1996), the learning concept that this research attempts to advocate is actually embodied in the entire BSC structure. In other words, the causal learning and validation process by the communities on the causal structure linkages of the various strategically important focus should activate the continuous learning of the communities, being manifested by the continuous adjustments of strategies in aspects of growth, internal business process (the business model), value propositions and sustainability achievement. The growth-oriented perspectives show five important variables, namely the socio-psychological variable represented by the attitude and belief of the community members towards CBT, the resource advantage firm of strategy, in terms of resources and their management, and human capital development, which is an important factor in strengthening
the efficacious belief and confidence of the community members. Innovation effort is also an important driving force contributing to business model development of the community-based tourism.

Although attitude and belief towards CBT have the direct relationship with the sustainability goals, economically, culturally, socially, and environmentally, the structural equation modeling (SEM) fit assessments highlight the partial mediating role of tourism activities and products (the supply-side activities) and values offered to tourists in their leveraging.

The simplicity of the BSC structure provides a simple concept in guiding the communities to design and implement business model. The business model is a theory of the business (Kannisto, 2017), which is made up of three important components, namely the supply-side activities, the values offered, and the demand-side activities. While the supply-side activities focus on developing the tourism activities and the products offered, the demand-side activities focus on the value communication, value identification efforts and the marketing initiatives. The mean profiles of these constructs show that the communities are generally strong in the supply-side and have strong preference for synergistic attitudes, but they are weaker in domains of the demand-side activities, tourist value design, and growth-oriented commitment, and as a result, the level of achievement in the four areas of sustainability would be lower than the expectation. This research also shows that there are significant perceptual gaps of the constructs studied in between the CBT head and the non-heads, and thus, communication measures and other relevant strategies should be developed to close this gap, so as to further leverage the socio-psychological strengths and the overall BSC competencies.

References


Muslim Tourists’ Satisfactory Behaviors Influencing Halal Tourism in Song Khla Province

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Abstract

The main purpose of this article aimed to explore the Muslim tourists’ satisfactory behaviors influencing Halal tourism in Song Khla province. For research methodology, A five rating scale-based questionnaire, with its reliability of 95%, was conducted with 404 Muslim tourists used as an infinite population (Thanin Silcharu, 2014: 46-47). Based on the qualitative research methodology, the descriptive statistics drawn for this research paper included mean (X) and standard deviation (S.D.), and the descriptive analysis was also carried out for data analysis.

The findings of the study revealed that factors on Halal tourism satisfaction in Song Khla province based on the concept of tourism industry (5As) were detailed as follows.
1) In terms of their attraction, the Muslim tourists’ satisfactory behaviors with its mean of 3.86 were mostly found; 2) In terms of their accessibilities, the Muslim tourists’ satisfactory behaviors with its mean of 3.85 were mostly found; 3) In terms of their amenities, the Muslim tourists’ satisfactory behaviors with its mean of 3.72 were mostly found; 4) In terms of their accommodation, the Muslim tourists’ satisfactory behaviors with its mean of 3.67 were mostly found, and 5) In terms of their activities, the Muslim tourists’ satisfactory behaviors with its mean of 3.75 were mostly found.

The research findings showed that Halal tourism management with emphasis on the Islamic religious provisions influencing the Muslim tourists’ satisfactory behaviors on tourism industry with 5As was mostly found in terms of their Halal gastronomy service management, and followed by their management of Muslim religious practices. Therefore, the research findings on the development for effective tourism hospitality management leading to the values of required Halal tourism in Song Khla province could be implicated for other different governmental and private organizations, as well as tourism-related business entrepreneurs.

Keywords: Muslim tourists’ behaviors, satisfaction, Halal tourism attractions, accessibilities, amenities, accommodations, activities

Introduction

Tourism is nowadays a part of industries, which influences on Thailand’s national economic development; moreover, such a government in different countries has signified its tourism aspects reflecting on all the different groups of tourists’ requirements for tourist marketing expansion. Otherwise, missions on tourism directly leading to competitive advantages, sustainable tourism development, and tourists’ expected feedbacks have been all emerged with the entire dimensions of national development (Ministry of Tourism and Sports, 2015, p.3).

According to the 2016 annual tourism report and the 2017 expected tourism situation report in the 1st quarter polled by Tourism Marketing Research Center, it was stated that the profits of 1.65 billion Baht, in terms of Thailand’s tourism industry on oversea tourist marketing, have been resulted from the ratios of economic growth with 9 percent together with the numbers of 32.6 million oversea tourists.

In 2017, the incoming numbers of 35,381,210 oversea tourists visiting Thailand rose up with 8.77 percent, and the amount of national income of 1,824,042 million baht increased by 11.66 percent (Tourism and sports Economic Division, 2018). Furthermore, the numbers of 789,847 tourists from the Middle-East region rose up by 5.70 percent, and the amount of national income of 1,824,042 million baht increased by 11.66 percent (Ministry of Tourism and Sports, 2017).
From a statistics report on the increasing growth of Middle-East tourists, it was stated that the ratios of economic growth have dramatically increased. With references to the expectation of Crescent Rating cited in global Muslim travel index (2017), it showed that the amount of national income of 200 million US dollars affected by the increasing numbers of 168 million Muslim million tourists were mostly found in 2020. The four major reasons for tourists’ visit were mostly preferred in terms of visiting friends and relatives (VFR) with 75%, followed by Haji and Umrah (10%), business (10%), and other purposes (5%).

Most importantly, Thailand, which is one of the ten tourist destinations organized by the non-organization of the Islamic cooperation (OIC), has been mostly preferred for Muslim tourists’ travelling purposes. These includes 1) Singapore; 2) Thailand 3) United Kingdom; 4) South Africa; 5) Hong Kong; 6) Japan; 7) Taiwan; 8) France; 9) Spain, and 10) USA (Master card –crescent rating global Muslim travel index, 2016. However, the Muslim tourists’ effective tourism hospitality management must be well-organized based on the Islamic religious provisions, which are so-called “Halal Tourism”.

Subsequently, Halal tourism activities mainly focused on factors affecting Muslim tourists’ Islamic religious provisions, which included accommodations, foods, and drinks. Halal food services together with non-alcoholic drinks and no pork-made food menus, Islamic praying practices, men’s and women’s spa and swimming pool services, proper praying sites facilitated in rooms, and praying mat services should be all provided for Muslim tourists’ amenities (Sarawut Aree, 2017).

With references to the analysis of databases conducted by International Institute for Trade and Development (ITD), it was cited that the ratios of Muslim tourists increased rapidly in terms of its tourism marketing potentialities found in different Islamic countries. Particularly, in Southeast-Asia, there are approximately 600 million inhabitants living in 10 Islamic countries, and 300 million Muslim inhabitants. These included 203 million in Indonesia and 17 million in Malaysia.

In fact, Thailand’s advantages on friendly Muslim-based tourism management, according to the numbers of Muslim inhabitants mentioned above, can be all supported for tourism market shares because of supportive factors on easy-to-visit distances, length of three hour-spend transport services, and inexpensive prices. Also, the numbers of Indonesian and Malaysian tourists holding with their national Islamic religion were considered as an important market group of Thailand.

From tourism trends, Song Khla is one of the lower Southern provinces, which borders with Malaysia, and three major border checkpoints, which include (1) Sa Dao Border Checkpoint in Sa Dao District, (2) Padangbeza Border Checkpoint in Sa Dao district, and (3) Ban Prakob Border Checkpoint in Natawee district, are all served for Song Khla residents’ transport services and other different tourists’ business negotiation and travelling purposes. Not only were the total numbers of economic values of 521,308.58 million baht resulted from them, but these border checkpoints cited above were also facilitated for Malaysian tourists’ visit convenience (Department of Foreign Trade, 2018).

In 2017, the incoming numbers of 3,354,800 Malaysian tourists visiting Thailand along with the numbers of tourism values of 87,132.21 million baht were mostly found; otherwise, the most preferred tourist destinations in China were mostly found, and followed by Thailand, as the 2nd preferred tourist destination ranked in East-Asian countries, and Thailand was also the 1st tourist destination ranked in Southeast-Asian countries (Department of Tourism, 2018).

In the same year, the incoming numbers of tourists in Phuket province were ranked in the first tourist destination, meanwhile the incoming numbers of 6,675,178 tourists visiting Song Khla province ranked in the 2nd tourist destination. Also, the total numbers of tourism values of 54,337.5 million baht found in Song Khla province were respectively ranked from Phuket, Krabi, and Suratthani provinces (Office of National Statistics, 2017, 145).

According to databases on the numbers of tourists in Song Khla province, it showed that there were 5,000,000 Muslim tourists and 3,000,000 different tourists visiting Song Khla province, followed by 2,000,000 Malaysians, 55,000 Indonesians, 30,000 Singaporeans, and other different Muslim tourists from Brunei Darussalam, and Philippines so that the numbers of 50,000 – 60,000 thousand millions baht taken from tourists’ visit rose up more increasingly (Sonthirat Sonthichirawong, 2018).

In order to serve the Muslim tourists’ travelling requirements in Song khla province, as well as to promote the Muslim tourists’ trusts and expectation on their Halal tourism service in Song Khla province leading to economic growth with the vast amount of tourism values, however, the Muslim tourists’ tourism management with emphasis on Islamic religious provisions must be mostly needed for Halal tourism. Thus, the Muslim tourists’ satisfactions on their tourism services in Song Khla province
in integration with the concept of tourism industry, which encompassed (1) Attractions, (2) Accessibilities, (3) Amenities, (4) Accommodation, and (5) Activities, should be investigated (Kulwadee Lamaichin, 2008, p. 27).

In terms of analyzing geographical contexts found in Song Khla province, it was stated that Song Khla was one of the Southern provinces in Thailand, bordering with Malaysia. In addition, there were three main border checkpoints found in Song Khla province: 1) Padangbeza Custom House, Sa Dao district, Song Khla province bordering with Perriis State, Malaysia; 2) Sa Dao Custom House, Sa Dao district, Song Khla province bordering with Kedar State, Malaysia, and 3) Ban Prakob Custom House, Natawee district, Song Khla province bordering with Kedar State, Malaysia. So, all of these border checkpoints could be facilitated for Malaysian, Indonesian, and Singaporean tourists’ 1-2 hour-spent transport services. Not only were the various numbers of 2-3 hour-spent direct flight services such as Thai Air Asia, Tiger Airline, etc. provided for Muslim tourists’ visit from Malaysia, Indonesia, and Singapore, but Hat Yai International Airport’s good facilities were also offered for different international tourists’ easy-to-visit transport services. However, in order to upgrade their international economic cooperation in relations to the development of Halal tourism and tourism values, as well as to be linked with Muslim tourists’ well-prepared amenities and convenient transport services, the Indonesia- Malaysia-Thailand tourism route from Ajeh, Penang, Phuket, Hat Yai, Pattani, Yala to Narathiwas province was set up for the project for the 2017 – 2021 Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT) reported in the 22nd ministerial conference. Subsequently, Song Khla was considered one of the ten pioneering provinces dealing with Hala food services and management (Office of Tourism development, 2008). In 2011, name lists related to Halal workplaces in 19 provinces were officially certified by the Department of Tourism. As the 1st Halal workplace was mostly found in Krabi province, meanwhile nine major Halal workplaces found in Song Khla province, which was ranked from the 2nd Halal workplace out of the 19 provinces (Department of Tourism, Division of Tourism and Service Development, 2017). Therefore, the Muslim tourists’ final decisions on their tourist destination in Song Khla province directly affected its economic expansion in Song Khla province, as well as the numbers of Muslim inhabitants of 35.11 percent dwelling in 16 different districts were mostly found in Song Khla province (Song Khla Provincial Statistics Report, 2017, p.47).

Aforementioned, it was reflected that the Muslim tourists’ tourism market values have more increased dramatically so that the Muslim tourists’ different tourism behaviors on their Islamic tourism services, particularly in both their religious practices and Halal food consumption are all resulted in major important factors influencing the Muslim tourists’ growth. Thus, a study of the Muslim tourists’ satisfactory behaviors on their Halal tourism services in Song Khla province in integration with the concept of tourism industry with 5As --- attractions, accessibilities, amenities, accommodations, and activities should be explored. In order to be guidelines for developing and upgrading the service quality served for the Muslim tourists’ requirements on tourism hospitality services with emphasis on their no Islamic religious provisions, however, the other different governmental and private organizations’, and the tourism-related business entrepreneurs’ effective Halal tourism management should be implicated for their vast numbers of Halal tourism values, as well as their Muslim tourists’ final decisions on their tourist destination in Song Khla province.

Objective

To explore the Muslim tourists’ satisfactory behaviors influencing Halal tourism in Song Khla province

Expected Outcomes

In order to be a central hub for Halal tourism in Song Khla province, as well as to be beneficial for the implication and development of tourist amenities in Song Khla province based on the Islamic religious provisions e.g. religious place (Prayer) and halal food. The results of the tourists’ satisfactory behaviors on their Halal tourism services in Song Khla province were all scrutinized.

Methodology

Population and Samples

In the this study, the population and samples, with its reliability of 95% and its error (e) of ±5%, used in this study included 404 Muslim tourists as an infinite population visiting Song Khla
province. The analysis of randomized data was detailed as shown below (Thanin Silcharu, 2014, p.46-47).

\[ n = \frac{p(1-p)(Z)^2}{\epsilon^2} \]

When \( n \) = Sample’s size
\( p \) = Percentage randomized from the whole number of population
\( \epsilon \) = Percentage of errors randomized from the samples of 5% or 0.05.
\( Z \) = Reliability level of 96% set up with its mean of 1.96

**Instruments Used**

A five-rating scale-based questionnaire related to the tourists’ satisfactory behaviors influencing Halal tourism services in Song Khla province was conducted with Muslim tourists visiting Song Khla province (Puangrat Taweerat, 1997, 99).

**Levels of Satisfaction**

\[
\text{Width of Class Interval} = \frac{\text{Maximum data} - \text{Minimum data}}{\text{Number of Classes}} \\
= \frac{5.1}{5} \\
= 0.80
\]

**Interpretative Criteria Used for Mean Scale**

- 4.21 – 5.00 means very mostly satisfied
- 3.41 – 4.20 means mostly satisfied
- 2.61 – 3.40 means moderately satisfied
- 1.81 – 2.60 means rarely satisfied
- 1.00 – 1.80 means less satisfied

**Research Instruments’ Validity**

1) In analyzing its content validity, a questionnaire with its content analysis was created and were then submitted to the major advisor and co-advisors correcting the questionnaire’s accuracy, as well as editing its language use in this research.

In order to validate the research instruments used in this study, the Index of item-Objective Congruence (IOC), with its scoring scales for each question item, was carried out for data collection. Also, a selected question item with its score of more than 0.5, and an adapted question item with its score of less than 0.5 were both used for educational experts’ criteria for their selection of each question item (Pranee thongkham, 1996, p.232), as shown below.

\[ \text{IOC} = \frac{\sum R}{N} \]

When
\[ \sum R = \text{The sum of experts’ opinions} \]
\[ N = \text{The number of experts} \]
According to the validity of a questionnaire with its category rating scale, it showed that the content validity with its score of 0.6 in consistence with the objectives of the study could be analyzed for data collection.

2) In analyzing the reliability of research instruments, 30 questionnaires approved by the supervisors and educational experts were all tried out with the Muslim tourists visiting Song Khla province. Subsequently, the approved data were figured out for alpha-coefficient with its reliability level of 0.05, using the Cronbach’s method. In fact, the reliability level of 0.7 was accepted by the social sciences research. Therefore, a selected question item with its reliability level of 0.7, which was validated with the category rating scale, was figured out for the alpha coefficients (Poungrat Taweerat, 1997, 125-126), as shown below.

$$\alpha = \frac{n}{n-1} \left(1 - \frac{\sum s^2_i}{s^2_t}\right)$$

When $\alpha$ means Coefficients of reliability
$n$ means numbers of question items
$s^2_i$ means Variance scores of each question item
$s^2_t$ means All question items’ variance

According to validating the category rating scale-based questionnaire conducted with 30 Muslim tourists, it showed that the alpha coefficient with its reliability level of 0.98 could be testified for data collection.

Data Collection
The procedures for collecting the quantitative data were detailed as follows.
1) A meeting for the better understandings of data collection supported for the objectives of the study was provided;
2) A letter of permission on data collection issued by the Office of Graduate Studies, Mae Jo University was submitted to tour agencies, restaurants, tourist attractions;
3) The quantitative data conducted with research areas were all collected;
4) The collected quantitative data were finally analyzed, interpreted, and summarized.

Data Analysis
In analyzing the levels of the Muslim tourists’ satisfactions influencing Hala tourism in Song Khla province based on the quantitative research methodology, the data were statistically analyzed using Average($\bar{X}$), and Standard Deviation (S.D.), and were than presented with the descriptive technique.

Results of the Study
The data analysis was sorted into two major parts as follows.

Part 1: In terms of the analysis of the study, it showed that the numbers of male Muslim tourists with 75.25% and female Muslim tourist with 24.75% were mostly found. In addition, their averaged age of 22.97 was mostly found; moreover, their relaxation with 79 % were mostly preferred for travelling purposes. In terms of factors on the Muslim tourists’ final decision on their tourist destination in Song Khla province, it showed that factors on the tourists’ attractions and tour services were mostly found in 57.90%, meanwhile their factors on Halal facilities were mostly found in 36.60%. In terms of their tourist attractions, it also showed that sea-related tourism resources with 58.70% were mostly found whereas tourist attractions with Halal food services and Islamic praying sites were mostly found in 34.70%.

Part 2: In analyzing the results of the Muslim tourists’ satisfactions on their Hala tourism in Song Khla province, it showed that the concept of tourism industry (5As) was categorized into five major elements: 1) Attraction; 2) Accessibilities; 3) Amenities; 4) Accommodation, and 5) Activities.
Additionally, the Muslim tourists’ satisfactions set up with the width of class interval were detailed as shown below:

- 1.00-1.80 means very least satisfied
- 1.81-2.60 means less satisfied
- 2.31-3.40 means moderately satisfied
- 3.41-4.20 means mostly satisfied
- 4.21-5.00 means very mostly satisfied

Also, the results of the study were analyzed as shown in Figure 1.

Figure 1 Mean of Muslim Tourists’ Satisfactions on Their Tourism Industry (5As)

<table>
<thead>
<tr>
<th>Elements of tourism Industry (5As)</th>
<th>Criteria for Assessment (Question Items)</th>
<th>A average mean score of the Satisfactions</th>
<th>Standard Deviation (S.D.)</th>
<th>Interpretative Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attractions</td>
<td>8</td>
<td>3.86</td>
<td>0.77</td>
<td>Mostly satisfied</td>
</tr>
<tr>
<td>2. Accessibilities</td>
<td>4</td>
<td>3.85</td>
<td>0.87</td>
<td>Mostly satisfied</td>
</tr>
<tr>
<td>3. Amenities</td>
<td>21</td>
<td>3.72</td>
<td>0.88</td>
<td>Mostly satisfied</td>
</tr>
<tr>
<td>4. Accommodations</td>
<td>10</td>
<td>3.67</td>
<td>1.02</td>
<td>Mostly satisfied</td>
</tr>
<tr>
<td>5. Activities</td>
<td>9</td>
<td>3.75</td>
<td>0.88</td>
<td>Mostly satisfied</td>
</tr>
</tbody>
</table>

Discussion

The Muslim tourists’ satisfactions on their tourism industry with 5As were mostly found in terms of their attraction with 3.86 %, followed by their accessibilities with 3.85 %, their amenities with 3.72%, their accommodation with 3.67%, and their activities with 3.75 %.

The Muslim tourists’ satisfactions on their tourism industry with 5As in Song Khla province, according to the discussion of this study mentioned above, were mostly found in consistence with the concept on the service quality cited in Supannee Inkaew (2007, 28), she insisted that required and over-expected services directly led to the tourists’ more satisfactions.

Furthermore, the significant elements of service quality could be trusted on the Muslim tourists’ tourism services without the conflicts of Islamic religious provisions (Parasuraman, 1985 as cited in Orachan Sirichot, 2013, p.249).

According to the previous study of Muslim Tourism conducte by Lina Munirah Kumarudin and Hairul Nizamismail in 2016, it was also insisted that the Muslim tourism activities served for Islamic religious provisions included their praying ceremonies, as well as their consumption of Halal food and drinks; otherwise, their satisfactions on tourist attraction, amenities, and activities were mostly found.

Also, the results of analyzing the significant elements of 5As-based tourism industry in relations to their amenities were all involved with the following different researches as shown below.

1) With references to the study of Crescent Rating Company, it was insisted that the Muslim tourists’ travel was mostly signified with their amenities, particularly in both Halal food and praying sites in different tourist sites; additionally, the Muslim tourists’ satisfactions on their Halal tourism were mostly satisfied in terms of their amenities on Halal food with its mean of 3.88, and followed by their praying sites with its mean of 3.83.

2) With references to the study of Islamic Economic and Commercial Cooperation Board (cited in Casting Rating Company, 2016), the findings of the study showed that amenities based on Islamic religious provisions were mostly required for the Muslim tourists’ travelling purposes.

3) With references to the study of Halal tourism conducted by Mohd Naszari Ismail in 2015, he also indicated that different Halal tourism activities leading to the marketing success of Halal tourism could be all set up in terms of no religious conflicts.

4) The findings of the study, according to the study of Fazal Barhadeen conducted in 2014, revealed that in order to upgrade business values, the provision of amenities such as Halal food and praying sites, etc. should be facilitated for not only Muslim tourists’ trust, but also their Halal tourism services.

5) With references to the concept of service quality by Parasuraman (1985 cited in Orachan Sirichot, 2013, p.249) and Berry (1985 cited in Thatheethorn Theerakwan, 2003, p.106-107, as well as...
the concept of tourists’ buying decision (Suweenus Sophonsiri, 2011, p.72), and Moslow’s theory on motivation (Chalongsri Pimolsompong, 2007, p.37-39), it insisted that all the three major concepts cited above were all involved with the Muslim tourists’ behaviors on their revisit in Song Khla province. Also, the Muslim tourists’ satisfactions on their attractions, amenities, accommodations, and activities directly led to their pull factors on the Muslim tourists’ revisit.

6) With references to the Maslow’s motivation theory cited in Chalongsri Pimomsompong (2007, p.37-39), it was stated that motivational factors involved with one’s essential needs directly affected the Muslim tourists’ selection of their final tourist destination in Song Khla province. In fact, the Muslim tourists’ satisfactions on their tourism hospitality services in relations to their physiological needs were mostly found in terms of their Islamic religious practices, and Halal food services; otherwise, the Muslim tourists’ satisfactions on their tourism hospitality services with emphasis on the implementation of major elements of tourism industry with 5As leading to the Muslim tourists’ reflections on their essential needs were mostly found in accordance with the Maslow’s motivation theory as well.

Aforementioned above, in order to promote the Muslim tourists’ trusts on Halal tourism services in Song Khla province, as well as to differentiate the other tourists’ tourism services, these previous studies could reflect on different dimensions on Muslim tourists’ tourism hospitality management with emphasis on the Islamic religious provisions.

According to the study of Vokonic (1996 cited in Sarawut Aree, 2016), he also indicated that in order to offer the Muslim tourists’ convenient services, Muslim tourism together with the Muslim tourists’ various amenities should not be separated from their tourism demands because of other different tourists’ tourism hospitality services.

Overall, the Muslim tourists’ satisfactory behaviors on their Halal tourism services in Song Khla province were mostly found. This was because their Halal tourism services were all resulted in their expectation leading to their revisit in Song Khla province. Most importantly, tourism services in Song Khla province based on the Islamic religious provisions, especially for the services of Halal foods and praying sites could be supported for the tour agencies’ better understandings of effective tourism hospitality management in Song Khla province.

Conclusion and implications

According to the study of Muslim tourists’ satisfactory behaviors influencing Halal tourism in Song Khla province, it showed that attractions, amenities, accommodations, and activities were mostly required for the Muslim tourists’ Halal tourism services and tourism industry based on the Islamic religious provisions. The findings of the study revealed that Islamic religious provisions for the Muslim tourists’ Halal food consumption and Islamic religious practices during their visit were mostly signified for their Halal tourism management.

Furthermore, the Muslim tourists’ satisfactory behaviors on their Halal tourism management, according to the analysis of the research results, were mostly found so that the concept of tourism industry (5As) with emphasis on no conflicts of Islamic religious provisions could be reflected on the Muslim tourists’ requirements for their tourism services in Song Khla province. As a consequence, two major occurring outcomes including the management of Halal food and Islamic religious practice sites were both resulted from successes on Halal tourism hospitality services in Song Khla province so that these Islamic religious provisions must be signified for the Muslim tourists’ stricter religious practices.

However, this research results could be implicated for the other different governmental and private organizations’ and business entrepreneurs’ development and better improvements for the Muslim tourists’ tourism service quality in order to be served for the Muslim tourists’ trusts, as well as to upgrade Halal food tourism values in Song Khla province. In other words, this province’s border with Malaysia together with three major bordering checkpoints -- Sa Dao, Padangbeza, and Ban Prakob bordering checkpoints, in terms of geographical advantages, were mostly facilitated for different tourists coming from Malaysia, Singapore, and Indonesia to Song Khla province.

In fact, the analysis of marketing strategies served for targeted tourist groups in Song Khla province was mostly found in terms of significant weak points related to tourism marketing management with the target group of Muslim tourists; on the other hands, the Muslim tourists’ satisfactions towards their Halal tourism services in Song Khla province, which were mostly found in
terms of the potentialities of tourism industry with 5As, could be all served for the increasing numbers of Muslim tourists visiting on Song Khla province.

As the Muslim tourists’ final tourist destination, it was, overall, stated that the quality of Halal tourism management in relations to their Halal food services and additional sites for Islamic religious practices in Song Khla province, which directly led to the Muslim tourists’ revisit, was mostly served for the increasing numbers of Muslim tourists.

Recommendations

1. According to the research results, it showed that Halal tourism emerged with the Islamic religious provisions was based on their tourism hospitality management so that both Halal food and Islamic praying site services directly led to key success factors on effective Halal tourism management in Song Khla province. In order to be compiled with the Muslim tourists’ expectation on their revisit in Song Khla province, the two major Islamic religious provisions cited above should be mostly signified for Halal tourism leadership in Song Khla province.

2. In analyzing the strengths of Halal tourism in Song Khla province, it was stated that important factors influencing demands on Halal tourism in Song Khla province included push factors and pull factors. In terms of push factors, it was stated that attractions, accessibilities, and activities were all well-prepared for Halal tourism in Song Khla province, meanwhile both amenities and accommodations were mostly found in terms of pull factors. In order to be prepared for the Muslim tourists’ revisit, however, Halal tourism management with emphasis on the Islamic religious provisions could be facilitated in Song Khla province, and opportunities in the development of tourism business ventures based on the Islamic religious provisions should be all offered.

3. In analyzing the weaknesses of Halal tourism in Song Khla province in relations to the analysis of target group, it showed that the analysis of successful strategies should be implicated for their tourism market management. In order to find out proper guidelines for the development of Halal tourism in Song Khla province served for its contexts and environmental circumstances, as well as to be a central regional hub dealing with Halal tourism, however, researches on marketing management leading to the success of Halal tourism in Song Khla province should be further explored.

References


Comprehensive Evaluation index System for China’s Industrial Transformation and Medium-to-High Level Economic Growth in the Connectivity Blueprint

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Abstract

‘Connectivity’ is an important prerequisite and theoretical guidance for China’s industrial transformation and medium-to-high level economic growth. The features of times’ characteristics and the interactive development relationships between industrial transformation and economic growth are presented. Adopted by entropy method, the evaluation index system is made by five aspects, which are the basis of the target growth of the complex of industry and economy.

Keywords: connectivity, industrial transformation, medium-to-high level economic growth, evaluation index system

Introduction

‘The connectivity blueprint’ was the earliest agreement signed among APEC members committing agreed targets to strengthen physical, institutional, and people-to-people connectivity by 2025. In recent year, the notion of ‘connectivity’ has repeatedly emerged in international cooperation. A powerful guiding theory, deeply embedded into ‘the Belt and Road Initiative’ and ‘Internet Plus’ actions, ‘connectivity’, is an essential value for China’s industrial development to fulfill rationalization, advancement, and efficiency under the ‘new normal’, and also a strategic signal for the economy to achieve a qualitative leap and a historical transition. Running on the ‘high-speed road’ in the world for several years, China is now facing the obstacle of the reality of structural slowdown and risk of falling into the middle-income trap (MIT) (Dieppe, Gilhooly, Han, Korhonen, & Lodge, 2018). Shifting from a two-digit rate to a medium-to-high rate, China is compulsorily standing at a place where China needs to make a change in the economic growth, as well as in the change of industries’ transformation and upgrade (Yu, & Zhang, 2015). Thus, desirable changes in quality, efficiency and motivation need to be embarked upon. In the new era, the China solution characterized by ‘connectivity’ endows China’s industrial transformation and medium-to-high level economic growth with a brand new life, with the state from being disconnected to be connected. An evaluation index system patterned with Chinese characteristic is urging to come out (see figure 1).
Characteristics of the Times in the ‘Connectivity Blueprint’ in the Evaluation System

**APEC Connectivity Blueprint**

China's industrial transformation and medium-to-high level economic growth firstly are incorporating into the framework of *The APEC Connectivity Blueprint (2015-2025)*. In November 2014, the APEC organization reached an agreement on the contents of *The APEC Connectivity Blueprint (2015-2025)*, aiming to achieve a seamlessly and comprehensively connected and integrated Asia-Pacific in ten years (ASEAN Pacific Economic Cooperation [APEC], 2014). In fact, the meeting themes of the APEC coincide with development strategies such as supply-side structural reform, medium-to-high level economic growth, new impetus, and industrial integration. Specifically, the connectivity of concept, physical, institutional, and people-to-people, has been deepened into the transformation and development, which is not only the basic requirement for promoting industrial transformation, but also the pilot to boost the high quality development of economic growth.

**‘The belt and road Initiative’**

China's industrial transformation and medium-to-high level economic growth must demonstrate integration under the framework of ‘The belt and road Initiative’ proposed by President Xi Jinping’s as a power to strengthen and constitute a new economic model which could lead to an absolutely different maps of the trade and investment in the world (Chaisse, & Matsushita, 2018). ‘Connectivity’ is a starting point to implement for it. The objectives of five connectivities support the strategic layout which is a great opportunity to create more open space for the industries’ transformation. Further, it is also a milestone as it shifts from high-speed growth to a medium-to-high level. Thanks to the Asian Infrastructure Investment Bank (AIIB), either industry’s transformation or economic development is benefit from its sufficient financial support showing the resilience of the global financial regime created by the West (Gabusi, 2017).

**Times of ‘Internet Plus’**

China's industrial transformation and medium-to-high level economic growth must discuss in the age of ‘Internet Plus’ (The Internet Plus Action Plan, government work report, China’s State Council, 2015), a plan expected to push forward the Chinese economic restructuring and even the industrial upgrade.

In those three years, state of the art for ‘Internet Plus’ has extended into many fields and industries through online platforms, such as manufacturing, finance, commerce, transportation, healthcare and education. Even so, accelerating restructuring from industry and economy is necessary in the ‘Internet Plus’ era (Wang, Chen, Guo, Yu, & Zhou, 2016). The role of digital economy cannot neglect, because it will become a new kinetic energy for growth of China’s innovation, and profoundly affect the growth of Chinese companies (Ma, 2017). The internet development report blue book 2017 reveals that the total scale of Chinese digital economy in 2016 reached RMB 22 580 billion, accounting for 30.3% of GDP, and China was ranked second in the world (Li, & Cao, 2018). No denying that it serves as a strong
force for China's economy and industry, while injecting new vitality into transformation and upgrading. At such an important time, making the gene of the "Internet Plus" graft into the industrial system will decide whether China could get rid of risk of no process and move forward a brand new step in the history.

**Period of ‘new normal’**

China's industrial transformation and medium-to-high level economic growth must illuminate innovation in the period of ‘new normal’. ‘New normal’ is the process of evolution moving to a more advanced stage (Zhu, & Zhang, 2016). ‘The common logic in future is to adapt and lead the ‘new normal’ instead of changing with people’s determination’, noted by Chairman Xi Jinping (Swaine, 2015). Since the Fifth Plenary Session of the 18th CPC Central Committee has put forward the five concepts of ‘innovation, coordination, green, openness, and sharing’ for the first time, these words have become the theoretical orientation of the ‘Thirteenth Five-Year Plan’. Viewing supply-side structural reform as a main task, innovation is the most valuable part of economic development. On one hand, the advanced, efficiency, and rationalization required by industrial transformation must fully reflect the role of innovation. On the other hand, autonomous innovation and technological advancement are the vital sources of economic efficiency, quality, and power change.

**Eco-construction**

China's industrial transformation and medium-to-high level economic growth must demonstrate sustainability from the policy of eco-construction. The 18th CPC National Party formally included eco-construction in the *Five-Sphere Integrated Plan* of socialism with Chinese characteristics. The improvement of the ecological environment is equivalent to enhancement of productivity. Thence, upholding green, recycling, and low-carbon principles are the fundamental strategies for achieving sustainable development (Yan, 2014). In terms of economic development, accompanied by industrial transformation, the fact is that China must insist on green economy and green industry in response to an era call. Meanwhile, industrial transformation and medium-to-high level growth must be marked by low consumption, low pollution, high quality and high efficiency. Adhering to the principles of coordination among economy, society and ecology, China need make efforts to reduce the environmental cost and loss, and build a beautiful China based on the coordinated development of industry and economy in harmony.

**Relationships between Industrial Transformation and Medium-to-high Level Economic Growth**

In the context of ‘the connectivity blueprint’, structure adjustment and maintaining growth are two critical missions. First of all, it is a pivotal stage as China's economy has been transitioning from a phase

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1. The *Five-Sphere Integrated Plan* is a plan to promote coordinated economic, political, cultural, social and ecological advancement.
of rapid growth to a stage of high-quality development. From this perspective, during the ‘new normal’ period, the three objectives of maintaining medium-to-high level quality growth in China include better quality, higher efficiency, and more robust drivers. Actually, economic growth is also a process of change in the industrial structure. The transformation, upgrading, and optimization of the industrial structure are respectively reflected in the form of transition from low-efficiency to high-efficiency, from low-value-added to high-value-added, and evolution from low-level to high-level industrial structures. This just makes agreement on the goal of medium-to-high economic growth in efficiency, quality and power revolution. Structural dividends from industrial structural evolution and upgrading can promote economic growth (Peneder, 2003). The interactive development relationships between industrial transformation and medium-to-high level economic growth are discussed (see figure 2).

**China's industrial transformation is the main driving force for maintaining medium-to-high level economic growth**

In order to maintain a sustainable economic growth, the structure adjustment, industrial upgrading and value-added enhancement are considerable efforts because of contributing to the process of industrialization (Cheong, & Wu, 2014). For that reason, we must strenuously undergo industrial transformation with the target of efficiency, advancement, and rationalization. Firstly, in terms of efficiency, industrial transformation manifests a shift from low-efficiency to high-efficiency, with improvement of production and optimization of resource allocation at the center. Efficiency improvement is always the core development momentum of structural adjustment and efficiency revolution in scale, technology, allocation and management is the foothold of industrial transformation (Shen, & Teng, 2015). Next, in terms of advancement, industrial upgrading is the process of shifting from low value-added to high value-added. Knowledge innovation and technological progress have become the key factors to enhance the endogenous comparative advantage that drives the industrial upgrading (Su, Zhen, & Mou, 2017). Depending on these, the capacity of advanced innovation, as a sustainable momentum, is critical for maintain medium-to-high level economic growth. Finally, in terms of rationalization, industrial optimization is a state of optimization from low-coordinated to high-coordinated. In order to be harmonious and coordinating, China must balance the structural of industry, region, employment, and labor force based on the foundation of optimization of industrial structure (Wang, Yang, & Wei, 2016).

**Maintaining medium-to-high level economic growth is an important guarantee for achieving industrial transformation**

It is undeniable that the accumulation of the economy must reach a certain level in order to be able to concentrate resources into more advanced and higher-end industries. Over the past three decades, the vast accumulation of the total economy has been ready to get a qualitative leap. It suggests that maintaining medium-to-high level growth economy must fundamentally ensure the quality. Moreover, the 19th National Congress report formally came up with the goal of high-quality economy, built a modern economic system, and supports the optimization and upgrading of traditional industries (Fewsmith, 2018). Truly, economic growth must be real and water-free. First, economic restructuring plays central role in the transformation of industrial structure by providing quality assurance. That is, it is conducive to optimize structure of economic and industry simultaneously, and release the potential Kuznets effect continuously. Second, the feature of efficiency contributes to strengthen productivity of economic output. The development mode of economy is shifting from extensively speed growth to intensively efficient growth so as to benefit for industrial upgrade. Last, the cultivation of new economic drivers is the power guarantee for industrial transformation, which takes the positive effects on upgrading industrial chain and improving the economic system to such a great extent.

**Construction of the Evaluation Index System for China's industrial transformation and medium-to-high level economic growth**

Based on analysis above, the evaluation index system contributes to five aspects patterned with characteristics of the times, namely, the structure between industry and economic, the efficiency between industry and economic, the power between industry and economic, international openly cooperation, and ecological sustainably environment (see table 1).
**Table 1** Evaluation index system for China's industrial transformation and medium-to-high level economic growth

<table>
<thead>
<tr>
<th>Target layer</th>
<th>Principle layer</th>
<th>subject layer</th>
<th>Measure layer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>China's industrial transformation and medium-to-high economic growth</strong></td>
<td>the structure of industry</td>
<td>The structure deviation index X1(%)</td>
<td>The value of secondary industry/ GDP X12(%)</td>
</tr>
<tr>
<td></td>
<td>the structure between industry and economic</td>
<td>The value of tertiary industry/ GDP X13(%)</td>
<td>Internet industry development index X14(%)</td>
</tr>
<tr>
<td></td>
<td>the structure of economic</td>
<td>Fluctuation rate of economic growth X21(%)</td>
<td>Ratio of investment and consumption X22(%)</td>
</tr>
<tr>
<td></td>
<td>the efficiency of industry</td>
<td>Comparison coefficient between urban and rural areas X23(%)</td>
<td>Rate of inflation X24(%)</td>
</tr>
<tr>
<td></td>
<td>the efficiency between industry and economic</td>
<td>Unemployment rate X25(%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the efficiency of economic</td>
<td>Fluctuation rate of economic growth X21(%)</td>
<td>Ratio of investment and consumption X22(%)</td>
</tr>
<tr>
<td></td>
<td>Intellectual property rights</td>
<td>Comparison coefficient between urban and rural areas X23(%)</td>
<td>Rate of inflation X24(%)</td>
</tr>
<tr>
<td></td>
<td>Science and technology innovation</td>
<td>Unemployment rate X25(%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cultivation of talents</td>
<td>Fluctuation rate of economic growth X21(%)</td>
<td>Ratio of investment and consumption X22(%)</td>
</tr>
<tr>
<td></td>
<td>international openly cooperation</td>
<td>Contribution ratio of technological advance X43(%)</td>
<td>Resource allocation rate X44(%)</td>
</tr>
<tr>
<td></td>
<td>The level of cooperation</td>
<td>Digital Economy to the proportion of GDP X45(%)</td>
<td></td>
</tr>
<tr>
<td>ecological sustainably environment</td>
<td>Ecological protection</td>
<td>Expenditure on environmental protection and pollution control/ GDP X91(%)</td>
<td>Comprehensive treatment rate of industrial &quot;three wastes&quot;( industrial solid waste/industrial sewage/ emissions from industry) X93(%)</td>
</tr>
</tbody>
</table>

**Evaluation method**

The evaluation index system under the connectivity blueprint focuses on five dimensions, which synthetically indicate the status of industrial transformation and medium-to-high level economic growth. Be different from other methods, entropy method is an objective weighting method which could overcome the processing difficulties of vast quantity of information, and exclude the effect of human interference. The amount of information is larger, the uncertainty is smaller. Thus, applying entropy method could deals with quantitative processing providing evidence of rationality for outcomes.
The steps of measure
Evaluation method is a technical means which reflects scientific calculation and measurement results, including subjective and objective analysis. Taking account into the whole factors, this paper studies the evaluation index system for China’s industrial transformation and medium-to-high level economic growth. The main steps are below:

Step1: Establish the data matrix
The original data matrix of the object, including $a$ indicators, $b$ objects, and this data matrix are formed as

$$X = \{x_{ij} \} \ (1 \leq i \leq a, 1 \leq j \leq b) \quad (1.1)$$

We take (1.2) to represent the $j$ value of indicator belonged to the $i$ object.

$$x_{ij} \quad (1.2)$$

Step2: Forward the indicators
Next, we need forward the reverse indicators and moderate indicators in the evaluation indicator system for better explanation. The formula is (1.3) (1.4), respectively representing the forward value of the reverse and moderate indicator $j$. Besides, $x_0$ refers to the optimal moderation value.

$$y_{ij} = \frac{1}{x_{ij}} \quad (1.3)$$

$$y_{ij} = \frac{1}{|x_{ij} - x_0|} \quad (1.4)$$

Step3: Standardize the raw data
Then, in order to eliminate the incommensurability in data processing, we use (1.5) to standardize the data with dimensionless index and different units. $x_j$ denotes the weighted values, $\sigma$ refer to the standard deviation

$$x_{ij}^* = \frac{x_{ij} - \bar{x}_j}{\sigma_j} \ (i = 1, 2, \ldots, a \ j = 1, 2, \ldots b) \quad (1.5)$$

As it is possible to exist negative value of $x_{ij}^*$ normalized, we need to translate it. So, we get new value named $E_{ij}$ (1.6), and $m$ refers to the translation distance.

$$E_{ij} = x_{ij}^* + m = \frac{x_{ij} - \bar{x}_j}{\sigma} + m \quad (1.6)$$

Calculate the proportion $p_{ij}$ of measure $E_{ij}$:

$$p_{ij} = \frac{E_{ij}}{\sum_{i',j}^a E_{ij}} = \frac{x_{ij} - \bar{x}_j + m \times \sigma_j}{\sum (x_{ij} - \bar{x}_j + m \times \sigma_j)} \quad (1.7)$$

Due to the effect of $m$ value on $p_{ij}$, $m$ value should be close to $\min (x_{ij}^*)$ in order to retain information among original data and get significant evaluation results.

Step4: Calculate entropy value:

$$e_j = -\frac{1}{\ln a} \sum_{i,j}^a p_{ij} \ln (p_{ij}) \ (0 \leq e_j \leq 1) \quad (1.8)$$

If $x_{ij}$ is more concentrated, $e_j$ is larger in the case of certain $j$. When $x_{ij}$ is all equal, $e_j = e_{max} = 1$, indicator $x_j$ don’t have any effect on comparing among evaluated objects.

Step4: Weight coefficient assignment
Then, calculate the difference coefficient $g_j$ of the $j$ indicator (1.9), which represents importance
of the indicators in evaluation indicator system. The entropy \( e_j \) is smaller; the difference coefficient \( g_j \) is greater, the indicator is more important.

\[
g_j = 1 - e_j \quad (0 \leq g_j \leq 1)
\]

Based above, we need define the weight of the \( j \) indicator \( e_j \), and calculate the final weight coefficient \( f_j \)

\[
f_j = \frac{g_j}{\sum_{j=1}^{b} g_j} \quad (j = 1, 2, \ldots, b)
\]

Step 5: Calculate the comprehensive evaluation index

\[
y_i = \sum_{j=1}^{b} f_j \cdot x_{ij}
\]

Therefore, we get a series of values to reflect the reform process and development depth of relationship between China's industrial transformation and medium-to-high level economic growth.

Research summary

The evaluation index system for China’s industrial transformation and maintaining medium-to-high level economic growth seems significantly prominent under the connectivity blueprint. By grasping the times’ overall characteristics of ‘connectivity’, the features of era we found are mainly manifested in five aspects. Further, we propose that there is an interactive development relationship between China’s industrial transformation and maintaining medium-to-high level economic growth in the evaluation index system. Finally, it is expected that this paper will provide theoretical guidance and operational evaluation tool for China's economic development.

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