19th Science Council of Asia Conference(2019), Special Issue 2020

Journal of the
Myanmar Academy of Arts and Science
ISSN 2520-0186, LCCN 2003-323143

Special Issue
2020

Science Council of Asia

19th Science Council of Asia Conference
3-5 December, 2019, Nay Pyi Taw

RESEARCH AND INNOVATION FOR SUSTAINABLE DEVELOPMENT IN ASIA

SUB-THEME IV
Alleviate Poverty through Socio-economic Development

Journal of the
Myanmar Academy of Arts and Science
ISSN 2520-0186, LCCN 2003-323143

Special Issue
2020

19th Science Council of Asia Conference

3-5 December, 2019, Nay Pyi Taw

SUB-THEME IV

Alleviate Poverty through Socio-economic Development

Journal of the
Myanmar Academy of Arts and Science **Special Issue**
ISSN 2520-0186 **2020**

Edition

2020, 400 Copies

Published by

Dr Aung Min (00322) Chairman, Journal Publication Committee,
Myanmar Academy of Arts and Science

ISSN 2520-0186
ICCN 2003-323143

Printed by

U Win Aung (00171), Manager
Universities Press, Yangon, Myanmar

FOREWORD

We would like to thank His Excellency Dr. Myo Thein Gyi, Hon'ble Union Minister for Education, for delivering the inaugural address at the Opening Ceremony of the 19th Science Council of Asia Conference, and for the support His Excellency had given for holding this international conference, for the first time, in Myanmar. We are also indebted to express our heartfelt gratitude to His Excellency Dr Wang Xi, Vice Minister, Ministry of Science and Technology of China, President, Science Council of Asia, and Vice President, China Association for Science and Technology (CAST) for his presence at this opening ceremony. We would also like to extend our gratitude to Professor Dr Hiroshi YOSHINO, the Secretary General/Treasurer of SCA. Special thanks would go to Dr Juichi Yamagiwa, the President of SCJ and to all distinguished guests and scholars from SCA member academies who, in one way or the other, contributed to the success of this conference.

MAAS owes its apology to all participants for the delay in producing the papers presented at SCA–19 Conference. The responsibility of opinions, statements, comments, etc. expressed in the papers lie with those of the authors. The views expressed in the papers presented at the conference did not reflect that of MAAS.

Dr Thet Lwin

President, Myanmar Academy of Arts and Science

Contents

Lists of Contributors

Message

It is a great pleasure and inspiring experience to host the 19th Science Council of Asia Conference, held with the theme "Research and Innovation for Sustainable Development in Asia" in Nay Pyi Taw, Myanmar.

This conference is particularly timely as all Member States are unanimously supporting research and innovation to achieve the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda.

A comprehensive range of the conference sessions reflects a very topical agenda as it provides a wonderful platform and opportunity for several experts, academia, scholars and researchers to exchange their break–through ideas, profound knowledge and invaluable experiences.

I sincerely hope this conference will help to identify ways to bring forward the transformative sustainability agenda and better align research and innovation policies with the SDGs, as set out in the United Nations Agenda 2030 for sustainable development.

To all delegates, I would like to suggest that we adopt innovation in science, technology, engineering and mathematics as integral elements of the strategies for SDGs. I would like to request you to produce action–oriented outcomes of the conference and keep supporting research and innovation for sustainable development in Asia.

Before I conclude, I wish all delegates and participants an enjoyable stay in Myanmar.

Thank you.

Dr Myo Thein Gyi
Union Minister for Education, Myanmar

Message

It is my great pleasure to welcome you all on behalf of Science Council of Asia(SCA) to the 19th SCA conference that brings together experts of scientific organizations to discuss " Research and Innovation for Sustainable Development in Asia". I thank all the local conference hosts in Myanmar and the SCA Secretariat. Thanks to their excellent effort, the SCA19 is organized jointly and successfully.

To a large extent, Asia's rapid economic development and subsequently booming consumption have prompted critical challenge for environment sustainability. Recently, Oxford Dictionaries and Cambridge Dictionary have named "climate emergency" and "upcycling" as their Word of the Year 2019, respectively. Change is necessary.

The 2030 Agenda, adopted at the United Nations Sustainable Development Summit in September 2015, positioned Science, Technology and Innovation as key means of implementation of the SDGs. Also with a new perspective of economic growth, there is a clear shift towards appreciating the adoption of sustainability standards, which has a positive correlation with increased profit as demand for products with sustainable credentials grows.

Many Asian countries have signed up to the SDGs, made growing commitment to address poverty, clean energy and pollution. New science and technology achievements have been applied to solve specific issues, new approaches have been used towards more sustainable activities.

SCA provides such a collaborative platform for member organizations to promote scientific exchange and cooperation, and to reach mutual understanding. We will continue to play a central role to face the common challenges for sustainable development in Asia and lead to a bright future.

Wishing you all a fruitful and joyful stay in Nay Pyi Taw and looking forward to your active participation in the Conference.

With best regards,

Prof. Dr. WANG Xi
President, Science Council of Asia

Message

Millennium Development Goals (MDGs) came to an end in December 2015; certain agenda of MDGs had been left unfinished. In 2015, UN General Assembly adopted the post 2015 Development Agenda and set Sustainable Development Goals (SDGs). The 2030 Global Development Agenda came into effect on 1st January, 2016 with the prospect of covering the five aspects: People, Planet, Prosperity, Peace and Prosperity. The approach to SDGs can be initiated through a different angle. For instance, People: End Poverty and Hunger in all forms and ensure dignity and equality; Planet: Protect our planet's natural resources and climate for future generations; Peace: Foster peaceful, just and inclusive societies; Prosperity: Ensure prosperous and fulfilling lives in harmony with nature.

Living beings inherited the earth, the only planet in the solar system, in which all known life forms can flourish. Human beings are the most intelligent species on earth. Throughout history, they try to change their environment to suit their needs and satisfy their desires. Among the continents, Asia happens to be the most populous region in the world. China and India, each with one billion plus population, have emerged as economic powers. Japan, Korea, Taiwan, and ASEAN TEN too witnessed economic growth. Inventions and innovations contributed to industrial revolutions. The fourth forthcoming inventions of IT and AI are expected to change traditional modes of manufacturing, transportation and urban amenities.

In 21st century, research across various countries in Asia highlight inter-linkages between natural resources and sustainable development goals along with the impact of climate change. The human society is seeking ways to safeguard human's wellbeing and to guarantee the sustainable use of resources. At the same time, it also tries to conserve the environment from natural calamities like floods, earthquakes, volcanic eruptions, drought, etc. so that our future generations will be inherited with green and peaceful environment.

I, on behalf of Myanmar Academy of Arts and Science, would like to express my deep appreciation to all those involved in making the conference a success. Special mention needs to be made to SCJ which co-hosted the SCA19 conference with MAAS for their guidance, support, co-operation and coordination. We fervently believe that the conference will provide our guests a cordial atmosphere for sharing experiences and exchanging views. The deliberations from this conference are expected to bring into light, effective means and ways for resolving common issues people are currently facing in Asia and elsewhere.

Dr. Thet Lwin
President of MAAS

Message

I am pleased to announce that the 19th Science Council of Asia (SCA) Conference is held in Nay Pyi Taw, Myanmar. First of all, I would like to express my sincere gratitude to Myanmar Academy of Arts and Science (MAAS) for its enormous efforts to prepare for this Conference. I also would like to express my deep appreciation to Member Organizations and SCA Secretariat for their cooperation and contribution in organizing this Conference and all the people who support it.

The theme of the 19th SCA Conference is "Research and Innovation for Sustainable Development in Asia". As you might already know, the purpose of SCA established in 2000 is "to facilitate scientific cooperation in Asia towards the progress in science and sustainable development of the region". With this purpose, SCA has contributed to society through the collaboration with academies in the region. Under such circumstances, "Transforming our world: the 2030 Agenda for Sustainable Development" with the 17 Sustainable Development Goals (SDGs) and 169 targets was adopted at the UN General Assembly in 2015. Since then, the efforts to realize the sustainable development in which a key principle is "no one will be left behind" have started at global level. We must continuously and collaboratively address a wide range of issues facing us since they are so challenging in the sense that human beings have never experienced them before.

The 19th SCA Conference is held for 3 days and nearly 180 presentations (oral and poster) are scheduled. I am delighted to know that we have received many applications exceeding our expectation. It indicates a high level of interest in this Conference's theme, "Research and Innovation for Sustainable Development in Asia". In the Conference, there are four (4) sub–themes that are discussed in their respective sessions. The main theme and sub–themes of the Conference have been carefully selected in order to inspire scholars and researchers in Asia to undertake interdisciplinary researches in partnership to contribute to the realization of the 17 SDGs.

This Conference is an advantageous opportunity to build a network of scholars in and outside the country. I am sure that there would be abundant outstanding discussions at this Conference.

Professor Hiroshi Yoshino

Secretary General / Treasure of SCA

Co-creation of Sustainable Regional Innovation for Reducing Risk of High-impact Environmental Pollution

Masayuki Sakakibara[1] et al

Abstract

Mercury (Hg) is a toxic metal that seriously threatens the embryonic and early-childhood development of humans, and extremely poisonous to the human body. Mercury pollution is one of the most serious environmental issues and requires global action for its resolution. One of the main causes of Hg pollution is an artisanal and small-scale gold mining (ASGM). Those ASGM activities are also the sources of social problems. The objectives of the research project is 1) to understand the link between poverty reduction and environmental management in ASGM areas, 2) to establish a process for constructing sustainable societies through regional innovations in ASGM areas, and 3) to strengthen environmental governance in ASEAN countries. In the project, we conduct within the context of all ASEAN countries: a) Case studies on reduction of Hg pollution using a future scenario of ASGM in Indonesia and Myanmar, b) Study on interregional networks that aim to generate Hg-free societies in Indonesia and Myanmar, c) Study on improvements in environmental governance in ASEAN countries, and d) Theoretical and practical studies of the design, practical use, and evaluation of TBO (Transformative Boundary Object), and cultivation, development process, and roles of TDCOP (Transdisciplinary Community of Practice).

Keywords: mercury, artisanal and small-scale gold mining, environmental pollution, regional innovation, transformative boundary object (TBO), transdisciplinary community of practice (TDCOP)

1. Introduction

Mercury pollution by ASGM

Mercury (Hg) is a toxic metal that seriously threatens the embryonic and early-childhood development of humans and is extremely poisonous to the human body. All forms of Hg, from elemental to inorganic and organic Hg, exert toxic effects on our nervous, digestive, and immune systems, skin, and internal organs. Mercury pollution is one of the most serious environmental issues and requires global action for its resolution [1].

One of the main causes of Hg pollution is ASGM, in which Hg is used as the traditional method of amalgamation to extract gold from the ore rock. This method is quicker, simpler, and more cost effective than alternative methods and widely used in many ASGM communities [1] [2]. According to data from the United Nations Environment Programme (UNEP), ASGM produces 20% of the gold produced throughout the world. Almost 15 million people, including about 3 million women and children, participate in ASGM activities in more than 70 countries. ASGM is the largest source (37%) of global anthropogenic of Hg emission into the atmosphere. The Hg pollution generated during ASGM indirectly affects more than 100 million people worldwide [3][4]. The extremely serious effects of Hg exposure are compounded by the

[1] Research Institute for Humanity and Nature, Kyoto 603-8047, Japan
*Corresponding Author: Masayuki Sakakibara, sakaki@chikyu.ac.jp, phone numbers: +81-75-707-2333, fax numbers: +81-75-707-2509
2. Katsuya Tanaka, 3. Hiroki Kasamatsu, 4. Motoko Shimagami, 5.Satoru Komatsu

widespread poverty and general lack of access to public health services and health awareness programmes in many ASGM areas around the world [5]. This activity is also a source of social problems, such as land tenure issues, migration and other forms of social instability, and conflict between residents.

Although there is increasing global concern about the Hg pollution generated by ASGM, the amount of Hg used worldwide is growing each year, with a particularly rapid increase in that used in ASGM in developing countries. The rapid increase in the gold price since 2000 has fostered a gold rush among poverty-driven residents in many developing countries. The environmental destruction that results from development intensifies the poverty problem, and those living in poverty become trapped in a cycle of poverty and environmental degradation, from which it is extremely difficult to escape [6].

Recent investigations by UNEP have highlighted the enormity of Hg pollution in developing countries and the associated harmful effects on human health and ecosystems. The Minamata Convention on Mercury is a global treaty established to protect human health and the environment from the adverse effects of Hg. The Convention addresses ASGM and the development of national plans to manage ASGM. These plans include the development of public health strategies to address the problems associated with the exposure of miners and their communities to Hg pollution. It offers an opportunity for the world to address this problem before it worsens. The implementation of international agreement on the Convention is expected to reduce the Hg pollution arising from ASGM activities over the next few decades.

Transdisciplinary approach to solving environmental problems

A transdisciplinary approach is essential if scientists need to contribute to the social innovation and transformation required to achieve global sustainability. This can be quite a useful method for creating theoretical, methodological, and practical innovations to solve complex environmental problems in society. Scientists recognize that by using this kind of approach, they can communicate with stakeholders (SHs) to bring about the transformation of society [7].

Drawing on learning theory and transdisciplinary practice, Cundill et al. (2015) [8] introduced the concept of “transdisciplinary communities of practice” (TDCOPs). TDCOPs can enhance our understanding of how communities of practice ([9]; COPs) function and how they might be nurtured. Greater attention to the social processes that underpin collaborative research efforts, in general, will be required in the years to come if the goals of transdisciplinary sustainability research are to be achieved. Cundill took a broader view and highlighted the practical lessons that can be learnt from COP theory on how TDCOPs can be nurtured. In this research project, it is appropriate that TDCOPs are groups that cross interdisciplinary boundaries, with shared knowledge and a commitment to solving complex social–ecological problems.

Goal and objectives of the research

The purpose of this research project is to understand the link between the reduction of poverty and environmental management, and to establish a process with which to construct sustainable societies through regional innovations in ASGM areas and to strengthen the environmental governance in developing countries. These innovations will arise as a consequence of the environmental and industrial innovations introduced with a transdisciplinary approach, including the creation of future scenario for an Hg-free society, the co-creation and practical application of TBOs, and the mobilization of TDCOPs. Furthermore, by strengthening

environmental governance, which consists of multiple layers of co-operative organizations, we will establish a route that leads to the solution of global Hg problem. In the research project, we will conduct: a) case studies of reductions in Hg pollution using a future scenario of ASGM; b) a study of regional networks that are working to generate Hg-free societies in Indonesia and Myanmar; c) a study of the improvement of environmental governance in ASEAN countries; and d) a study of the design, practical use, and evaluation of TBOs and TDCOPs, based on a transdisciplinary approach.

2. Methods

a) Case studies of reduction of mercury pollution using a future scenario in ASGM

***Research locations*:** Our research areas are North Gorontalo Regency and Bone Bolango Regency in Gorontalo Province, Bombana Regency in Southeast Sulawesi Province, and surrounding areas on Sulawesi Island, Eastern Indonesia.

In the case studies, we will conduct the following strategies, steps and procedures.

① Environmental impact assessments: Before and after the environmental innovations established with the co-created environmental remediation technology are implemented, our project members will assess the environmental impact in each area and analyse the effects of the project scientifically. In each area, our project members will investigate the ecology, conduct chemical analyses of environmental Hg, including in soil, water, plants, animals, and human hair, nails, and blood, to undertake epidemiological and public health surveys, and to simulate the oceanic dispersal of the Hg emitted from ASGM areas.

② Research into living conditions, culture, history, and regional sociology: This will be performed by reviewing existing data, investigating the circumstances of each community, administering questionnaires and interviews to SHs, and collecting basic information in the study areas.

③ Cultivation of TDCOPs: In the FR, the concept of TDCOPs is used to conduct transdisciplinary research projects. TDCOPs are consciously cultivated on a platform needed for the TDCOPs to undertake the co-design. TDCOPs can involve large numbers of participants, including scientists and SHs, who identify local knowledge. Once they identify the local knowledge required for a seed for which environmental and industry innovations can be co-created, they will use the “Kikigaki” method and work with young SHs to determine the stories of their lives and their values. This should help them to better understand the value of important local knowledge [10]. The core group of TDCOPs, which will address the complex problems, will be required to establish a network among future TDCOPs and create the TBO of the project.

④ Co-creation of a future scenario: The core group of the TDCOPs will create future scenarios for constructing Hg-free societies in the case study areas. We will adopt the methodology of Dreborg (1996) [11] to construct the back-casting scenarios.

⑤ Co-design and co-production of transdisciplinary practical research by TDCOP’s members and SHs: The co-creation of the integrated knowledge for sustainability will be conducted by the TDCOPs. The co-design and co-production of the transdisciplinary practical researches will be performed in collaboration with the institutions, including local

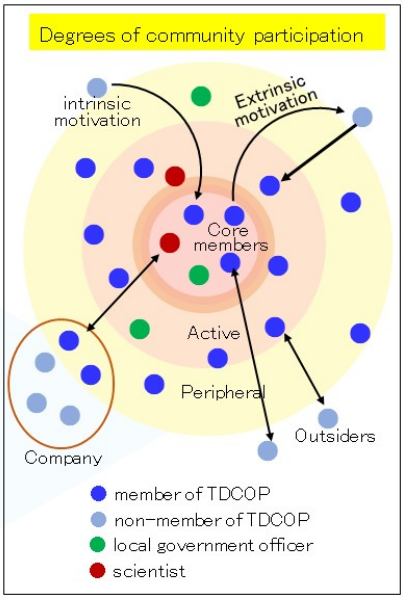
governments, residents' associations, and universities, to find a sustainable solution to Hg pollution.

⑥ Evaluation of the progress of the research project with social and economic research: The progress of the research project will be evaluated by studying the regional economies, policies, and industries in the target areas. The effects of the introduction of new industries that utilize ecosystem services or other environmental innovations will then be quantified by integrating local and scientific knowledge. We will also evaluate the social acceptance of each environmental innovation.

b) Study on regional networks to aim at mercury-free societies in Indonesia and Myanmar

In this FR, we will study the validity and role of regional networks in solving the problem of Hg pollution, and also their socio-economic effects and meaning in a developing country. Following the cultivation of various TDCOPs, we will establish regional networks to expand the residents' networks further. When a regional network working towards an Hg-free society is formed, we will establish a collaboration between the members of various TDCOPs and carry it out.

This research will be performed in three steps: (1) the construction of an exchange platform for information and collaboration on Hg management; (2) the improvement of organizing ability and communication; and (3) strengthening the communication of policy to local and central governments. First, a website for the Indonesian Hg-free society network will be created for the circulation of information. Second, opportunities for exchange among members will be provided by seminars and an international forum. Third, the accumulation of information and the evolution of the organization will be achieved by developing an information-circulating system and creating a policy advocacy body to address local and central governments.



c) Studying how to strengthen environmental governance in ASEAN countries

In this project, the principles and processes involved in using multilayer, co-operative environmental governance will be investigated in collaboration with central governments, local governments, some international organization or NGO, to tackle global environmental problems, especially the Hg pollution generated by ASGM activities.

d) Study on the design, practical use, and evaluation of Transformative boundary object (TBO) as a tool for dynamically promoting SH dialogues and transformation

The most important factor in this transdisciplinary approach is the dialogue between scientists and SHs, which drives the mutual changes of opinion required to resolve the problem. However, in areas where high pollution loads have persisted for a long time, conflicts of interest can block the dialogue between SHs. For example, there are negligible local dialogues among governments, miners, and the local inhabitants of ASGM areas.

The concept known as the "boundary object" (BO) was introduced by Star (1989) [12] as a tool to promote dialogue between SHs with different perceptions and values. Star and Griesemer (1989) [13] defined BOs as arrangements that allow different groups to work together without consensus. According to the literature, BOs have frequently been used to describe interactions among communities in the environmental context.

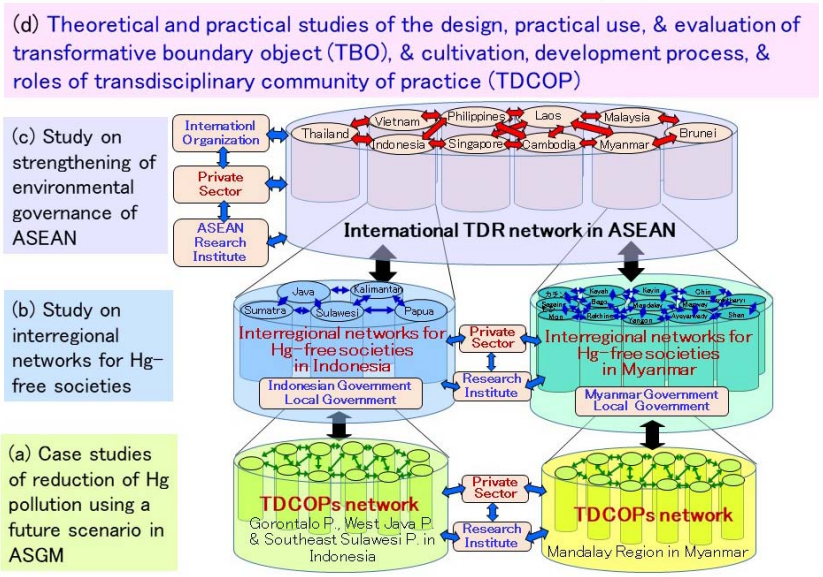


Figure2. Whole structure of our research project

Although researchers maintain that BOs promote dialogue among SHs, it is still difficult to promote constructive dialogue between SHs with conflicting interests. In the feasibility study in RIHN, we examined not only the elements of the BO, including its credibility, salience, and legitimacy, but also the SHs' characteristics, including their economic interests, social participation, environmental interests, local culture, history, geography, external environment, and social acceptance, from various perspectives. Our research findings suggest that it is possible to develop and apply a BO that dynamically promotes dialogue and mutual transformation among SHs. In our research project, this type of BO is called a "transformative boundary object" (TBO). The concept of the TBO was introduced by Tsurusaki et al. (2013)[14], and was first defined as the transformation of scientific learning into a context in which the traditional boundaries between students' lives and school science are blurred. In the research project, the TBO is redefined as a functionally superior BO, such as a technology, occupational stepping-stone, or collective action, that dynamically promotes dialogue among SHs with conflicting interests, and the mutual transformation of those SHs. Together, these can make a considerable contribution to the sustainability of a social–ecological system damaged by high loads of environmental pollution.

In the project, we define “regional innovation” as a situation in which a TBO facilitates the development of a new relationship among people who did not previously communicate with one another, so that there is a dynamic change in society.

Reducing poverty by regional innovations using TBOs

To utilize a TBO effectively to bring about behavioural transformation, “communicators” must offer relationship support to the poor. The creation of regional innovations to solve these problems requires the activities of TDCOPs using TBOs, which should lead to the efficient and effective co-creation of environmental and industrial innovations through the dynamic transformation of the participants. An environmental innovation consists of technical, social, and political developments and uses newly integrated knowledge to manage various environmental problems. An industrial innovation promotes sustainable industrialization that will develop into a resilient industry based on a network of various SHs. A regional innovation is created when an environmental innovation is combined with an industrial innovation.

3. Results and Discussion

In the case study (a), we have propelled the studies on the natural resource including the solid and fluid earth resources, and biological resource, Hg pollution of the nature and human, and resident health effect, social-economy evaluation, and cultural history in Gorontalo and Bombana areas in Indonesia [15][16][17]. In particular, in the Bone Bolango Regency, Gorontalo Regency, and North Gorontalo Regency where the studies were conducted as the investigations of each ASGM site by 16 members. The investigation of Hg pollution and resident health effect were conducted in all the ASGM areas in these regencies. Moreover, baseline investigation for the statistical social-economy evaluation in FR was conducted as the important result. 20 key SHs were identified during the dialog process with the residents. In addition, we co-created a draft of the future scenario for the reduction of Hg pollution with some key SHs. Furthermore, three TDCOPs were organized or cultivated by collaboration with the FR members and key SHs. In the meantime, the establishment of a preparatory committee for the Gorontalo Global Geopark was worked on. The seminar on preparatory committee establishment was held in September and it was sponsored by the Gorontalo Province, and the Project Lead gave a special lecture about the potential and socioeconomic effect by the Gorontalo Global Geopark.

On (b) a study of interregional networks that aim to generate Hg-free societies in Indonesia, we have established the website of research network between areas in November: " Hg Free Society Networks " by the Indonesia citizen participation, and share the information related with the Hg pollution by ASGM. More than 300 members already have joined to the Facebook page of " Hg Free Society Networks " in the early January 2019.

In the research (c) on environmental governance strengthening by the countries’ citizen participation in Southeast Asia, we started the concertation with the administration officials of Indonesia and Myanmar in the PR.

In the research (d), the FR member show the results of some domestic case studies on community of practice. We also started the dialog with the important and isolated SHs.

4. Conclusions

The study began in earnest in April 2019. The regional innovation in Indonesia and Myanmar will arise as a consequence of environmental and industrial innovations introduced with a transdisciplinary approach, including the development of a future scenario for an Hg-free society, the co-creation and practical application of TBOs, and the mobilization of TDCOPs. By strengthening environmental governance, which consists of multiple layers of co-operative organizations, we will also develop a route via which the problem of global environmental Hg pollution can be resolved.

Acknowledgements

We gratefully acknowledge the work of past and present members of our laboratory in RIHN and Ehime University. This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (A), 2016-2018（16H02706, Masayuki Sakakibara）and Research Institute for Humanity and Nature (RIHN: a constituent member of NIHU) Project No. 14200102.

References

[1] Gibb, H. and O'Leary, K. G., "Mercury Exposure and Health Impacts among Individuals in the Artisanal and Small-Scale Gold Mining Community: A Comprehensive Review", ENVIRONMENTAL HEALTH PERSPECTIVES, http://dx.doi.org/10.1289/ehp.1307864, 2014.

[2] United Nations Economic Commission for Africa, "Compendium on Best Practices in Small-Scale Mining in Africa", 2002.

[3] United Nations, "*The Millennium Development Goals Report 2012*". the United Nations, New York, 2012.

[4] United Nations Environment Programme, UNEP Chemicals Branch, Global Mercury Assessment, "Sources, Emissions, Releases and Environmental Transport (2013)",

http://www.unep.org/PDF/Press Releases/ GlobalMercury Assessment 2013.pdf, 2013.

[5] Environmental Law Institute (ELI), "Artisanal and Small-Scale Gold Mining in Nigeria: Recommendations to Address Mercury and Lead Exposure". ELI Project No. 121001, Washington, D.C, 2014.

[6] McQuilken, J., Hilson, G., "Artisanal and small-scale gold mining in Ghana: Evidence to inform an "action dialogue." London IIED". http://pubs.iied.org/16618IIED, 2016.

[7] Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll. P., Swilling, M., Thomas, C.J., "Transdisciplinary research in sustainability science: Practice, principles, and challenges". Sustainability Science, 7, DOI: 10.1007/s11625-011-0149-x, 2012.

[8] Cundill, G., Roux, D.J., Parker, J.N., "Nurturing communities of practice for transdisciplinary research". Ecology and Society 20, 22. http://dx.doi.org/10.5751/ES-07580-200222, 2015

[9] Wenger, E., McDermott, R., Snyder, W. "*Cultivating communities of practice: a guide to managing knowledge*". Harvard Business School Press, 2002.

[10] Shirota N., Yoshino, N., "Listening and Documenting –"Kikigaki": A tool for sharing wisdom for sustainable societies-", 2012.

[11] Dreborg, K., "Essence of Backcasting," Futures, 28, 813-828, 1996.

[12] Star, S.L, "The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In Readings in distributed artificial intelligence", ed. M. Huhns and L. Gasser. Menlo Park, CA: Kaufman, 1989.

[13] Star, S.L, Griesemer, J.R., “Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology”, 1907-39. Social Studies of Science, 19, 387-420, 1989.

[14] Tsurusaki, B.K., Barton, A.C., Tan, E., Koch, P., Contento, I., “Using transformative boundary objects to create critical engagement in science: A case study”. Science Education, 97, 1-31. DOI:10.1002/ sce.21037, 2013.

[15] Prasetia. H., Sakakibara, M., Omori, K., Jamie S.L., Sera, K. Kurniawan, I.A., “Mangifera indica as Bioindicator of Mercury Atmospheric Contamination in an ASGM Area in North Gorontalo Regency, Indonesia”. Geosciences, 8, 31pp: doi:10.3390/geosciences8010031, 2018.

[16] Gafur, N. A., Sakakibara, M., Sano, S., Sera, K., “A Case Study of Heavy Metal Pollution in Water of Bone River by Artisanal Small-Scale Gold Mine Activities in Eastern Part of Gorontalo, Indonesia”, Water, 10, 1507, 10 pp ; doi:10.3390/w10111507, 2018,.

[17] Pateda, S.M., Sakakibara, M. Sera, K., “Lung Function Assessment as an Early Biomonitor of Mercury-Induced Health Disorders in Artisanal and Small-Scale Gold Mining Areas in Indonesia”, International Journal of Environmental Research and Public Health, 15, 2480; https://doi.org/10.3390/ ijerph15112480, 2018.

Sustainable Culture: Burmese Lacquerware

Theint Theint Aung[1]

Abstract

This paper will focus on Burmese lacquerware in court art during the 19th Century Konbaung period to highlight its sustained heritage. The history of Burmese lacquerware has survived throughout the periods but particularly developed in the Konbaung. The Burmese kings used lacquerware as a gift to foreign countries as well as in daily usage and religious contexts. A plain lacquerware teak box is dated to the Bagan period when lacquerware may have been very popular. King Bayin-Naung obtained the craftsmen, lacquer artists, elephants, silk, ponies from Thailand during the reign of King Chieng-Mai in 1557. Mandalay is very renowned for glass mosaic lacquerware, which was very popular in the Kongbaung period (1857-1885). The glass cutting derived from western countries and developed in that time. It can be seen on the Hsiang-waing, traditional Burmese drum circle, the lion throne and Buddha images. The glass-inlay lacquerware technique was much used by the royal family. For example, a glass-inlay door of a royal family was brought to London in 1885. It can be found in the Victoria Albert Museum, London. This paper will discuss how lacquerware influence in the court art can be seen in Painting, furniture, Sar deik or manuscript boxes during Konbaung Period. Today, lacquer continues to change but remains popular with domestic and tourist markets. In summary, the lacquerware heritage spans the Bagan period, peaked in the Konbaung and continues today. With this sustained heritage, preserving its legacy for future generation is vital.

Keywords: Burmese Lacquer, court art, Sustained heritage

1. Introduction

The lacquer objects were greatly used by Burmese kings as a gift to the other countries. Myanmar old lacquer objects were used for keeping letter at court. Burmese often used lacquer objects for daily use. They used lacquer dishes for food. Most of royal family practiced the lacquerware to store jewelry. Moreover, lacquer objects were used for ritual. People bring the food in the lacquer containers to offer to the monastery. This is very typical traditional Burmese culture. Not only lacquer ware was used in royal family and monastery, but also it was used in daily life of normal people. Interestingly, they often keep the cosmetics, cloth in the lacquer boxes.

This essay will discuss clearly highlight of the Burmese lacquer in court art in terms of painting, furniture for daily use and manuscript in 19th CE. The historical background of lacquer art, materials and techniques, the practice of the lacquer objects will be given and it is still sustain from Bagan period to until the present time.

2. Methodology

This research paper includes library survey, data collection, interview the lacquerware workshops in Bagan, and taking photograph of Burmese lacquer objects in UK art market.

[1] Post Graduate student. SOAS University of London

3. The Background History of Lacquer Art

Myanmar is well known for cultural heritage, traditional technologies and cultural arts. One of the most famous handicrafts, which represent the cultural and traditional heritage of Myanmar, is lacquerware. Lacquerware can be defined as a smooth object with a framework of bamboo and wood which is completely covered by lacquer (varnish).[1] Named 'Yun the' in Myanmar, lacquerware is a traditional art in Myanmar and has a unique style.[2] Lacquerware is found in various parts of Myanmar but Bagan, in the central part, is the predominant region for lacquerware industry.[3] Lacquerware has been used in the daily use, decoration, and decorative arts for Buddha sculpture. The lacquerware products have been traded for a long times.[4]

In terms of the historical background, lacquerware first arrived in Thaton from northern Thailand.[5] Thahton is located in the lower part of Myanmar and it was conquered by the king Anawrahta in the 11th century AD. A number of craftsmen and artists were brought from Thahton to Bagan. Some Thaton artists were expert in making lacquerware art and many artists were involved in the making of lacquerware in that period in Bagan.[6] Possibly the earliest Lacquer ware box with a date of 12th century AD was excavated at the Mingala Zeti pagoda in Bagan.[7] Lacqerware industry has been developed since the Bagan period (11th century to 13th century AD).[8] Antique lacquerware can be studied in Bagan Archaeological Museum.[9]

The raw materials for Burmese lacquer

The lacquer tree (*Melanhorres Usitata*) is an essential role in the production of the lacquer objects. The *thitsi* trees are divided into three kinds of colors such as the white, the black, and the red. The three kinds of thitsi tree is a slightly different. The black one is much used in making of lacquerware in Myanmar. The *thisti* tree is growing in some areas of Myanmar.[10] The *thitsi* tree is about 7 feet- 10 feet in hight and it could be average size. Sometimes, it measures 14-6 inches in hight. There is an important time to collect the lacquer sap from June to January. The size of *thitsi* tree about 6 feet, which can be tapped. It is interesting to note that the lacquer sap can only be collected in plantation.[11] The black lacquer sap (thitsi) can be occurred in Mawk

---

[1] Lwin Lwin Mon, 'The Social Value and Function of Myanmar Lacquer Ware in Bagan, International Conference on Japan &- Myanmar', 2014, https://uyr.uy.edu.mm/ handle/123456789/262.
[2] A.P Morris, 'Lacquerware Industries of Burma', *American Baptist Mission Press* 9 (1919): 1–13.
[3] Monika Kopplin, *Lacquerware in Asia, Today and Yesterday* (Paris: Unesco, 2002).
[4] Kopplin.
[5] Ralph Isaacs, T. Richard Blurton, and British Museum, *Visions from the Golden Land: Burma and the Art of Lacquer* (Chicago: Art Media Resources, 2000).
[6] Morris, 'Lacquerware Industries of Burma'.
[7] Kopplin, *Lacquerware in Asia, Today and Yesterday*, 2002.
[8] Isaacs, Blurton, and British Museum, *Visions from the Golden Land*.
[9] UNIDO, 'Diagnostic Study on a Lacquerware Cluster in Bagan and Nyaung-U, Myanmar' (United Nation Industrial Development Organization, June 2014), https://www.unido.org/sites/default/ files/2015-05/Diagnostic_Study_on_a_Lacquerware_Cluster_in_Report_0.pdf.
[10] Dehra Dūn (India)., Dehra Dūn (India), and India) Forest Research Institute(Dehra Dun, *The Indian Forest Records.*, vol. v.6(1917-1918) (Delhi [etc.]: Manager of Publications., 1917), https://www.biodiversitylibrary. org/item/240456.
[11] Dehra Dūn (India)., Dūn (India), and Forest Research Institute (Dehra Dun).

Mai, May Myo, Monghong areas. Interestingly, it is only tapped for local use, not for export.[12]

The technique of the lacquerware

The technique of the lacquer was received from the China. There was a strong relationship between Myanmar and China since Pyu in 5th to 9th century CE. There are several basic techniques in Burmese lacquerware such as gold leaf technique, incised technique, glass inlay technique, relief moulded technique, incised technique and modern technique. All of which are incredible work.[13] Myanmar is well known for incised lacquerware. Incised technique is still use until the present time. Iron stylus has been used in the engraving on the surface of the lacquer vessels.

Glass-Inlay is called Hman-zi Shwe-cha in the history of Myanmar. Hman-zi Shwei- cha technique was arrived in Myanmar in 18th Century CE. Some scholar assumed that Hman-zi shwe-cha technique originally came from Thailand when Burmese King conquered Thailand. Hman-zi shwe-cha had become popular in Myanmar since 18th CE. The earliest Hman-zi shwe-cha was found in 1790 CE as a palm leaf manuscript. The use of glass is very simple in Hman-zi-swe-cha work in very first time. When European to arrive in Burma in 19th century CE, they brought the fine cutting glass technique. As a result, the cutting glass had improved in Myanmar. The artists richly used the fragments of the glass in Hman-zi shwe-cha. The emerald and pink colour are very common colours in lacquer production with Hman-zi shwe –cha or glass- inlay.[14] For instance, the manuscript chest (sar deik) was made by Hman Si Shwe Cha technique in late 19th CE (Fig.1). Manuscript chests were used in keeping the manuscripts in the monastery. In terms of painting, the lacquer objects can be seen in the mural painting and the artists painted the practice of lacquer objects (fig.2). Notonly the lacquer objects can be seen in the mural painting but also it can be found in the watercolor drawing (fig.3.a.b). Interestingly, the royal families used the lacquer furniture in the glass inlay technique as showing their wealthy status (Fig.4. a, b). The lacquer manuscript was used in 19th Century CE in Myanmar (Fig.5). The lacquer coated and gilt on the wooden cover of the manuscript. This manuscript shows the religious symbols. Offering vessel has been used in Konbaung period (Fig.6). Betel-box is a very common in Myanmar in 20th Century CE.[15] The practice of the betel box is a traditional object for Burmese. It is possibly assumed that betel box had an important role as one of the royal identity in the Burmese court (Fig.7).[16] As a result, the influences of Burmese lacquer objects can be found in court art.

The lacquer artists have always handed down techniques of making lacquer ware and cultural arts to the next generation of artists.[17] The lacquer objects still produce from Bagan period to until the present time and practice in Myanmar. It is produced for souvenir in Bagan.

---

[12] George Watt., 'Burmese Lacquer Ware and Burmese Varnish. (Melanorrhoea Usitata, Wall.)', *Bulletin of Miscellaneous Information (Royal Botanic Gardens, Kew)* 1906, no. 5 (1906): 137–47, https://doi.org/10.2307/4111295.

[13] Sylvia Fraser-Lu, *Burmese Lacquerware / Sylvia Fraser-Lu.* (Bangkok: Tamarind Press, 1985).

[14] Than Htun, *Lacquerware Journeys: The Untold Story of Burmese Lacquer / Than Htun (Dedaye).* (Bangkok: River Books, 2013).

[15] Ralph Isaacs, *Visions from the Golden Land: Burma and the Art of Lacquer / Ralph Isaacs and T. Richard Blurton.* (London: British Museum, 2000).P. 76

[16] Sylvia Fraser-Lu, *Burmese Lacquerware / Sylvia Fraser-Lu.*

[17] UNIDO.

In addition, some large lacquerware workshops form a group of young trainees from surrounding villages and provide on-the-job training and accommodation.[18] The government also established the lacquerware training centre at Bagan in 1924. This became the Lacquerware Technology Collage in 2003. However, at the moment it is seen only as a way of entering high education. It lacks facilities and also only takes high school graduates and does not give vocational courses. Clearly it can be improved.

Another reason for sustainability for lacquer ware is the value of handicraft. Lacquer ware production is a traditional handicraft and it is valued as tangible cultural heritage. Lacquerware industry in Bagan has been gradually developed since 11th and become a remarkable traditional value.[19] The custom and practice of Myanmar people reveal this traditional value. For instance, the lacquerware item which is called hni daung lan has been used to serve family's daily meals since 17th century AD. In some villages and monasteries, this kind of lacquerware is still used to maintain their tradition. According to the Myanmar chronicles, lacquerware items were used for formal state occasion and royal receptions. For example, picked tea was served on a fire lacquerware cup which is called kalat to those missionary or embosser of other countries. Moreover, it is assumed as royal gift of priority to show the diplomatic mission. On the other hand, a responsibility of a nation is to preserve own traditional culture. It is also true of Myanmar because most of the traditional culture were given as an heir generation to generation. Among these traditional culture, lacquerware is a fabulous handicraft tradition which has been maintained for centuries. For a sustainability of these popular crafts, state school of lacquerware is opened to teach the Myanmar traditional crafts to young generation. [20]

The practice of using lacquerware as household items is important and it could be seen for centuries to recent days. Particularly, to serve tealeaves to guest, lacquerware box is used not only in rural area also in urban society. Another item called lacquer tray is used to put cold or hot drink for guests in Myanmar families and to put prizes in traditional ceremonies. Moreover, form the aspect of religious affair, lacquerware bowls and boxes are showing the respect and it is used to offer food to the Buddhist monks. These customs are standing as a social dignity of Myanmar.

4. Conclusions

This research paper has described how Burmese lacquer ware could be sustained by giving examples. It is true that lacquerware is one of the handicrafts of Myanmar, which has been maintained since 11th century AD. As it is hand-made production, it takes a long time and has to pass through several stages. It is highly assumed that the practice of Burmese lacquer have been traced in terms of mural painting, watercolor paintings, and furniture.

[18] UNIDO.
[19] UNIDO.
[20] Monika Kopplin, ed., *Lacquerware in Asia, Today and Yesterday* (Paris: Unesco, 2002).

5. Acknowledgements

I would like to express my special thanks to Alphawood scholarships.

Figure1. Manuscript Chest (Source from V@A)

Figure 2. The influence of lacquer objects on the mural painting in Taung Bi, Bagan

Figure3a. The influence of lacquer objects in the watercolour painting

Figure3b. The lacquer objects in the watercolour painting

Figure4a . The Mirror in the glass inlay technique from the Mandalay Palace (Source from V&A Museum)

Figure4b. The Arch door at the Mandalay Palace as architecture design [21]

Figure.4c The furniture at the Mandalay Palace[22]

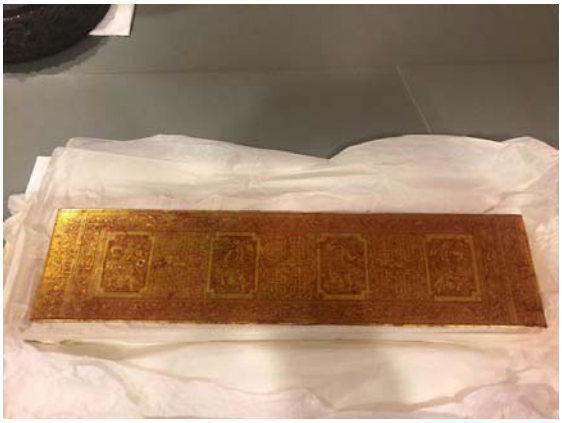


Figure5. The lacquer manuscript at British Museum (Photo by Researcher)

Figure6. Offering Vessel at Shin Pin Sar Gyo (Photo by Researcher)

Figure7. The Betel box (Photo by researcher from UK art Market)

References

[1] Dehra Dūn (India)., Dehra Dūn (India), and India) Forest Research Institute (Dehra Dun. *The Indian Forest Records.* Vol.v.6 (1917-1918). Delhi [etc.]: Manager of Publications., 1917. https://www.biodiversitylibrary.org/item/240456.

[2] Htun, Than. *Lacquerware Journeys: The Untold Story of Burmese Lacquer / Than Htun (Dedaye).* Bangkok: River Books, 2013.

[3] Isaacs, Ralph, T. Richard Blurton, and British Museum. *Visions from the Golden Land: Burma and the Art of Lacquer*. Chicago: Art Media Resources, 2000.

[4] Kopplin, Monika. *Lacquerware in Asia, Today and Yesterday*. Paris: Unesco, 2002., ed. *Lacquerware in Asia, Today and Yesterday*. Paris: Unesco, 2002. Mon, Lwin Lwin. 'The Social Value and Function of Myanmar Lacquer Ware in

[5] Bagan, International Conference on Japan &- Myanmar', 2014. https://uyr.uy.edu.mm/ handle/ 123456789/262.

[6] Morris, A.P. 'Lacquerware Industries of Burma'. *American Baptist Mission Press* 9 (1919): 1–13.

[7] Ralph Isaacs. *Visions from the Golden Land: Burma and the Art of Lacquer / Ralph Isaacs and T. Richard Blurton.* London: British Museum, 2000.

[8] Stephen A. Murphy. *Cities and Kings Ancient Treasures from Myanmar*, n.d. Sylvia Fraser-Lu. *Burmese Lacquerware / Sylvia Fraser-Lu.* Bangkok: Tamarind Press, 1985.

[9] UNIDO. 'Diagnostic Study on a Lacquerware Cluster in Bagan and Nyaung-U, Myanmar'. United Nation Industrial Development Organization, June 2014. https://www.unido.org/sites/default/files/ 2015- 05/Diagnostic_Study_on_a_Lacquerware_Cluster_in_Report_0.pdf.

[10] Watt., George. 'Burmese Lacquer Ware and Burmese Varnish. (Melanorrhoea Usitata, Wall.)'. *Bulletin of Miscellaneous Information (Royal Botanic Gardens, Kew)* 1906, no. 5 (1906): 137–47.

Toward Rabies Elimination: Japan's Experience, Sri Lanka's Goal by 2020, and its Application to Myanmar Context

Koji Kanda[1], Ananda Jayasinghe[2], Chandrika Jayasinghe[3], Takahiko Yoshida[4]

Abstract

Rabies is endemic in 150 countries and territories worldwide, particularly among the poorest of the poor including children. Nearly 60% of global human rabies deaths occurred in Asia, but Japan is one of a few countries have achieved rabies elimination. Japan has implemented strong rabies control activities including registration of pet dogs over 91 days old to the municipality of owner's residence, annual regular vaccination of pet dogs, and elimination of stray dogs. Since 1957, only three imported human cases have been recorded. Then in Asia, Sri Lanka has been tremendous efforts to combat human rabies by implementing female dog sterilization, animal birth control, surveillance and community awareness, which resulted the remarkable reduction of rabies deaths from 136 cases in 1991 to 24 in 2015. In contrast, Myanmar is still facing on the increasing number of dog bites and records one of the highest rabies prevalence in the world. In this paper, we reviewed the success stories of rabies control and its challenges overcome by our epidemiological researches in Japan and Sri Lanka, and proposed effective recommendations toward rabies elimination in Myanmar.

Keywords: Rabies, Elimination, Japan, Sri Lanka, Myanmar

1. Introduction

Rabies is endemic in more than 150 countries and territories worldwide. There are approximately 59,000 deaths of dog-mediated rabies annually, with an associated loss of 3.7 million Disability-Adjusted Life Years (DALYs) [1, 2]. Asia records the largest number of human rabies deaths, which consists of nearly 60% of global deaths [2]. Only a few countries, such as Japan, Maldives, and Timor-Leste enjoy rabies-free status in the region. Particularly, Japan has recorded only three imported human rabies cases since the nationwide interruption of an indigenous animal case in 1957.

WHO depicts the progress towards rabies elimination into five different phases from endemicity to eradication: endemic, control, zero human deaths, elimination, and maintenance [2]. For more than a half century, Japan has kept the stage of "Maintenance" by pet dog registration and their mandatory vaccination as well as stray dog confinements. There are also several amendments of related laws and regulations to maintain no indigenous and imported rabies for both humans and animals during the "Maintenance" stage. However, most countries are still trying to reach the status of "Zero human deaths", meaning no human rabies deaths for at least 24 consecutive months. Sri Lanka is amongst the nations about to achieve this status in Asia. The latest number of annual deaths from human rabies is 21 in 1 January - 28 December, 2018 [3]. The Sri Lankan government has shown tremendous efforts to eliminate rabies by implementing female dog sterilization, animal birth control, and community awareness, which resulted the remarkable decline of rabies deaths from 136 cases in 1991. Although the country

[1] Department of Social Medicine, Asahikawa Medical University, Japan, kkanda@asahikawa-med.ac.jp
[2] Department of Community Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka, ajaya83pera@gmail.com
[3] Department of Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka, jayasinghe_chandrika@yahoo.co.uk
[4] Department of Social Medicine, Asahikawa Medical University, Japan, tyoshida@asahikawa-med.ac.jp

faces on difficulties in reducing the number of human rabies deaths in the last several years (around 20-30 cases each year), this Sri Lanka's successful experience can be applied to other rabies endemic countries particularly in Asia. In contrast, Myanmar is still struggling with the increasing number of dog bites and one of the highest rabies prevalence in the world. The current statistics shows that there are more than 1,000 estimated human rabies deaths in the country, which is the largest among the Association of Southeast Asian Nations (ASEAN) [4]. It is also the third worst among the Member States of the WHO Regional Office of South-East Asia (SEARO), followed by populous India and Bangladesh [5]. Unlike Sri Lanka, Myanmar has absence or shortage of national rabies control strategy, funding, coordination and collaboration mechanism as well as low level of public awareness, limited dog population control and laboratory and surveillance capacity on rabies control [4]. In order to catch up the regional goal of rabies-free by 2020, the above shortages or limitations need to be solved at national, regional, and township levels, accordingly.

In this paper, we reviewed the success stories of rabies control and prevention in Japan and Sri Lanka and propose effective recommendations toward rabies elimination in Myanmar. Information given here is based on literature review and existing data, and research outcomes of rabies control and prevention in three countries.

2. Japan's experience

The first recorded rabies control activity has been read in the 8th century, when the basic law of ancient Japanese political system called "Yoro Law" mentioned slaughter deposition of dogs. By the 10th century, rabies was considered as a human disease. Since then, rabies outbreaks have sporadically occurred until the modern era but not officially recorded. In 1896, Epizootics Prevention Law was introduced throughout the country. The Law stipulated official recording of animal rabies cases started in 1897. The peak period of rabies endemic was during 1920s and 30s, when the nation's public health infrastructure was damaged due to natural disasters such as Great Kanto Earthquake in 1923. Also, the first Domestic Animal Infectious Diseases Control Law was enacted to increase the reporting of animal rabies cases countrywide. The number of both human and canine rabies cases dropped in 1930s, but due to incomplete control activities as well as unfavorable social situations the rabies epidemic was reverted again in the early 1940s. After the World War II, rabies prevention and control were greatly improved by the country's reconstruction of public health system and regulations, including the enactment of Communicable Diseases Prevention Law (1947), Rabies Prevention Law (1950), and New Domestic Animal Infectious Diseases Control Law (1951). In particular, the Rabies Prevention Law mandated pet dog registration and twice-a-year anti-rabies vaccinations as well as stray dog confinements. Civil servants with a veterinary license were also appointed as a rabies prevention officer. These powerful control strategies with strong political commitment rapidly eliminated the indigenous human and canine rabies in 1954 and 1956, respectively. The annual reported dog-mediated rabies cases during 1953-1956 were 176, 98, 23, and 6, respectively [6]. The last animal case was recorded in 1957 as a feline rabies.

Due to its successful eradication of indigenous rabies during the short period of time, current strategies of keeping zero rabies are still based on the Rabies Prevention Law introduced in 1950. Under the Law, pet owners require the registration of pet dog with age of 91 days and older to their municipality. The registration fee is dependent on each municipality, but the current

average cost is approximately USD 30. After the registration, the municipality issues the registration tag attach to the pet dog and sends a letter of anti-rabies vaccination schedule annually. Then the pet owners visit an animal clinic with the letter and their pet dogs receive an anti-rabies vaccination, which costs another USD 30 per shot. According to the report from the Ministry of Health, Labour and Welfare of Japan (MHLW), there are approximately 6.3 million registered dogs with 71.4% of vaccination coverage in 2017 [7]. However, it is estimated that there are 8.9 million registered and unregistered pet dogs [8], meaning that the vaccination coverage undergoes only to 50.7%, which is much lower than the WHO recommendation of at least 70% coverage. The Rabies Prevention Law mentions the penalty for those failing to comply with pet dog registration or annual vaccination with a maximum fine up to JPY 200,000 (approximately USD 1,800), but the penalty has not strictly applied so that the vaccination coverage dropped from nearly 100% in 1985 to current 71.4%. On the other hands, a national quarantine system has been improved and strictly enforced at the port of entry. In 2003, amended Infectious Disease Control Law introduced a notification form and a health certificate from government authorities of the exporting country for imported mammals [9]. In November 2004, new quarantine regulation started for importation and exportation of dog, cat, racoon, fox and skunk, including the introduction of microtip prior to any animal vaccination and testing. So far, no rabies-suspected animals have been imported.

For human rabies prevention, the country needs increasing awareness of rabies prevention among both pet owners and people going to non-rabies-free countries. As mentioned above, annual dog vaccination rate has been gradually reduced to nearly 70% and there are certain numbers of unregistered pets nationwide. Also, three imported cases were recorded since the last human case in 1954. All victims traveled to rabies endemic countries, were bitten by dogs, and showed rabies symptoms after several months of returning to Japan. None of them were vaccinated against rabies prior to the departure. At present, it is reported that Japanese travelers were unlikely to receive a pre-exposure prophylaxis prior to leaving the country, probably due to poor awareness and knowledge of pre-exposure prophylaxis to vaccine preventable diseases epidemic outside of Japan [10, 11]. In fact, limited numbers of anti-rabies vaccines in the country make the vaccination extremely expensive (USD 100-150 per shot) and a public awareness leaflet of rabies prevention by MHLW is not well disseminated. No recent awareness raising campaign has been heard in the World Rabies Day of 28 September.

Table1. Human and canine rabies deaths in Japan since 1896 (Data source: Japan Veterinary Medical Association, 2007 [12]; Metropolitan Police Department, 1938 [13]; Ohashi, 1927 [14]; Tokyo Metropolitan Government [15])

Year	Human Rabies	Canine Rabies	Event / Law enforcement
1896-1900	N/A	509	• Epizootics Prevention Law (1896)
1901-1920	※570	10 474	※Data available since 1912
1921-1940	834	14 448	• Domestic Animal Infectious Diseases Control Law (1922)
1941-1960	※214	※3 383	• Communicable Diseases Prevention Law (1947) • Rabies Prevention Law (1950) • New Domestic Animal Infectious Diseases Control Law (1951) ※ Last human case in 1954, last canine case in 1956
1961-1980	※1	0	※ Imported case (1970)
1981-2000	0	0	• Infectious Diseases Control Law (1999)
2001-	※ 2	0	• Amended Infectious Diseases Control Law (2003) • New Quarantine Program for Importation and Exportation of Animals and Pets (2005) ※ Imported cases (2006)

3. Sri Lanka's goal by 2020

Sri Lanka achieved a gradual decline of human rabies deaths after a long history to combat against the disease over the decades. The first rabies control activity was recorded in the late 19th century, when the nation was colonized by the British regime. Under the Rabies Ordinance of 1893 with several amendments, the Act focused only on the enforcement of possible rabies outbreak prevention by local authorities, including a seizure of all stray dogs [16]. In late 1950s to 1960s, Department of Health Services of Sri Lanka took over the responsibility of rabies control and formulated the rabies eradication plan, but it was not until 1970s that the rabies control activities were active. In 1971, human rabies was identified as a notifiable disease. Figure 1 shows that the death toll soon reached the highest number, 377 in 1973 [17, 18]. Then two years later, in 1975, the Sri Lankan government launched the five-year national rabies control and eradication program under the support of WHO [9, 17, 18]. WHO mainly assisted the setup of a laboratory to produce Fleury type anti-rabies vaccine for animals [18]. The second

rabies control program followed in next five years. During the implementation of the programs, the government provided various services including dog immunization, post-exposure prophylaxis (PEP) for suspected animal bite victims and periodic evaluation of the control program and removal of stray dogs [9]. These two programs resulted the sharp decline of human rabies deaths in late 1970s to 1980s.

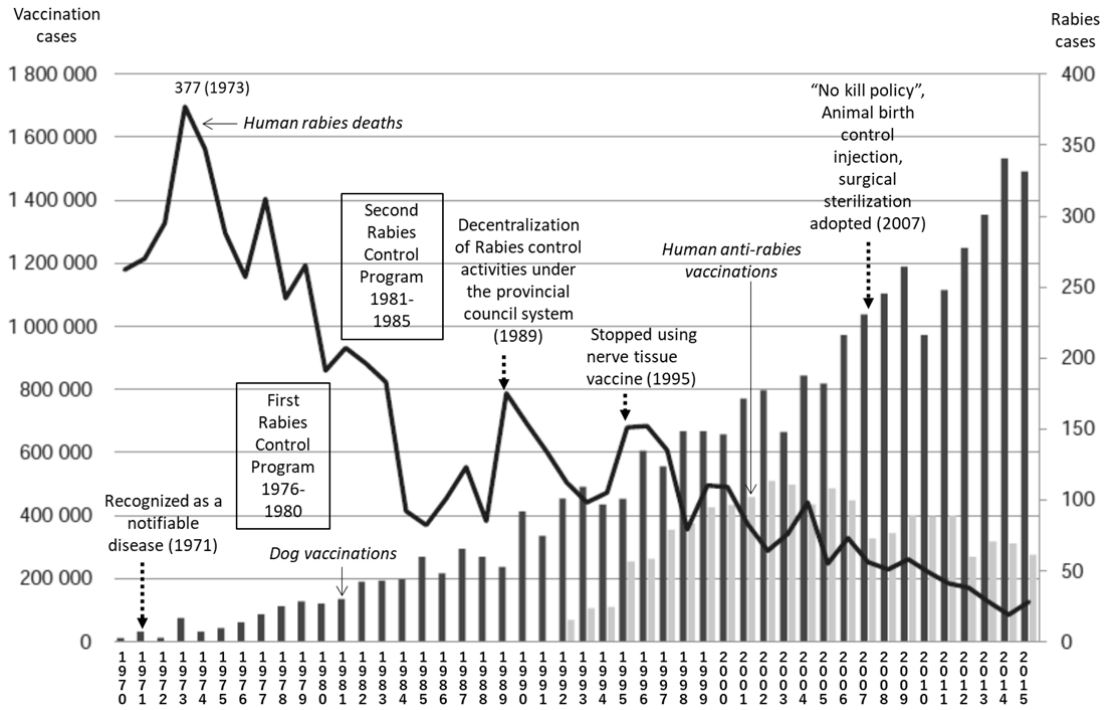


Figure1. Human rabies deaths, dog rabies vaccinations, human anti-rabies vaccinations and important events in Sri Lanka, 1970-2015.

(Revision of Harischandra et al 2016 [17])

In 1989, the government decided to decentralize the rabies control activities into provincial level to enhance the roles of local governments to implement more community-participated rabies control activities [18]. At the national level, Sri Lanka reached the first nation among South Asian Association for Regional Cooperation (SAARC) countries to have successfully stopped using nerve tissue vaccine in 1995 [19]. The government implemented "No-kill policy" among the dog population in 2007 due to animal welfare and religious reasons; instead, animal birth control injection and female dog sterilization launched in the same year to minimize the explosion of the dog population [18]. Rabies in domestic animals became notifiable in 2012 [17]. Cost-effective ID vaccination schedule has been also practiced [19]. At the end, with strong political commitment, the number of human rabies deaths declined from 136 in 1991 to 21 in 2018 (up to 30 December) [3], despite the internal conflict lasted for nearly three decades from early 1980s. The number of dog vaccination now also reached 1.5 million per year, as of end 2015 [17].

The country now faces on the difficulties in reducing the number of human rabies deaths, which have remained around 20-30 per year since 2013. In order to meet the goal of nationwide rabies elimination, it is essential to boost up the ongoing control activities, including human and

dog rabies vaccination, dog population control, surveillance for both human and animal cases, and public awareness campaigns. Of those, details and importance of scaling up first three activities have been mentioned in several documents [17, 19]. Particularly, the PEP still remains a key strategy for rabies prevention and control in spite of its high cost and the national dog vaccination coverage of below 70% [19]. However, raising public awareness seems left behind and should be more intensified toward elimination. For example, people's awareness and knowledge level of rabies prevention and control were sporadically assessed in limited region and communities, reporting inadequate preparation against rabies [20, 21]. The National Health Strategic Master Plan (2016-2025) also indicated that there was still a significant lack of awareness and knowledge of PEP among some of the vulnerable population who are mostly the people who doesn't have a permanent residency due to their occupation [22]. In fact, only three community level awareness programs on rabies prevention were conducted in 2018 [23]. To improve current conditions, the government should make best use of the outcomes of several awareness and knowledge enhancing activities particularly focusing on Sri Lankan context, which have been successfully implemented [24, 25].

Raising awareness is also quite important because Sri Lanka is now about to achieve the rabies elimination. This means that rabies is really heading to a neglected tropical disease among general population of Sri Lanka and public awareness will be finally decreased again like Japan. Responsible pet ownerships should be more emphasized for proper pet dog management. Japan used to maintain nearly 100% dog vaccination coverage for the thirty years after rabies elimination. More difficulties are "Maintenance" so that it is not too late for the country to prepare for the era of post-elimination.

4. Conclusion: Application to Myanmar's context

Myanmar is still a leading country of rabies epidemic in Asia. It is estimated that there are at least 1,000 human rabies deaths annually, with 600,000 dog bites [4, 26]. The ASEAN Secretariat reported that Myanmar had constraints on rabies control, due to lack of a national rabies control strategy except the guideline for PEP, poor public awareness and limited coordination and collaboration mechanism, funding, technical capacities including surveillance and laboratory practices for rabies control [4]. At the national level, limited surveillance system and laboratory capacities for the detection and confirmation of rabies virus infections cause insufficient, underestimated epidemiological data [27]. On the other hands, poor knowledge of rabies is common in local levels so that raising community awareness are crucial to further interruption of rabies virus transmission cycle from animals to human [26, 27]. Control of stray dog population and distribution of mass dog vaccination are also critical challenges [26].

Countries of enjoying successful rabies elimination strongly emphasized the intensive activities of pet dog vaccination, stray dog elimination, surveillance, and raising public awareness, all of which are necessary to be included in the rabies control strategies in Myanmar. It is true that improving dog vaccination coverage in Myanmar is a huge hurdle due to its large land size, inaccessibility to rural areas and varieties of ethnicities. A land area of Myanmar is 1.8 times bigger than Japan, but the population density is much lower. This indicates that a large amount of budget is needed for transportation and other indirect costs as well as vaccination itself. However, it is more cost-beneficial to reduce the chance of contracting rabies virus to community people than to provide enough number of highly expensive PEPs in each accessible

local health center. A reliable surveillance system is also an asset. For example, Japan recognized human and canine rabies in the late 19th century, resulting that the county was able to identify the trend of rabies epidemic which helped establish the Rabies Prevention Law enacted in 1950. Sri Lanka has also recorded rabies cases since early 1970s and already achieved the rabies-free status in the several of 25 districts. Although Myanmar has a huge country size and many of rural communities are hard to reach, a small-scale but routine data collection would help the nation to precisely monitor the epidemic and to implement more effective rabies control and prevention activities in national, district, and township levels.

Lastly, enhancing awareness of rabies control and prevention among general public is the powerful, easy way to reach overall goal of rabies elimination and to maintain a zero-rabies status thereafter. Raising awareness encourages community involvement and engagement in activities to eliminate dog-mediated rabies [28]. So far, there are few studies and reports regarding awareness raising activities in Myanmar, but a small-scale program would produce a bigger outcome in a long run. Continuation of high awareness will maintain rabies-free status after elimination. Sri Lanka recently eliminated malaria from the country and now rabies is about to be removed. Myanmar has successfully reduced the mortality and morbidity of malaria by sustainable financial, technical and political commitments [27]. Therefore, it is believed that Myanmar has a high potentiality to soon reduce rabies epidemic with high priority.

Acknowledgements

The authors would like to thank the Faculty of Veterinary Medicine and Animal Science, and the Medical Faculty Library, University of Peradeniya, Sri Lanka. This study was financially supported by JSPS KAKENHI Grant Numbers 18H06337 and 19K21421.

References

[1] Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M et al. Estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis. 2015; 9(4):e0003709

[2] World Health Organization [WHO]. WHO Expert Consultation on Rabies: Third report. Geneva: WHO, 2018.

[3] Ministry of Health, Nutrition and Indigenous Medicine of Sri Lanka [MHNIM]. Weekly Epidemiologic Report Sri Lanka 2019 Vol.46, No.01. Colombo: MHNIM, 2019.

[4] The ASEAN Secretariat. ASEAN Rabies Elimination Strategy. Jakarta: ASEAN, 2016.

[5] WHO Regional Office for South-East Asia [SEARO]. Strategic Framework for Elimination of Human Rabies Transmitted by Dogs in the South-East Asia Region. New Delhi: WHO-SEARO, 2012.

[6] Ministry of Health, Labour and Welfare of Japan [MHLW]. Rabies. Retrieved on 30 September, 2019, at https://www.mhlw.go.jp/bunya/kenkou/kekkaku-kansenshou10/ (in Japanese).

[7] MHLW. Number of registered and vaccinated dogs by prefecture, FY2012-2017. Retrieved on 30 September, 2019, at https://www.mhlw.go.jp/bunya/kenkou/kekkaku-kansenshou10/01.html (in Japanese)

[8] Japan Pet Food Association. A result on the national survey on pet dog and cats, FY2018. Retrieved on 30 September, 2018 at https://petfood.or.jp/data/chart2018/index.html (in Japanese).

[9] Tamashiro H, Matibag GC, Ditangco RA, Kanda K, Ohbayashi Y. Revisiting rabies in Japan: is there cause for alarm?, Travel Med Infect Dis, 2007, 5, 263-275.

[10] Basnyat B, Pokhrel G, Cohen Y. The Japanese need travel vaccinations. J Travel Med. 2000;7:37.

[11] Kashino W, Piyaphanee W, Kittitrakul C, Tangpukdee N, Sibunruang S, Lawpoolsri S, et al. Incidence of potential rabies exposure among Japanese expatriates and travelers in Thailand. J Travel Med.

2014;21(4):240-247.

[12] Japan Veterinary Medical Association [JVMA]. Textbook of rabies prevention strategy. Tokyo: JVMA, 2007. Retrieved on 4 October, 2019 at http://nichiju.lin.gr.jp/pdf/h190225_textbook.pdf (in Japanese)

[13] Metropolitan Police Department of Tokyo [MPD]. Rabies epidemic in Tokyo. Tokyo: MPD, 1938. (in Japanese)

[14] Ohashi S. Rabies. Chuoujuikaizasshi (Journal of Veterinary Medical Science), 1927;40(5):437-487.

[15] Tokyo Metropolitan Government. Rabies epidemiology in Japan. Retrieved on 4 October, 2019, at http://www.fukushihoken.metro.tokyo.jp/kankyo/aigo/dog/kyouken/kyouken2.html (in Japanese)

[16] An ordinance to provide for the suppression of rabies in Sri Lanka. 1984.

[17] Harischandra PAL. Gunesekera A, Janakan N, Gongal G, Abela-Ridder B. Sri Lanka takes action towards a target of zero rabies death by 2020. WHO South-East Asia J Public Health, 2016;5(2):113-116.

[18] Public Health Veterinary Services of Sri Lanka [PHVS]. History of rabies control activities in Sri Lanka. Retrieved on 3 October, 2019 at http://www.rabies.gov.lk/english/history.php.

[19] WHO-SEARO. Prevention and control of rabies in SAARC countries. New Deli: WHO-SEARO, 2016.

[20] Matibag GC, Kamigaki T, Kumarasiri PV, Wijewardana TG, Kalupahana AW, Dissanayake DR, et al. Knowledge, attitudes, and practices survey of rabies in a community in Sri Lanka. Environ Health Prev Med, 2007:12(2):84-89.

[21] Muthunuwan JT, Ganhewa AGKH, Perera HDSG, Hishaam M, Bandara WMMS, Gunasekera HAKM. Preliminary survey on knowledge, attitudes and practices regarding rabies. Sri Lankan J Infect Dis, 2017;7(1):38-46.

[22] Ministry of Health of Sri Lanka [MOH]. National Health Strategic Master Plan 2016-2025: Vol II – Curative Service. Colombo: MOH, 2016.

[23] MHNIM. Annual performance report 2018. Colombo: MHNIM, 2018.

[24] Matibag GC, Ohbayashi Y, Kanda K, Yamashina H, Kumara WR, Perera IN, et al. A pilot study on the usefulness of information and education campaign materials in enhancing the knowledge, attitude and practice on rabies in rural Sri Lanka. J Infect Dev Ctries, 2009;3(1):55-64.

[25] Kanda K, Obayashi Y, Jayasinghe A, Gunawardena GS, Delpitiya NY, Priyadarshani NG, et al. Outcomes of a school-based intervention on rabies prevention among school children in rural Sri Lanka. Int Health, 2015;7(5):348-353.

[26] Rabies updates in Myanmar. Retrieved on 2 September, 2019 at https://rr-asia.oie.int/fileadmin/Regional_Representation/Programme/B_One_Health/2018.12_ASEAN_Rabies_Hanoi/Update_Rabies_Poster_Vietnam_Myanmar__-__%E4%BA_%E6__%E3%83_%E3%83_%E3%83_.pdf

[27] Mu TT, Sein AA, Soe C, Aung NPP, Kyi TT, Hanson J. Rabies in Myanmar: Prevalent, Preventable but not Prioritized. Am J Trop Med Hyg, 2017;97(4):989-991.

[28] WHO, World Organization for Animal Health. Global framework for the elimination of dog-mediated human rabies. Retrieved on 2 September, 2019 at https://www.who.int/rabies/control/Poster_Global_framework_for_the_elimination_of_dog-mediated_human_rabies.pdf

The Porifera (Sponges) of Tanintharyi Region and its potential used in natural medicine

Nang Mya Han[1], Aung Aung Aye[2]

Abstract

The present research was carried out from the Ross Island, Pyinsabu Island, Zardetgyi Island, Than Kyun Island and Boulder Island of the Tanintharyi Region in 2017 to 2019. The Phylum Porifera has three classes, the Demospongiae (siliceous sponges), Calcarea (calcareous sponges) and Hexactinellida (glass sponges). There are about 5000-6000 described worldwide species. The sponges found in Tanintharyi Region are approximately 200 species. Among them the research emphasized on the Class Demospongiae (siliceous sponges) which possess the Genus 1: *Clathria, Clathria prolifera* species, the Genus 2: Amphimedon, *Amphimedon erina* species, the Genus 3: *Erylus*, *Erylus formosus* species, the Genus 4: Stylissa, *Stylissa massa* species and the Genus 5 : Spongia, *Spongia officinalis* species. Sponges are significance for economic as undesirable colonizers of man-made structures (and destructive pests of oysters), and their pharmaceutical potential (Hooper et al. 1998). In Tanintharyi Water Areas the ongoing research found the species *Clathria prolifera* possess a valuable source of pharmacologically active secondary metabolites. Some of these metabolites are reported to have antitumor, antiviral, anti-inflammatory, anti-malarial, immunosuppressive or antibiotic activities.

Keywords: Demospongiae**,** siliceous sponges, *Clathria prolifera* species, secondary metabolites, pharmaceutical potential products

1. Introduction

The term sponge derives from the Ancient Greek word σπόγγος (*spóngos*). Marine sponges are sessile animals that look like plants; they are multicellular, heterotrophic, lack cell walls and produce sperm cells. Sponges have three body types: asconoid, syconoid, and leuconoid. They attached themselves to a rock, shell or seafloor when they are young and there live for the rest of their lives. Most sponges eat tiny, floating organic particles and plankton that they filter from the water the flows through their body. Their "skeletons" are made of Spicules consisting of fibers of the protein spongin, the mineral silica, or both.

The sponges Phylum Porifera have three Classes; the **Demospongiae** (siliceous sponges, horn sponges, like the bath sponge), **Calcarea** (calcareous sponges) and **Hexactinellida** (glass sponges). Globally there are from 5,000 to 10,000 known species of sponges. Most sponges live in salt water - only about 150 species live in fresh water. Sponges evolved over 500 million years ago. The sponges found in Tanintharyi Region, Myanmar are approximately 200 species. The present research emphasized on the Class Demospongiae (siliceous sponges) among the 3 classes. This class possesses the Genus *Clathria* and *Clathria prolifera* species which possess a valuable source of pharmacologically active secondary metabolites.

The demo sponge is one of the few marine creatures that can live in both freshwater and saltwater environments. Demo sponges are found in all oceans, most seas, and gulfs. The Demospongiae can reproduce both sexually and asexually. Methods of asexual reproduction include both budding and the formation of gemmules. In budding, aggregates of cells differentiate into small sponges that are released superficially or expelled through the ocular

[1] Dr, Ext. Professor, Department of Marine Science, University of Myeik, Myanmar
[2] Dr Assistant Lecturer, Department of Marine Science, University of Myeik, Myanmar.

("little mouth").These can survive even extremely unfavorable conditions. They survive even after the rest of the sponge dies due to the unfavorable conditions.

Sponge benefit to ocean: Inside the sponge, tiny hair-like structures called flagella create currents to filter bacteria out of the sponge's cells and trap food within them. As sponges contain enzymes that can prevent bacterial growth they can lower the bacterial contamination in the ocean floor environment. Their strong skeletal structures help sponges withstand the high volume of water that flows through them each day. Although most sponges are harmless to humans, but some examples of toxic sponges are found world- wide. They occurred painful skin irritations, sometimes persisting for many hours, are the most common syndrome. No fatalities are known. Sponges are also important in nutrient cycles in coral reef systems. This process would lower excess nitrogen levels in coral reefs, also preventing harmful ecosystem changes. Scientists believe that the conversion of nitrogen gas into useful nitrogen is also beneficial to the survival of other organisms in the area. Sponges breathe by taking oxygen from the water that they filter through the pores and canals in their bodies. They then send carbon dioxide out with the water they excrete.

Sponges are also important in nutrient cycles in coral reef systems. This process would lower excess nitrogen levels in coral reefs, also preventing harmful ecosystem changes. Scientists believe that the conversion of nitrogen gas into useful nitrogen is also beneficial to the survival of other organisms in the area. Sponges breathe by taking oxygen from the water that they filter through the pores and canals in their bodies. They then send carbon dioxide out with the water they excrete.

Early Europeans used soft sponges for many purposes, including padding for helmets, portable drinking utensils and municipal water filters. Until the invention of synthetic sponges, they were used as cleaning tools, applicators for paints and ceramic glazes and discreet contraceptives. Typical materials used are cellulose foam, polyurethane foam, breast implants and less frequently, silicone foam. On the plus side, many people consider natural sea sponges to be eco-friendly. Sponges are able to grow back after they are harvested, so they could be considered a sustainable resource. However, by the mid-20th century, over-fishing brought both the animals and the industry close to extinction.

Biologically active compounds and Pharmaceutical potential products of sponge: Among the marine organisms marine sponges have the richest sources of pharmacologically-active chemicals and have medicinal potential due to the presence in sponges themselves or their microbial symbionts of chemicals that may be used to control viruses, bacteria, tumors and fungi. Sponges also have been found to have anti-cancer, anti-bacterial and anti-fungal properties in its. More than 5,300 different products are known from sponges and their associated microorganisms, and more than 200 new metabolites from sponges are reported each year. As infectious microorganisms evolve and develop resistance to existing pharmaceuticals, the marine sponge provides novel leads against bacterial, viral, fungal and parasitic diseases. (Laport MS, Santos OC, Muricy G, 2019) Tough sponges can help scrape away dead cells lingering on your skin with the potential to clog pores.

2. Methods

2.1. Study Areas

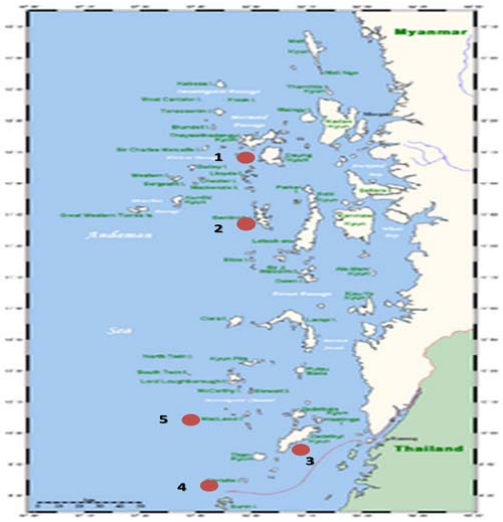
The present research was carry out in 2017April to 2019 April from the five Islands of Tanintharyi Region (the southern coast of Myanmar), Ross Island (Lat 12˚ 11'45.9″ N Long 098˚ 07' 44.3″ E), Pyinsabu Island (Lat 11˚48'46.6″ N Long 098˚ 01' 00.8″ E), Zardetgyi Island (Lat 09˚59'23.1″ N Long 098˚ 16' 28.1″ E), Than Kyun Island (Lat 09˚47'24.1″ N Long 098˚ 01' 58.1″ E)and Boulder Island (Lat 10˚ 12' 05.8″ N Long 097˚ 52' 25.1″ E).

2.2. Samples Collection

Samples were collected at the depths of 0.5 - 3 m in the intertidal zone and gloves were worn during collection. Collected samples were transferred directly to sterile plastic bags containing seawater to prevent contact of sponge tissue from air. After that the samples were transported to the laboratory and processed immediately for the identification.

All the sponge contained bottles and (TS 10) bottle which will place the specimens to extracts the Spicules were cleaned and labeled.

Map showing the study areas



(a) TS 10 bottle

a

(b). Sponge collection contained bottles

b

2.3. Methods Used

All the field specimens and a voucher specimen (TS.10) were deposited at Laboratory of Marine Science Department of Myeik University. The identification of sponges is very difficult due to their unique morphological traits and intra-specific variability in shape and colour. Therefore, proper identification often requires collection and microscopic examination of their skeleton (Spicules).

Common features used to identify sponges are the following:

(1). **Spongin fibres** – organic skeletal elements made of collagen and forming very complex networks in many sponges. (2).**Dispersed collagen filaments** – skeletal material found in all

sponges. (3). **Spicules** – inorganic elements present in almost all sponges' skeleton and made of either calcium carbonate or silica.

The Classes of known sponges are separated based on these characteristics:

(1) The Calcarea have calcium carbonate spicules,

(2) The Hexactinellida; siliceous spicules and

(3) The Demospongiae; siliceous spicules and sponging fibres or both.

Many observable morphological characters can be used to aid in sponge identification including overall shape, distribution of surface pores, colour, texture and size. Knowledge of other non-morphological characteristics, such as the ecological traits of the different species can also be useful in sponge identification. Several tools, such as posters and field guides and designed to be used by non-specialist individuals while at sea observation have been developed. As a field guide a selection of these is provided in the FAO Vulnerable Marine Ecosystems webpage(www.fao.org/in-action/vulnerable-marine-ecosystems/background/vme-tools/en/). In analyzing some specimens were identified down to species according to "Identification of sponge species of FAO (2017)" and for preservation and isolated compounds were followed by the method of Toyama Medical Institute, Japan. The chemical structures of the isolated compounds were determined using extensive spectroscopic techniques, including NMR, HRESIMS, IR, and optical rotation. To isolate the specimens, the isolation procedures are as follow; (1). The sponge specimens were cut into small pieces and digestion in household bleach 30 minutes. (2). Then 10 minutes wash with distilled water were repeated 4 times. (3). Place the specimen on the glass slide and covered by cover slid after washed. (4). Take the photos of sponge's Spicules by using microscope

Identified the Spicules Sponge under microscope	Spicules	Spicules
		

3. Result and Discussion

Species identification is important for ecological, evolutionary, systematic, and biodiversity studies which contribute too many of the development of conservation and management plans of sponge. (Identification of sponge species, FAO, 2017)

The present study emphasized on the identification of Class Demospongiae (siliceous sponges) which possesses the Genus 1: Clathria, *Clathria prolifera* species,

the Genus 2: Amphimedon, *Amphimedon erina* species,

the Genus 3: Erylus, *Erylus formosus* species,

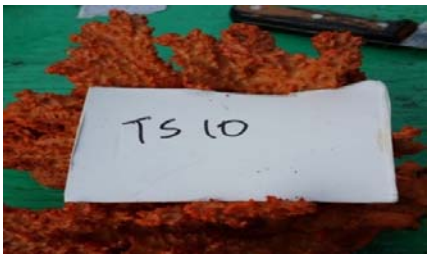
the Genus 4: Stylissa, *Stylissa massa* species and

the Genus 5: Spongia, *Spongia officinalis* species.

Table3.1. Occurrence of sponges at the five sampling stations (+ = Present, - = Absent)

Sr No.	Species Name	Ross Is.	Pyinsabu Is.	Zardetgyi Is.	Than Kyun Is.	Boulder Is.
1.	*C. prolifera*	+	-	-	-	-
2.	*A. erina*	-	+	+	+	-
3.	*E. formosus*	-	-	+	+	-
4.	*S. massa*	+	+	+	+	+
5.	*S. officinalis*	-	-	-	+	-

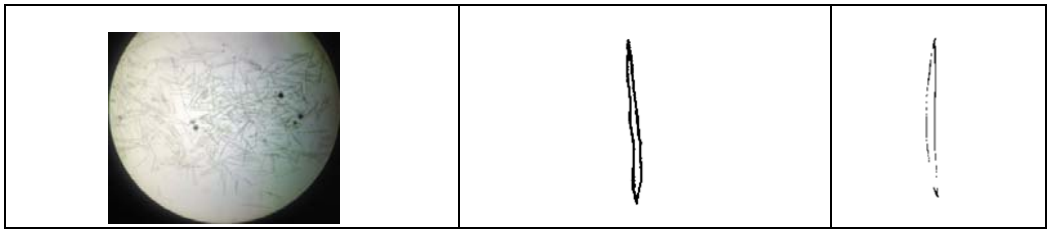
3.1. Classification of TS 10



Phylum: Porifera (Grant, 1836)
Class: Demospongiae (Sollas, 1885)
Order: Poecilosclerida (Topsent, 1928)
Family: Microcionidae (Carter, 1875)
Genus: *Clathria* (Schmidt, 1862)
Species: *Clathria prolifera* (Ellis & Solander, 1786)

Description: *Clathria prolifera* has an encrusting base that may be up to 20cm (8in) across but less than 3mm (0.12in) thick. It forms bushy masses up to 20cm (8in) tall of orange or red branches up to 6mm (0.24in) thick. These resemble fingers, or may join together to form fan-like or drapery-like folded sheets. The spongy surface is covered with minute pores through which water is drawn into the sponge.

Spicules of TS 10



3.2. Classification of No (1) Bottle to No (4) Bottle

No (1) Bottle

Phylum: Porifera (Grant, 1836)
Class: Demospongiae (Sollas, 1885)
Order: Haplosclerida (Topsent, 1928)
Family: Niphatidae (Van Soest, 1980)
Genus : *Amphimedon* (Duchassaing & Michelotti, 1964)
Species: *A. erina* (de Laubenfels, 1936)

Description: Massive lobate to ramose. Color: dark green externally, lighter internally. Surface of the texture is smooth with oscular chimneys which have 0.5 - 1 cm diameter mouth wide. The species is compressible but crumbly in consistency. Maximum surface diameter is 1 cm.

Commonly found on shallow reefs, on the hard substrate of seagrass beds and mangroves. Members of the Class Demospongiae are hermaphroditic. Life cycle: The zygote develops into parenchymella larva (free-swimming) before settling down on a substrate where it grows into a young sponge.

No (2) Bottle

Phylum: Porifera (Grant, 1836)
Class: Demospongiae (Sollas, 1885)
Order: Astrophorida (Bowerbank, 1862)
Family: Geodiidae (Gray, 1867)
Genus: *Erylus* (Gray, 1867)
Species: *E. formosus* (Sollas, 1886)

Description: Repent branches or ridged masses or stalked lobes; detachable dermis black, internal color cream. Oscular flush water to the surface then scattered till reach on to the ridged protuberances, it has 0.8– 1.5 cm diameter wide. Consistency of the dermis is slightly leathery, choanosome is crumbly. The material varies slightly with locality in the spicules complement (width and shape of aspidaster spicules, size of tylaster spicules, etc.), but the overall shape and color are quite similar and we are quite certain that there is a single open reef species.

No (3) Bottle

Phylum: PoriferaG (rant, 1836)
Class: Demospongiae (Sollas, 1885)
Order: Halichondrida (Gray, 1867)
Family: Dictyonellidae(Van Soest, Diaz &Pompoi, 1990)
Genus: *Stylissa* (Hallmann, 1914)
Species: *S. massa* (Carter, 1887)

Description: Massive lobate to ramose. Color: dark yellow externally. Surface texture is smooth with oscular chimneys which has 0.8– 1.5 cm diameter wide. The species is compressible but crumbly in consistency. Maximum surface diameter is 3-4 cm. Commonly found in shallow reefs and on the hard substrate among seagrass beds.

Bottle (4)

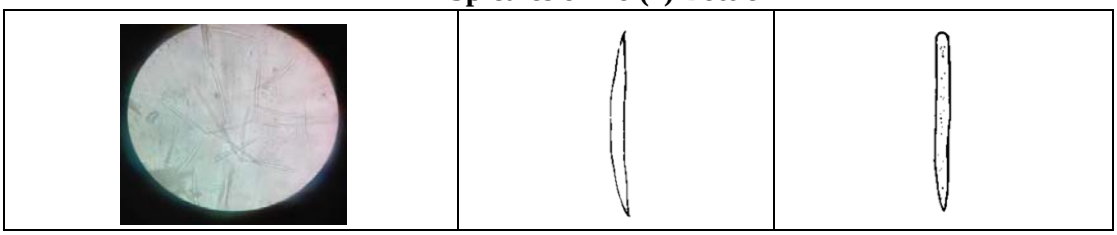
Phylum: Porifera (Grant, 1836)
Class: Demospongiae (Sollas, 1885)
Order: Dictyoceratida (Minchin, 1900)
Family: Spongidae (Gray, 1867)
Genus: *Spongia* (Lennaeus, 1759)
Species: *S. officinalis* (Lennaeus, 1759)

Description: *S. officinalis* better known as bath sponge which is a commercially used sea sponge. It is a hermaphroditic animal and can reproduce asexually by means of budding or through sexual reproduction. When alive, its color is dark grey; upon drying it becomes either yellow or brown. Young larvae swim freely until they attach themselves to the sea floor or other adequate ground. After that, they start growing slowly, as it may take as much as 40 years to grow the size of a baseball.

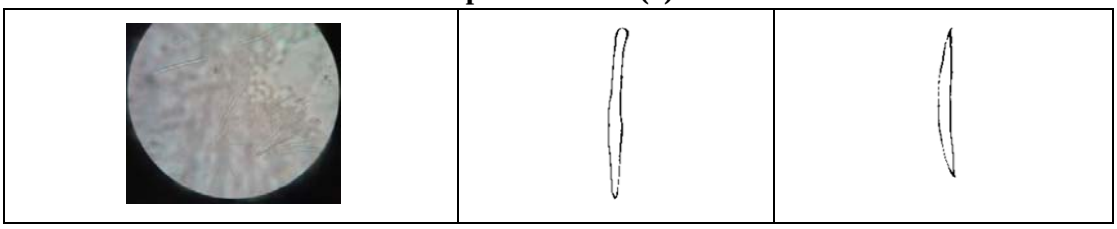
Table3.2. Pharmacologically active secondary metabolites of sponges

Species	antitumor	antiviral	inflammatory	antibacterial	antibiotic
C. prolifera	+	+	+	+	+
A. erina	-	+	-	+	+
E. formosus	-	+	-	+	+
S. massa	-	+	-	+	+
S. officinalis	+	+	+	+	+

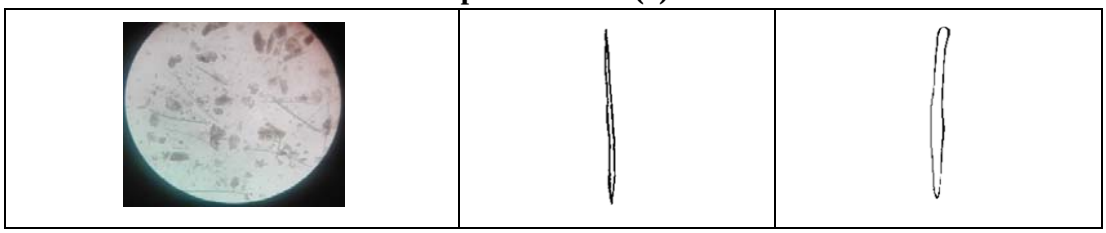
Spicules of No (1) Bottle



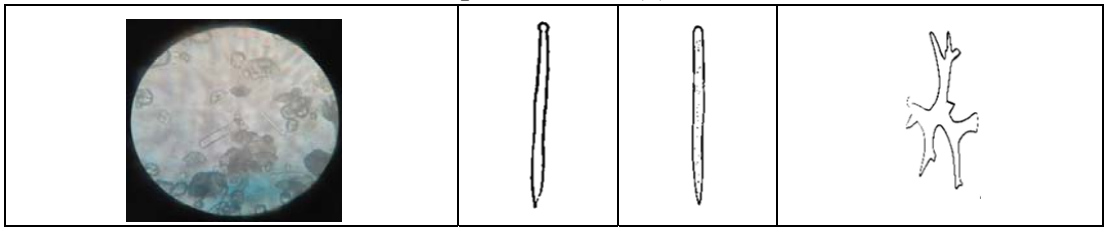
Spicules of No (2) Bottle



Spicules of No (3) Bottle



Spicules of No (4) Bottle



2. Conclusions

The present study was recorded and identified the five species belonging to the five Genus under the Class Demospongiae (siliceous sponges), they are the **Genus 1**: Clathria, *Clathria prolifera* species, the **Genus 2**: Amphimedon, *Amphimedon erina* species, the **Genus 3**: Erylus, *Erylus formosus* species, the **Genus 4**: Stylissa, *Stylissa massa* species and the **Genus 5**: Spongia, *Spongia officinalis* species. This study showed that there are still a lot of sponges yet to be discovered in Myanmar waters, hence the needs to conduct similar study in other areas of the country, possibly using the developments in natural science.

Acknowledgement

The first author is grateful to the Aquamarine Ecotourism Co., Ltd. and Boulder Bay Eco Resort Co., Ltd. for their assistance in the field collection and sampling of sponges.

References

[1] Alonso, D., Khalil, Z., Satkunanthan, N. andLivett, B. G. 2019. Drugs from the sea: conotoxins as drug leads for neuropathic pain and other neurological conditions.

[2] Collin, R., Díaz, M. C., Norenburg,J., Rocha, R. M., Sánchez,J. A., Schulze,A., Schwartz,M. and Valdés,A. 2005. Photographic Identification Guide To Some Common Marine Invertebrates of Bocas Del Toro, Panama. *Caribbean Journal Of Science.* 41:3, 638-707.

[3] Donia, M. and Hamann, M. T. 2019. Marine natural products and their potential applications as anti-infective agents.

[4] Laport, M. S., Santos, O. C. and Muricy, G. 2019. Marine sponges: potential sources of new antimicrobial drugs.

[5] Longakit, M. B. A., Sotto, F. B., and Kelly, M. 2005. The Shallow Water Marine Sponges (Porifera) of Cebu, Philippines.*Science Diliman* 1**7:**2. 52-74.

[6] So Yeun Woo, Nwet Nwet Win, Chin Piow Wong, Takuya Ito, Shotaro Hoshino, Hla Ngwe, Aung Aung Aye, Nang Mya Han, Huiping Zhang, Fumiaki Hayashi, Ikuro Abe, Hiroyuki Morita. 2018. Two new pyrrolo-2-aminoimidazoles from a Myanmarese marine sponge, *Clathria prolifera. Journal of Natural Medicines* 72. Page no. 803–807.

Monitoring and Modeling Environmental Sustainability Indices of Intensified Agriculture in South Korea

Seung Woo Park[1]

ABSTRACT

Environmental sustainability is generally considered to be the final pillar of the sustainable development goals (SDGs) in rural and agricultural development projects. Whereas intensified agriculture has contributed to higher productivity, it also alters hydrology, accelerates soil erosion, and degrades downstream water quality. The agro-ecosystems are also affected. This paper presents the results from long-term monitoring and modeling researches on the hydrology, soil erosion, water quality, and agro-ecosystems in fields and watersheds. It also discusses the applications of parametric models to simulate the environmental impacts of land-use variations and agricultural management practices. Several hydrological parameters including the runoff curve number and irrigation return flow for irrigated paddies are presented. The results from ecological surveys of irrigated paddies and the surrounding territory are presented. Moreover, indicator biota species are proposed for characterizing the environmental integrity of the agro-ecosystem. The results of these studies may be applicable to the quantitative assessment of the environmental impacts.

Keywords: environmental sustainability, hydrological and water quality monitoring, parametric models, ecological surveys

1. Introduction

The total land area of the Republic of Korea (hereafter Korea) is 100,300 km^2. Approximately 2.9% of this comprises inland water areas. Forests and cultivated land occupy 63.4% and 16.4%, respectively. The acreage of paddy fields and the upland are 8,950 and 7,500 km^2. Approximately 3% of the cultivated land is used for greenhouses. Moreover, 81.3% of paddy fields is irrigated from public water sources, and the remaining is partially irrigated by individual farmers (MAFRA[2], 2017).

The annual water use for agriculture is reported to be approximately 15.2 billion m^3 or approximately 20% of the renewable (or available) water resources (ME[3], 2016). The average fertilizer application in 2016 was 274 kg/ha. According to a recent report by OECD (2019), Korea's surplus of N and P balances in agricultural lands (240 and 47 kg/ha, respectively) is one of the highest among OECD countries.

These high inputs for intensified agricultural production systems have caused severe environmental issues. Excessive water intake for transplanting rice seedlings generally reduces the in-stream flow in small creeks and rural streams. In addition, the irrigation return flow from paddy fields causes degradation of the water quality of the downstream water bodies. Nonpoint source pollution from upland fields has also generated significant concern with regard to water quality. For example, the soil erosion from vegetable crop fields in hill slopes degrade the water quality of the Soyang Lake and other large lakes and significantly increases the downstream city water treatment costs.

---

[1] Ph. D, Professor Emeritus, Seoul National University and Member, The National Academy of Sciences, Republic of Korea
[2] Ministry of Agriculture, Food and Rural Affairs
[3] Ministry of Environment

Cultivated land is one of the five fundamental ecological systems, which include air, forest, water, and urban areas as well (Novotny and Olem, 1994). In addition to food production, agricultural land offers conservation functions to the ecosystems. It is important to preserve the integrity of the natural environment and ecosystems of agricultural land. Moreover, the sustainability of agricultural ecosystems should be maintained to the extent feasible.

The purposes of this paper[1] are to review the national environmental monitoring systems; present experimental programs for monitoring watershed hydrology and water quality, and biota for paddy and rural environments; and discuss hydrological and water quality models applicable to agricultural watersheds.

Environmental Indicators for K-Sdgs

The 2030 Agenda for Sustainable Development was committed to by the member states of the United Nations in September 2015. The agenda contains 17 goals (SDGs) and 169 targets. In addition, 232 indicators were specified to document the progress and achievements of the member states with regard to the SDGs. To comply with the agenda, the Korean-SDGs (K-SDGs) were published. They comprised 17 goals, 132 targets, and 224 indicators to reflect the nation's circumstances (Table 1).

Table1. Number of environmental indicators of the K-SDGs (Korea Government, 2018).

SDGs	No. of targets	No. of Indicators in four dimensions*					Examples of environmental indicators
		Total	Social	Eco-nomic	Environ-mental	Inter-national	
1	5	9	7	(1)	1	1	no. of casualties from natural disasters
2	6	8	5		3		ratio of sustainable agriculture land to total
3	8	17	14		3		ratio of population in cities of unqualified air quality to total
4	8	14	12	2			
5	9	20	20				
6	7	17			17		wastewater reuse rate, water leakage rate
7	4	7	4	1	2		ratio of renewable energy for power generation
8	10	9	6	2	1		footprint of material
9	5	7	4	2	1		CO_2 emission per added value
10	5	8	8				

[1] This paper is a review of a few papers and reports written and published by the author and his associates and colleagues.

SDGs	No. of targets	No. of Indicators in four dimensions*					Examples of environmental indicators
		Total	Social	Eco-nomic	Environ-mental	Inter-national	
11	9	17	15		2		air pollution of metropolitan
12	11	14	4		10		ratio of recycled plastics to total
13	3	4	1		3		ratio of greenhouse gas reduction revenue to total
14	6	8			8		annual average pH in coastal zones
15	9	12			12		sustainable forest management, Korean red list index
16	13	30	28			2	
17	14	23				23	
Sum	132	224	128	6	63	26	

* Number of indicators for four dimensions was solely based on the author's review.

The indicators for the K-SDGs on the water environment (flash water) and agricultural and forest environments were altered during the past three years. In 2016, the water quality conditions of the four rivers were included. They were not considered in the 2018 list of indicators. Meanwhile, indicators for rural water environments are presented, such as the national statistics of wastewater treatments and water reuse. It should be noted that Table 1 is a draft and may not be the final statistics.

2. National hydrological and biosystems

Monitoring programs

Hydrological Investigations

Table 2 summarizes the hydrological and water quality survey programs that are being implemented presently by government agencies and the three government investment corporations. The densities of the hydrological measurements are 142 and 134 km^2 for each precipitation and water stage station, respectively. These are higher than or equal to the international standards for hydrological gaging networks. The water discharge stations by National Institute of Environmental Research (NIER) in Table 2 are for Total Water Pollution Load (TWPL) programs.

The Basic Plan for Hydrological Investigation (BPHS) reported the uncertainties in the hydrological measurements (MOLIT[2], 2008). The probable errors in the precipitation and water stage data from 1997 to 2007 were reported as follows: 1) Missing data in precipitation and water stage records owing to gage failure were determined 5.5% and 4.8%, respectively, on average, and 2) incorrect data by irregular observations or recording were 0.9% and 7.5%, respectively. Since then, no additional information on the uncertainty in hydrological records has been documented. A few of those sources of errors could have been reduced. Nevertheless, it is likely

[2] Ministry of Land, Infrastructure and Transport

that the hydrological records have approximately 10% or less of irregularities or uncertainties. This needs to be reduced to less than 2–3%.

Table2.Summary of the hydrological and water quality monitoring programs (ME, 2019)

Parameters		No. of gaging stations by agencies*								Km^2 per station
		ME	NIER	KMA	K-water	KEPCO	KRA	Local gov't.	Sum	
Hydrology	Precipitation	425		80	186	15			706	142
	Water stage	549	2		156	7	37		751	134
	Discharge	211	262		28				501	200
	Sediment	14			8				22	4,564
	Ground water	442							442	227
Water quality**	River	221	160		31			271	685	
	Lake	81	7		80			23	198	
	agricultural						955		955	
	Urban conduit							37	37	
	Industrial park streams	70							70	
	TWPL stations	64	273(106)						337(106)	
	Automatic WQ	70							70	
	Sum								2,249	44.6

*ME: Ministry of Environment, NIER: National Institute of Environment Research, KMA: Korea Meteorological Administration, K-water: Korea Water Resources Corporation, KEPCO: Korea Electric Power Corporation, KRC: Korea Rural Community Corporation, Local gov't.: Cities and Provinces

**TWPL: Total Water Pollution Load, WQ: water quality measurement

The total number of water quality observatories at rivers, lakes, agricultural reservoirs, city conduits, and industrial park streams is 2,249. These include general, TWPL, nonpoint source pollution, sediment deposit, and radiation observatories. Two government agencies, 15 local governments, and two government investment corporations operate the observatories.

The frequency of the general water quality investigations varies with the purpose of water quality measurements. For the general water quality observatories for rivers and lakes, the measurements are implemented once a month (12 samples a year). The results are used to define the annual average water quality conditions of the rivers. Measurements are being performed three times a month for TWPL observatories (36 samples a year). For agricultural reservoirs, water quality samples are extracted and analyzed two times a year.

Natural Environment and Forest Resources Investigations

Two nationwide surveys on natural resources and environment are carried out annually. They are 1) Nationwide Natural Environment Survey (NNES) by ME and 2) National Forest Resources Survey (NFRS) by Korea Forest Service (KFS). NNES is a map-based national ecosystem survey program to be implemented once in five years. Each of the 824 basic topographic maps of scale 1:25,000 is segmented into nine grids. The investigations are conducted for nine categories of natural environment conditions: landforms, vegetation, flora, benthic macro-invertebrates, terrestrial insects, freshwater fish, amphibians and reptiles, flora, and birds and mammals. In addition, close examinations of the six types of ecological importance including estuaries and national parks are carried out.

NFRS[3] is being implemented for national forests in 4 × 4 km^2 grids once in five years. Approximately 800 sites have been surveyed each year, i.e., approximately 4,000 sites in five years, during the past three decades. Figure 1 is an example of 2010 NFRS site map in the northern part of Korea (Kangwon Province).

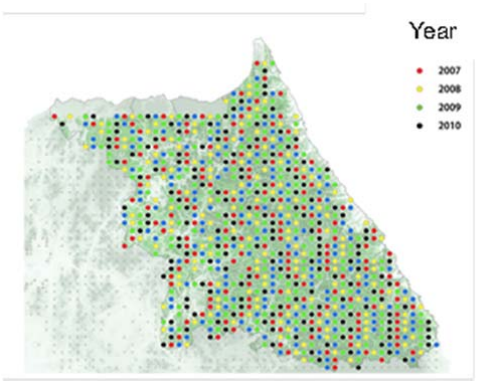


Figure1. A map of Forest Resources Surveys during 2006-2010 (Kangwon Province) (NFCF)

3. Monitoring and Modeling Watershed Hydrology and Water Quality

The author had developed and implemented field and watershed monitoring programs for hydrology, soil erosion, and water quality for 20 years since 1996. The programs involved 1) measurements of the runoff and soil losses from soil erosion experimental plots and an upland field, 2) hydrological and water quality measurements at rice paddies, and 3) measurements of the hydrology and water quality of the streams and lakes from agricultural and forest watersheds. In addition, surveys on geomorphological and land use characteristics, soil characteristics, and cropping and management practices were carried out. As the field and watershed data were filed up, different hydrological and water quality models were applied and validated. Those models

[3] http://nfric.nfcf.or.kr

have been developed for watershed conditions that are significantly different from Korean watersheds. They were observed to be inapplicable to irrigated paddy field conditions and therefore required certain modifications.

The monitoring programs and observations from long-term study results are summarized as follows.

Hydrological and Water Quality Measurements

Figure 2 shows a schematic diagram of the watershed monitoring program for the Baran watershed at Hwasung city. The area of the watershed was 2,649 ha, and the land use was 23% paddy, 4.5% upland field, and 63.3% forest. There are two agricultural reservoirs in the Baran watershed: Gichun and Baran. It consisted of six hydrological measurements using recording stage gages and nine water quality observatories for the watersheds. In addition, six hydrological measurements were implemented at six irrigation canals and paddies. They revealed when and how much water was irrigated. Furthermore, the water depths of 61 paddy fields were surveyed each day during the growing seasons. The irrigation return flow from the paddy blocks was monitored and estimated in the hydrological measurement programs.

Figure 3 shows various devices and settings for soil erosion and hydrological measurements. Soil erosion experiments were carried out in Yeoju and Suwon. Hydrological and water quality measurements were implemented at the Baran watershed. For nonpoint source pollution measurements, an automatic sampler was used to investigate the temporal variations in water quality during flash floods at the discharge stations. All the water samples were taken to the laboratory for analyzing the suspended sediment, nutrient, and coliform concentrations. The details are presented in Table 3. The table also presents the frequencies of hydrological and water quality measurements for the watersheds. The precipitation data were measured using a self-recoding tipping bucket rain gage. Daily and hourly rainfall data for heavy storms were recorded.

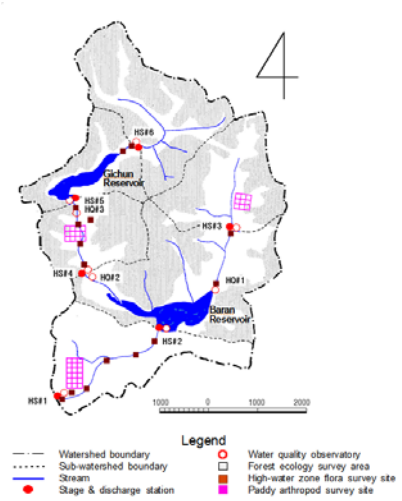


Figure 2. Hydrological and water quality measurements and ecological survey programs at Baran watershed (Park, 2000).

Table 3. Summary of the hydrological and water quality investigation at the Baran watersheds.

Monitoring types		Items		No. of stations	Instrumentation	Frequency of surveys	Survey methods and recorded data
watershed	hydrology	precipitation		1	recording rain gage	weekly	daily, hourly
		water stage	stream	12	stage gage, staff gage	weekly	daily, hourly stage (flash floods)
			lake	2			daily stage, stage-discharge relationship
		discharge		4	current meter	bi-monthly, flash flood	average velocities over cross section
		ground water level		3	ground water level ruler	weekly	ground water observation wells, weekly
	water quality	stream		7	grab sampling, automatic sampler	weekly, flash flood	field measurement: water temperature, pH, EC Lab. analyses: DO, SS, NO3-N, NH4-N, T-N, PO4-P, T-P, coliform
		lake		2			
		ground water		3	grab samples	bi-monthly	
field	water stage	irrigation canal		4	recording gage	weekly	no. of hours/day
		paddies		25	staff (ruler)	daily	daily ponding depth
	drainage(discharge)			5	H-L flume, stage gage	weekly	daily, hourly drainage amount
	water quality			2	grab sampling	weekly	same as in watershed survey

Table4. Hydrological and water quality models applied and validated with the Baran watershed data.

Models	Spatial		Temporal		Simulated/applied parameters*					Applications		References
	Field	Water shed	Event	Con- tinuous	Q	q_p	SS	TN	TP	Modified	Validated	
AGNPS		O	O		O	O	O	O	O	O	O	Lee et al (2007), Chang et al(2011)
CREAMS-PADDY	O			O	O		O	O	O	O	O	Jin et al (2002), Kim et al (2008)
GWLF		O		O	O	O	O	O	O		O	Hwang et al (2006)
HSPF		O		O	O		O	O	O		O	Ko et al (2007), Kim et al (2009)
IREFLOW		O		O	O					O	O	Im & Park (2006), Kim et al (2009)
NRCS CN	O	O	O		O	O					O	Im et al (2007)
NRCS CN-PADDY	O	O	O		O						O	Im & Park (1997)
SSARR		O		O	O		O	O	O		O	Kang et al (2011), Kang & Park (2014)
SWAT		O		O	O		O	O	O		O	Kim et al (2011), Jeong et al (2016)
WEPP	O		O		O	O	O				O	Kang et al (2004)

The stream discharge was determined by multiplying the cross-sectional area by the average velocities measured using a current meter (Figure 3). The velocity measurements were obtained bimonthly at the low and medium water stages, and at intervals of at least 30 min during flash flood events. Meanwhile, the drainage from five paddy fields was measured using H/L flumes equipped with self-recording stage gages. Examples of the hydrological and water quality data for the watersheds are available in a few references (e.g. Park, 2000; Im and Park, 2006; Kim et al, 2009).

1) Soil erosion experimental plots, 2) H/L flume at upland field, 3) stage gaging site, 4) flow velocity measurement, 5) downloading water stage data at irrigation canal, 6) measuring water depth in paddy field, 7) water sampling in paddy field, 8) water sampling in irrigation ditch, 9) water sampling in stream

1	2	3
4	5	6
7	8	9

Figure 3. Soil erosion experimental plots and hydrological and water quality measurements in Baran watershed.

The hydrology and water quality in irrigated paddy fields were observed to be significantly different from those in upland fields or forest watersheds. The direct runoff from paddy fields and the peak runoff were less than that of the forest watershed for storms larger than 60 mm of rainfall during the growing season. However, the hydrological differences between the two watersheds were reversed after the irrigation periods. This is because all the drainage sluice gates in the paddy fields were removed by the farmers.

Other noteworthy features of the paddy hydrology were as follows: 1) The drainage rates decreased as the water depths reduced. Thereby, the drainage time in a large paddy field was over two days. 2) The ground water levels in the paddy fields were affected more by rainfall than by the irrigation. 3) The water quality of the nearby streams deteriorated significantly during the transplanting periods owing to muddy flow from paddy fields. Hydrological models for paddy watersheds were recommended to consider the drainage hydraulic characteristics of paddy.

Certain issues with the monitoring programs that may be noteworthy were as follows: 1) The investigation of water stage in the Baran watershed was not implemented during the frozen

seasons (from late November to early March). 2) The hydrological data for the periods were estimated to supplement the missing data by using mathematical models, although they were not used for the historical data. 3) It was expensive to frequently perform water quality analyses. Nonetheless, bi-monthly water quality data were observed to be inadequate for accurately depicting the variations in the nutrient concentrations, which varied with flash flood and irrigation return flow. 4) The water quality of streams and lakes revealed that the water pollution concentrations were lower in March and higher in May. Irrigation return flow is likely to be the cause of the high concentrations in the transplanting period.

Geomorphological, Soil, and Land Use Surveys

Table 3 summarizes the geomorphological, soil, and land use surveys. The geomorphological surveys detailed watershed parameters such as the watershed area, relief ratio, shape factor, and river density of the six watersheds. Topographic maps of scale 1:25,000 were used to define them. They were verified with satellite images using GIS tools.

The land use and its variations were also revised annually based on interviews with local residents and satellite images. Geological information system (GIS) was used to define the data.

The soil survey was carried out to analyze the soil properties. A soil map of scale 1:25,000 was used for the survey. Moreover, the hydrological soil groups were determined according to the permeability of the soil series.

Table5. A summary of the geomorphological and land use investigations

Survey types	Target areas	Items	Methods
Geomorphological/ land use survey	6 watersheds	watershed area, relief ratio, shape factor, mean slope gradient, river density	1/25,000 topographic map, satellite images, GIS
		land use change	interview, satellite images, GIS
Soil survey	6 watersheds	soil properties (physical), hydrologic soil groups	1/25,000 soil map, soil sampling & lab. Analyses, GIS
Stage-storage relationship	2 reservoirs	Gichun, Baran reservoirs	historical surveying data, satellite images
Agricultural practices survey	4 watersheds	cultural practice survey (interview*)	cropping records (crop types, acreage), tillage, fertilizer and pesticide application rates, seeding & harvesting dates, irrigation water sources

* Interviewing methods were used to keep agricultural practice records (representative farmers)

Cropping and management practice parameters including the times of tillage, seedling, and fertilization days and amounts, and irrigation management information were surveyed

through interviews with farmers and from the local extension officers. The interviews were performed in early March. The land use and hydrological parameters such as the NRCS runoff curve number were analyzed using GIS.

Modeling Field and Watershed Hydrology and Water Quality

Table 4 summarizes ten hydrological and water quality models applied and validated with the data for a few of the Baran watersheds. Three models were developed for paddy field applications. The remaining seven are parametric field and watershed models. All those models were observed to be applicable to complex watersheds with forest and irrigated paddy fields when parameters for irrigation practices were considered adequately.

The return flow from irrigated paddy consisted of two types of runoff processes (Im and Park, 2006). One was the quick return flow in the form of drainage or overflow from paddy fields. The other was the delayed flow released from the recharged ground water owing to ponding irrigation. Simulated irrigation return flow varied with the operation and management of the reservoirs. The return flow at the Gichun reservoir irrigation area ranged from 39 to 48%, whereas it was approximately 33% at the Baran reservoir area. The portions of quick return flow ranged from 30 to 40% of the total return flow. Approximately 40% of the irrigated amount was released in forms of return flow.

The NRCS runoff curve number for irrigated paddy fields was estimated to be 69, 82, and 91 for antecedent moisture conditions (AMC) I, II, and III, respectively (Im et al., 2007). Field measurement data and simulated values were used in the study. The curve number for AMC I and III was derived from probability analyses.

The water quality in irrigated paddy fields revealed that the higher nutrient concentrations (TN and TP) from the fertilization decreased gradually in the form of recession curves when affected by the irrigation and rainfall. CREAMS-PADDY was developed to simulate daily hydrological features and the TN and TP concentrations in a paddy field. It was applied to present the effects of different management practices such as fertilization rates and irrigation practices, on the pollutant loadings to the downstream stream.

Ecological Surveys on Forest, Stream, And Paddy

Three natural ecological surveys were carried out to determine the effects of spatial and temporal intervals on the results from ecological surveys. These were 1) forest resource investigations, 2) flora surveys on fluvial high-water zone and banks of stream reaches, and 3) fauna (arthropod species) surveys in three paddy fields (Table 6). Detailed information is available in the reference (Park et al., 1996).

Forest Resources and Flora Survey

Forest resource investigations were carried out in the three zones: the upstream of the Gichun and Baran reservoirs, exterior of reservoir watersheds, and remote areas from villages (Figure 2). Forest resource investigation was carried out for three 10 × 10 m rectangular zones at 30 m interval for three types of tree species: quercus, pinus, and sorbus.

Quercus, pinus, sorbus, and their combinations were observed to be the dominant trees in

natural conditions. In plantation areas, pinus rigida, koraiensis, populas, acacia, and castanea were surveyed. Oak trees were observed to encroach into pinus plantation areas and are likely to be dominant in the near future.

Table 6. Summary of the forest, high-water zones and stream banks, and paddy ecological investigations.

Survey types	Target areas	Items	Methods
Forest ecology survey	4 forest zones (12 sites)	forest vegetation survey, forest ecology and productivity survey, major forest groups	rectangular network setting, field survey
High-water zone/ bank flora survey	15 sites	vegetation map, biomass, ecology habitat survey, soils	field flora survey, soil sampling & lab analyses
Paddy arthropod survey	3 paddy fields	arthropod distribution, density, biomass	field survey, collecting fauna, Tullgren funnel analyses

For herbaceous plant surveys, 1 × 1 m or 2 × 2 m rectangular plots were laid out. The dominant plant species were determined using the Braun–Blanquet (1964) method. The total number of herbaceous plant species ranged from 31 to 40. It was higher in April and May and lower in October. No significant variations were observed in the species in any of the sites during the five year investigation. Thus, it was concluded that the five-year interval may be feasible for the forest ecological surveys.

a) Forest resources and soil surveys

b) High-water zone and riverbank flora survey sites and biomass measurements

Figure 4. Forest resource and stream bank flora investigation

Flora Survey in Stream High-Water Zones and Banks

Fifteen sites on high-water zones and banks along the streams in the watersheds were selected for flora surveys. The investigation sites were selected at 400–500 m intervals. Among these, five sites were selected for biomass measurements and soil investigation at the upstream and downstream of the two reservoirs.

The herbaceous species and their seasonal coverage were investigated at rectangular quadrat. Moreover, biomass samples were extracted from three 1 × 1 m quadrat for each site, and their 48 h dry weights were recorded in the laboratory. Soil samples were also extracted to analyze physical and chemical properties.

The survey results revealed that the total numbers of herbaceous species in April, June, and August were 46, 101, and 79. Significant spatial variations in the herbaceous species were also observed. However, there were no significant trends wherein the species depended on the surrounding cropland conditions. The spatial variations were more closely related to the streambed materials and soil properties.

Paddy Arthropod Survey

The paddy arthropod survey was conducted in three paddy blocks, as shown in Figure 2. For each block, three zones were selected for the investigation. Before transplanting rice seedling, three tilled and one untilled paddy zones were selected and surveyed for arthropod species on ten 1000 cm^3 soil samples. The samples were placed in Tullgren Funnel to collect all the arthropods for 72 h, which were then regrouped by species and counted. Figure 5 shows three traps and their field applications, i.e., to catch and collect arthropod species.

To investigate the arthropod inside rice stalk, acrylic cages of size 0.5 × 0.5 × 0.7 m were placed over the sampled rice. The arthropod inside the cages was collected and analyzed for the population. The total number of samples extracted in each zone was 10. All the three zones were surveyed on the same day from 10 am to 5 pm.

The results from the survey were as follows: 1) No significant differences in arthropod population were observed among the three zones. 2) The dominant species varied with the growing season. Midge was dominant in the first month following the transplanting. Insect pests followed it, and the spider population increased. The number of natural enemy groups (spider) remained approximately 20 throughout the season. It was observed that the population of the enemy group of paddy was a good indicator of the paddy ecological conditions.

a) Traps for Chironomidae b) Wing traps c) Flypaper traps

Figure 5. Three traps and their field applications for arthropod sampling.

4. Conclusions

This paper presents the results from field and watershed monitoring and modeling programs performed over 20 years to evaluate hydrology, water use for irrigation, soil erosion, water quality, and the agricultural and forest ecology. The monitoring schemes at the Baran watershed are introduced in detail. Thereby, the frequencies and timing of the water quality sampling and ecological surveys are discussed. The testing and validation of hydrological and water quality models with data from the watersheds are also presented. The results are as follows:

1. The hydrological and water quality parameters are better indicators for sustainable development because they are more sensitive to the variations in land use and management in agricultural and rural conditions. The K-SDGs programs need to be revised to include those parameters.

2. The frequencies and timing of water quality measurements are recommended to be adapted to the flow conditions. Better scheduling of the measurements that consider the flow duration of water pollutant loads is necessary. At least one sampling should be performed during the rainy seasons (June to September).

3. The forest resource investigation results reveal that the survey intervals for tree species could be as long as five years similar to the National Program. The herbaceous plant surveys need to be carried out three times annually, so that the dominant species are sampled.

4. The population of spider species is a good indicator of the arthropod ecology in paddy. They better reflect the density of other insect populations, which is a good indicator of the ecological conditions.

Acknowledgments

This paper was partially supported by the Academic Activity Support Program by the Office of the National Academy of Sciences, Republic of Korea.

References

Cho, J.P., S.W. Park, and S.J. Im, 2008. Evaluation of agricultural nonpoint source (AGNPS) model for small watersheds in Korea applying irregular cell delineation. Agr. Wat. Management 95:400-408.

Hwang, S.W., T. Jang, S.W. Park, and M.S. Kang, 2006. The application of the GWLF model for rural small watershed. J. KSAE[4] 48(3):23-34.

Im, S.J. and S.W. Park, 1997. Estimating runoff curve numbers for paddy fields. J. KSWR[5] 30(4):379-387.

Im, S.J. and S.W. Park, 2006. Prediction of daily streamflow on agricultural watershed. J. KCIA[6] 13(2):86-94.

Im, S.J., S.W. Park, and M.S. Kang, 2002. A comparative study of storm runoff characteristics for irrigated paddy fields and forest watershed. J. KSAE 44(3):65-72.

Im, S.J., S.W. Park, and T.I. Jang, 2007. Application of SCS curve number method for irrigated paddy field. J. KSCE, Water Engineering 11(1):51-56.

Jin, Y.M, S.W. Park, S.M. Kim, M.S. Kang, and M.G. Kang, 2002. Nutrient loads estimation at paddy field using CREAM-PADDY model. J. Rural Planning 8(1):60-68.

Jang, T.I., H.K. Kim, S.J. Im, and S.W. Park, 2010. Simulations of storm hydrographs in a mixed-landuse watershed using a modified TR-20 model. Agr. Wat. Management[7] 97:201-207.

Jeong H.S., H.K. Kim, T.I. Jang, and S.W. Park, 2016. Assessing the effects of indirect wastewater reuse on paddy irrigation in the Osan River watershed in Korea using the SWAT model. Agr. Wat. Management. 163:393-402.

Jeong, H.S., H.K. Kim, C.H. Seong, T.I. Jang, and S.W. Park, 2013. Effects of wastewater effluent on river discharge using SWAT model. J. Agr. & Life Sci. 44(1): 32-38.

Jeong, H.S., T.I. Jang, C.H. Seong, and S.W. Park, 2014. Assessing nitrogen fertilizer rates and split applications using DDSAT model for rice irrigated with urban wastewater. Agr. Wat. Management. 141:1-9.

Kang, M.G., S.W. Park, J.H. Son, and M.S. Kang. 2004. Applications of WEPP model to a plot and a small upland watershed. J. KSAE 46(1):87-97.

Kang, M.S., S.W. Park, J.J. Lee, and K.H. Yoo, 2006. Applying SWAT for TMDL programs to a small watershed containing rice paddy fields. Agri. Wat. Management, 79:72-92.

Kang, M.G., S.W. Park, and J.M. Park, 2009. Identifying two-dimensional characteristics of surface water hydraulics in an irrigated paddy field. J. Irr. & Drain. Eng. ASCE[8] Jul/Aug 431-442.

Kang, M.G. and S.W. Park, 2014. Modeling water flows in a serial irrigation reservoir system considering irrigation return flows and reservoir operations. Agr. Wat. Management 143:131-141.

Kim, H.K., M.S. Kang, S.W. Park, J.Y. Choi, and H.J. Yang, 2009. Auto-calibration for the SWAT model hydrological parameters using multi-objective optimization methods. J. KSAE 51(1):1-9.

Kim, J.H., H.S. Jeong, M.S. Kang, I.H. Song, and S.W. Park, 2012. Simulation of 10-day irrigation water quality using SWAT-QUALKO2 linkage model. J. KSAE. 54(6):53-63.

Kim, H.K., E.J. Lee, S.W. Park, and M.S. Kang, 2009. Assessment of impacts of the impervious surface change in the farm region on watershed hydrology. J. KSAE 51(6):17-23.

Lee, E.J., H.K. Kim, and S.W. Park, 2007. Assessing impact of non-point source pollution by management

[4] The Korean Society of Agricultural Engineering
[5] The Korean Society of Water Resources
[6] Korea Commission on Irrigation and Drainage
[7] Agricultural Water Management
[8] American Society of Civil Engineers

alternatives on arable land using AGNPS model. J. Agr. & Life Sci., 41(4):55-61.

MAFRA, 2017. Agriculture, food and rural affairs statistics yearbook 2017. 11-1543000-000261-10. 375p.

ME, 2019. Installation and management plan for water environment measurement networks. 502p. Appendix.

Ministry of Land, Transport and Maritime Affairs, 2008. Basic plan for hydrological survey. GOVP1201015975 627p.

Park, S.W., 2000. Monitoring agro-ecological environments and developing comprehensive agricultural environmental management systems, Final report. Ministry of Agriculture and Forest.

OECD, 2019. Agri-environmental indicators: Nutrient balance. COM/TAD/CA/ ENV/EPOC (2018)5/FINAL. 30P.

Park, S.W., K.S. Yoon, S.J. Im, and M.S. Kang, 1996. Monitoring of agro-ecological environments at small watershed. J. Rural Planning 2(2):91-102.

Seo, C.S., S.W. Park, S.J. Im, K.S. Yoon, S.M. Kim, and M.S. Kang, 2002. Development of CREAMS-PADDY model for simulating pollutants from irrigated paddies. J. KSAE 44(3):146-156.

The Government of the Republic of Korea, 2016. Year one of implementing the SDGs in the Republic of Korea. From a model of development success to a vision for sustainable development. 2016 National Voluntary Review. 33p.

Sustainable Power of Urban Growth from the Standpoint of Investment and Global Division for the Industry of Upscale clothing: The Case Study of Jingu- mae Shibuya Ward Tokyo

TOMOMI MITA[1]

Abstract

This paper is uncovering the change of the main street and close alleys of backside in Omote Sando District Tokyo, from the standpoint of the sign value of urban space and investment. The first, close alleys were residential street until the 1980s. However, from the 1990's the close alleys changed to the global hub of upscale clothing design. This change generated a sharp image of the Omote Sando with the magazine exclusively for fashion. The second, bright image of this district attracted many investment companies. The investment companies and large company of upscale clothes are making some spatial renovation of the buildings. These processes make the land prices in the Omote Sando raised slowly until now. As a result, investment companies and the residents began to update the sign value of urban space to raising the exchange value of urban space. This finding makes sign value of urban space secure connection to the global economy the investment leads. From the case, the sustainable power of urban growth seems like only the design of upscale clothing and investment. However, the potential power is also the global division works for upscale clothing. The significance of this research is discussing the global restructuring of the industry for upscale clothing from the standpoint of urban growth, cultural production, Asian labor and the investment, main theme of the Contemporary Urban Sociology. Also from the case, the sustainable power of urban growth seems like only the design of upscale clothing and investment. However, the potential power is also the global division works for upscale clothing.

1. The purpose of this paper

The purpose of this paper is as follows. The first one is discovering the social process that the investment companies have raised the exchange value of commercial property in the main street and close alleys of the Omote Sando district of Tokyo.

Moreover, the second one, we are discussing this case study from the standpoint of the cultural production, the urban growth and the global economy.

From the 1920s, the Urban Sociology has pursuit the process and social problem of the urbanization. For example, Robert E. Park, E. Burgess, and Luis Wirth did search the process of urbanization with the case studies about the inner area of Chicago (Park, 1925; Burgess, 1925; Wirth,1928). So, they made succeed in finding the social problems that urban growth generates. In the 1920s of Chicago, with rapid urbanization, there are many jobless workers, a divorced person, gangs and suicides. So, the urban sociology in this era is the required solutions to reduce these social problems.

However, from the 1970s, due to the Oil Shock, the sector of manufacture in the large cities of the advanced countries were declined because the industrial plants moved from the developed countries to the Newly Industrializing Economies (NIEs). For example, industrial plants get away from advanced countries and made many enclaves in East Asia, South Asia,

[1] Dr Associate Professor, Sociology Department of Administrative Studies Prefectural University of Kumamoto Japan

North Africa, and South America. These phenomena make developed countries around the world experience declining. So urban researcher pursuit what is the power of urban regrowth.

The contemporary urban sociology has grasped the power of regrowth as knowledge production. Case in point is the derivatives trading (Sassen, 2001). For example, in contemporary Financial, Insurance, Property Sector and Producer Service, with derivatives, the secured asset will be the core of the global economy (Sassen, 2001). There are increasing demands from clients who prefer a variety of investment instruments, including foreign bonds, investment trusts and derivatives traded under foreign currencies. So contemporary urban sociology grasped urban regrowth power as investment trusts and derivatives. Sassen mentioned that the global economy is proceeding the urban restructuring with the securities investment trust (Sassen, 2001).

From the standpoint of the economic geographies, Olds uncovers global social processes underlying the production of contemporary urban renewal projects, with the case study of Pacific Rim cities from the 1980s (Olds, 1995). Olds focuses on the exchange of real estate with Securities as the way of the Urban Mega Project (Olds, 1995). Also, Neil Smith mentioned the ideas of urban regrowth as the investment to real estate (Smith, 2002). Weber discovers that spatial policies, such as urban renewal funding for slum clearance or contemporary financial incentives, depend on discursive practices that stigmatize properties targeted for demolition and redevelopment (Weber, 2002).

In this way, Olds and Weber described global financial markets seeking short term returns from subsidized property investments. Also, Toshio Kamo, economic geographer of Japan, said in the urban restructuring, investment trusts and derivatives are the most critical factors (Kamo, 1995). Like this, knowledge production focused on urban sociology, and economic geographies are from the standpoint of the global economy.

On the other hand, the contemporary urban sociology from the standpoint of the cultural production by some researcher -The pursuit of the relation of urban growth and the design of art, design of clothing, consumer of apparel, and so on. The case study about the art and the urban growth (Zukin, 1988), the case study about the digital design (Lloyd, 2006), also, the case study about the design of clothing and furniture (Bovone, 2005; Mita, 2013).

The production of the art is grasped as a power of urban growth and gentrification with "Loft living" (Zukin,1988). Zukin argued that in the 1960s, the manufacturing buildings on the Lower Manhattan had been closed because manufacturing got out to any other country or area. So, the Lower Manhattan was like a wasteland in the last 1960s, so a rental fee of the building was cheaper. On the other hand, there were young or poor artists searched lower pay in Lower Manhattan. They gathered the vacant rooms. So, they were succeeding for updating the design of the space in these buildings. The image of the buildings and this area had been aesthetic.

However, the developers bought these buildings from the owners as high prices. These developers and the owners swiped the artists and sold the room for young adults and white collars (Zukin, 1988). Also, Zukin grasped the young power of renewing the urban space and gentrification.

Richard Lloyd argued that the spatial change of Wicker Park in Chicago (Lloyd, 2006). This district is near the Damen station and Division Station of the blue line train for O'Hare Airport via the LOOP.

This area is the inner area of Chicago city. Until the1980's, The Wicker Park district was wasteland (Lloyd, 2006). From the 1980s, Young artists have the skill about digital design, were gathering into the Wicker Park. The young artist rent the offices for digital design and the school of digital design near the Division Station and Damen Station of the Blue Line Train. Until the 2000s, Wicker Park has been a "farm league" of professional designers with digital skills (Lloyd, 2006). Lloyd grasped the cultural production with digital skills is as the power of urban growth of the inner area of Chicago by "Neo-Bohemia" (Lloyd, 2006).

The paper of Mita (2013) describes the social process in which close residential alleys developed into the global hub of clothing design by with the case study of Jingu Mae Shibuya Ward Tokyo. Also, Mita (2013) discuss this social process from the standpoint of Urban Sociology (Mita, 2013). This paper discovered as follows. In the 1990s, self-employed clothing designers have established the offices on the nearby alleys in the Jingu Mae. Initially, these nearby alleys were for residents. However, in the early 1990s, after the asset- inflated bubble burst, these close alleys began to be transformed into the global hub for self-employed clothing designers (Mita, 2013). The reason for this transformation of the nearby alley is as follows (Mita, 2013). During the 1980s, when land prices went sky high, many residents who could not pay the rising fixed property tax moved out to other areas and sold to the developers with high prices.

On the other hand, some residents scrapped their house and rebuilt the low- rise, and low rents commercial buildings owned themselves. These buildings attracted some designers of clothing, and they gathered to the close alleys and made the base for clothing design. They have some global networks specialized for clothing design.

Moreover, they have created an advanced style with sophisticated knowledge and excellent skills. These self-employed designers attract some large high brand clothing companies made a business alliance with them. These large companies could buy a new design and sell it as the latest fad clothing.

As a result, the close alleys in Jingu Mae have become "the global hub for research of clothing design." (Mita, 2013). The academic significance of Mita (2013) is to focus on the global network of self-employed designers. Also, this previous research focuses on the new role as a global hub for clothing design of the close alleys in Jingu Mae Shibuya Tokyo, one of the Global Cities (Sassen, 2001). The second significance is the discussion of the finding from the standpoint of the income gap among producer services of the fashion design in the global city (Mita, 2013).

In this way, the researcher of urban Sociology grasped the urban regrowth power as cultural production. Contemporary research of cultural production can understand as the knowledge production because contemporary designers and artists need much knowledge about the trend of fashion and the style of contemporary art and high digital skill.

However, any previous case studies could not discuss with connecting the cultural production, the investment the global economy leads, and the urban regrowth. From the 2000s, by easing of regulation of the investment in Japan, the companies for investments in the real estate are inaugurated by the sector of global finance in Tokyo (Yabe, 2008). Global REIT companies may do in New York, Sydney, Paris, Tokyo, and so on (Yabe, 2008). From the 2000s, some companies for investment began trading the real estate in the fashionable street in the Jingu Mae district Shibuya Ward Tokyo (Yabe, 2008). Because the investment companies grasp

cultural production of upscale clothing and creating of the esthetic urban space as the powers of making economic resources, these companies for investment may do; they could get the economic resources and distributes the margin to themselves and the client corporations around the world.

So, we can understand the significance of grasping the cultural production not only as of the power of urban growth but also as the target of derivative financial instruments. Furthermore, we will understand that contemporary urban sociology should discuss the cultural production and urban growth from the standpoint of the investment companies that the global economy lead. An above story means the importance of considering fastening cultural production, urban growth, and the global economy. These descriptions are the academic significance of this research.

Then the purpose of this research is discovering the research questions as follows. The first one is discovering the social process that the investment companies have raised the economic value of commercial property in the main street and close alleys of the backside of it in Tokyo. The second one is discussing this case study with fastening the cultural production, the urban growth and the global economy.

2. Frame of Analysis: The Sign Value of Urban Space raising the Exchange Value of Urban Space

This paper will focus on four values of the urban space. The first is the Value in Use of Urban Space. The second is the Exchange Value of Urban Space. The third one is the Symbolic Value of Urban Space. For Example, the Common and the Beacon Hill in Boston City (Firey, 1945). Also, Matsumoto (2014) [in Japanese] The Symbolic value of Urban Space in the case study of the “Creative Scene” in the Southside of MM21 District in Yokohama City, Greater Tokyo (Matsumoto, 2014).

The last is the Sign value of Urban Space. “Sign Value” is a concept generated by Jean Baudrillard (Baudrillard, 1970). Baudrillard thinks that sign value denotes and describes the value accorded to an object. Because he thinks that the style our lifestyle consists of the design of clothing, logo, architecture and space and so on. Baudrillard thinks sign value as important as the value of the material.

So, he generates the concept "distinction."(Baudrillard, 1970). Baudrillard thinks contemporary society is launched and operated by the distinction of sign value. For example, the design of clothing is changed frequently; we are buying a new style one.

In generally, the using value of urban space decides the exchange value of urban space. However, not only the using value decides the exchange value. But also, the Symbolic Value and Sign Value of Urban Space decide the exchange value of urban space. Because, we think not the only economic issue in the urban life in every day, but also, we think the issue of social relation, symbolic issue and cultural issue in the urban life in the everyday.

So, we should think not only the value of urban space but also the value of sign value (Boaurdrialled, 1970). That is to say, the chance of consuming is increased, contemporary society is operated sustainably. Then the society based on the consumption, Baudrillard calls “Consumption Society.”

In the Contemporary Consumption Society, the urban space consists of the fashionable space in the boutiques, the flag shops of upscale clothing, the building the design office rent, and so on. So, the urban space may generate a fashionable atmosphere. This atmosphere is changing into the new one with the fashion of clothing design are changing to the new one. So, the value of urban space based on these atmospheres can be called as a new concept, the sign value of urban space.

From the 1920s, Urban Sociology has pursuit the social process of the urbanization. However, from the 1970s, due to the Oil Shock, the sector of manufacture in the main cities around the world were declined. So, the urban sociology pursuit any answer to the research question what the power of urban regrowth is.

However, they did not think the urban regrowth from the standpoint of the cultural production in the global city and the investment sectors global economy lead. We present a new hypothesis that the new image of the urban space as a fashionable cultural centre, the presence of the clothing design industry will generate the sign value of urban space. Also, the sign value of urban space raises the exchange value of the clothes design there.

The hypothesis of this research is that not only Value in Use of Urban Space and Symbolic Value of Urban Space, but also Sign Value of Urban Space determines the Exchange Value of Urban Space.

Support for this hypothesis would indicate that the distinction for the sign value of urban space provides opportunities for getting economic resource with real estate investment. Also, this case study, local resident, culturally designed clothes, and retail companies will become strongly connected to the global economy, which is already influenced by investment companies.

This connection of the sign value of urban space to the global economy could foster sustained urban growth of the fashionable quarters with investment to the significant value and use in value.

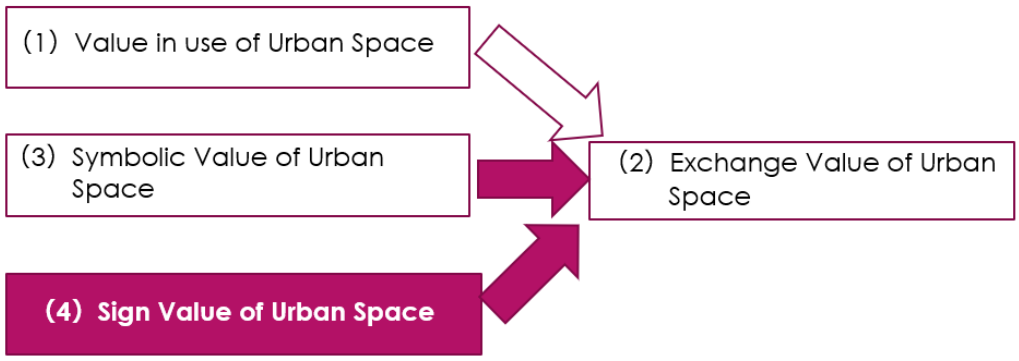


Fig. 1 Alternative Frame of the relationship around the value of urban space

3. The case and the way of Research

3.1 The Case

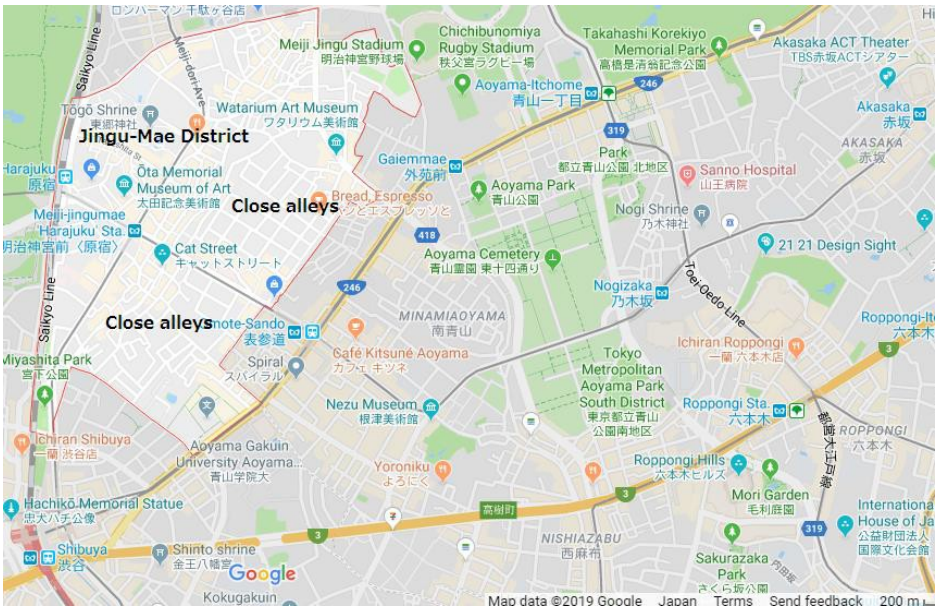
The place of this Case Study is the upscale quarter Omote Sando District, Jingu Mae Shibuya Ward and Minami Aoyama Minato Ward Tokyo. The way of the survey is the interview for Fashion Designers, the company of real estate in this area. The duration of this case study is

four years. The estimated fiscal year of completing this research will be 2021.

The main street consists of large pliers beside the temple path and the close alleys in the Minami Aoyama Minato Ward and Jingu Mae Shibuya Ward Tokyo Metropolis. We take around 60 minutes from Tokyo Haneda International Airport with Shuttle Train and the Subway from the heart of Tokyo. Furthermore, we should take more than 120 minutes from Tokyo Narita International Airport with the Airport Shuttle Train from North side of Tokyo. Also, the field of this study is near the candidate venue of the main stadium for the Tokyo Olympics and the Tokyo Paralympics 2020.

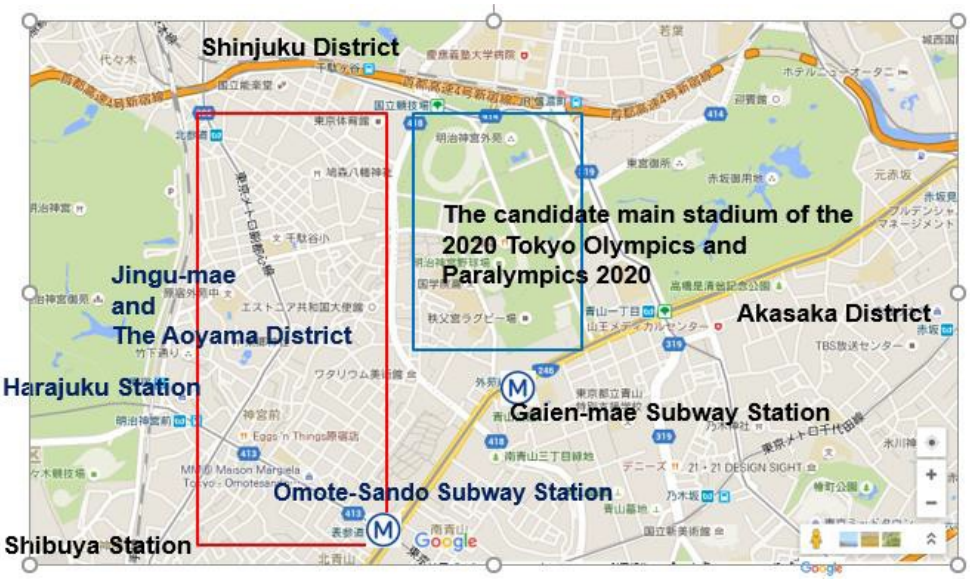
By Google Maps/ Reference on May. 1 - 2019.

Map 1: The location of the Shibuya Ward Tokyo



By Google Maps/ Reference on May. 1 - 2019.

Map 2: The location of Jingu Mae



Map 2: The location of Omote Sando
By Google Maps/ Reference on May. 1 - 2019.

The field of this study is near the candidate venue of the main stadium for the Tokyo Olympics 2020 and the Tokyo Paralympics 2020. The large pliers beside the temple path and close alleys in the Omote Sando district were residential streets until the 1980s. However, from the 1990s, large pliers beside the temple path and the close alleys have changed to the global hub of clothing design and shopping. This change in the close alleys made with the sharp image of this area by doing make domestic and international magazines, TVs, Web, and so on. These alleys prepared for use as a diversionary channel of the Meiji-Dori main avenue due to the massive traffic congestion. Also, the close alleys near the Omote Sando subway station are the covered conduit of the sewerage between the Shinjuku and the Shibuya.

Tokyo Metro-politan Government suffers significantly from the traffic congestion of Meiji Dori Avenue, in the Tokyo Olympic 1964. However, the close alleys are very narrow, so the police and the Tokyo Metropolitan Government did not allow this alley as the diversionary channel of Meiji-Dori Avenue.

Photo1. Omote Sando Street (Main Street)

*Shooting it by Author

Photo 2. Omote Sando Street (Main Street) *Shooting it by Author

Photo 3. Residential and shopping alley in the Jingu Mae district
*Shooting it by Author

Photo 4. Omote Sando Hills
The Omote Sando Hills is operated by Mori Hills (REIT Company)
*Shooting it by author

Moreover, the parts of large pliers beside the temple path in the Omote Sando district consisted of the houses for the employee of Electric Tram, operated by Tokyo Metropolitan Government. They were an employee of the Aoyama Car Base until the 1970s. The residents of

the Jingu Mae who did work on the Aoyama Car Base was the technology person of cars, the drivers and the conductors.

The commercial property in this area should be designated more than one house-hold room in every building, due to the zoning regulations by Shibuya Ward and Tokyo Metropolitan Government. The close alleys in the Jingu Mae district were residential streets until the 1980s. However, from the 1990s, the close alleys have changed into the global hub of clothing design and shopping with household rooms.

3.2 The Way of this Research

This research consists of four surveys and making some discussion on the base of descript. The first, we will uncover the change of spaces with the case of the close allay in the Jingu Mae (Harajuku) District. The second, we will get some knowledge around fashion and investment. The Final, we will discuss the case of this study from the standpoint of the Urban Sociology.

The way of a survey is as follows. The first, this author has interviewed the designers who have the design office in the close alleys of Jingu Mae district from 2003 to 2015. In 2003 to 2008 this author saw as the Kitchen staff and galley of café lounge in Minami Aoyama Minato Ward Tokyo nearby the Jingu Mae Shibuya Ward.

The author has been speaking with customers of this lounge. In this way, the author has been hearing them the workflow of an industry for fashion. Also, the author made a global social network of designers for upscale clothing. So, this author could on going to hear them.

The designers and models have the office for design not only in Tokyo but also in Paris, Antwerp, New York, and so on. The reason for gathering to this café lounge is that these designers should participate in the Fashion Show "Tokyo Collection" and "Tokyo Fashion Week." They finished the show and gathering to this café lounge.

Further, the owner and the staffs of this lounge have the other office for trading the imported clothing in the Jingu Mae, Minami Aoyama, and Gifu. So, the owner and the teams of this lounge have the global network of the designers of upscale clothing, press, and models. Also, this author could be hearing the DJ working in this lounge and night jazz club, and so on.

The participant observation by the author could understand the cultural production of upscale clothing. As well, the way of sampling is snow bawl sampling through the influence of the customers of lounge who are the designers of upscale clothing, the female fashion model from the Euro and the chief of this lounge. The duration of the social survey on this lounge is 17 years (from 2002 to 2019).

The second, the author had heard the owner of the local shop for real estate in 2011 to 2015. The hearing for the owners by this author could understand the history of the Jingu Mae district. Also, the author grasps the owner and residents as the key person of spatial change in the close alleys of this area. As well, the way of sampling is snow bowl sampling through the influence of Professor Iguchi Norio Aoyama University. The duration of the social survey for local real estate shop is from 2011 to 2015.

The third, the author had heard the staffs of some megabanks that established the paper

companies. This author could listen to the flame of Real Estate Investment Trust "REIT." The way of sampling is snow-bawl sampling through the influence of the customers of the lounge who are the staffs of real estate companies in the heart of Tokyo. Duration of a social survey of this research is from 2012 to 2019.

So, the last, the author could hear the investment companies on the Aoyama Tokyo, Osaka and the East 9th street in the Lower Manhattan New York. The author could get the strategies for investment to the small offices of fashion design and retail companies. Duration of this social survey is 2014 to 2017 (four years). Thus, data of this paper consists of an interview and free discussions.

The case study includes two points. The first point is the investment companies which specialize in dealing with the commercial property in close alleys in Jingu Mae and Minami-Aoyama. The second point is uncovering the economic value of the commercial property with changing the image and brand value of the urban space made by cultural producers of upscale clothing, sellers of upscale clothing, the developers and the investment companies for real estates.

4. The Change of the close alleys in the Jingu Mae District Shibuya Ward Tokyo

The Omote Sando district consisted of temple path and residential streets until the 1980s. From the residential street to the global hub of clothing design, the area had consisted of several residential neighbor hoods until the mid- 1980s. After the asset-inflated bubble economy has burst, it has become a fashionable commercial district with many boutiques, hair salons, and some clothing design firms. The transformation of the close alleys in the Jingu Mae is described below.

Initially, the residents in the Jingu Mae had developed regional activities for improvement of the living environment until the early 1980s. Because, Takeshita district, the South of Jingu Mae, had been accumulated the beaver bases from the 1950s to the 1970s. Takeshita Avenue is the nearest the Meiji- Jingu Shrine. So many Japanese Inn is running in the Takeshita Avenue for the customers for worshipping at a Shinto shrine (only Japan) from the North Kanto,

Tohoku and so on, with an extra train to the Harajuku Station.

By the regulation of worshipping at a Shinto shrine, the Japanese Inn on the Takeshita Avenue changed the business category from the Japanese into the beaver bases. In Takeshita Avenue, the bad women are going on the prowl even as school-commuting roads to the Jingu Mae Junior School. That is why the residents in the Jingu Mae had been on the high alert, and they kept close tabs.

Not only that, the problem of Takeshita Avenue, but also the Jingu Mae district, has many problems. In 1964, Tokyo Olympic was ongoing in the National Sports Stadium near the Jingu Mae district. The crowds were going home via the Jingu Mae district. They have a night long Binge with themselves. Also, the bike gangs were gathering to Meiji Avenue in every late night. The residents in the Jingu Mae district suffer torment due to the tremendous noise.

In the late 1960s, the residents had a petition for the City Office of Shibuya Ward and Tokyo Metropolitan Government for the formulation of the regulation of local government for the improvement of the living environment. Also, then the Tokyo Metropolitan government set the regulation of the local government that the prohibition of running all the accommodations and the control of the Business category. In the Jingu Mae district, running is prohibited except for the shop of clothing, the coffee shop, and the restaurant with a current environment.

Moreover, the local merchants' association of the Jingu Mae and Aoyama Minato Ward Tokyo planted the Zelkova trees (Japanese Called "Keyaki") on the Omote Sando Street. They are doing beautification activities in all areas of Jingu Mae district. Beautification activities by the local merchants' association and agglomeration of trendy shops and offices for clothing design make Jingu Mae fashionable district.

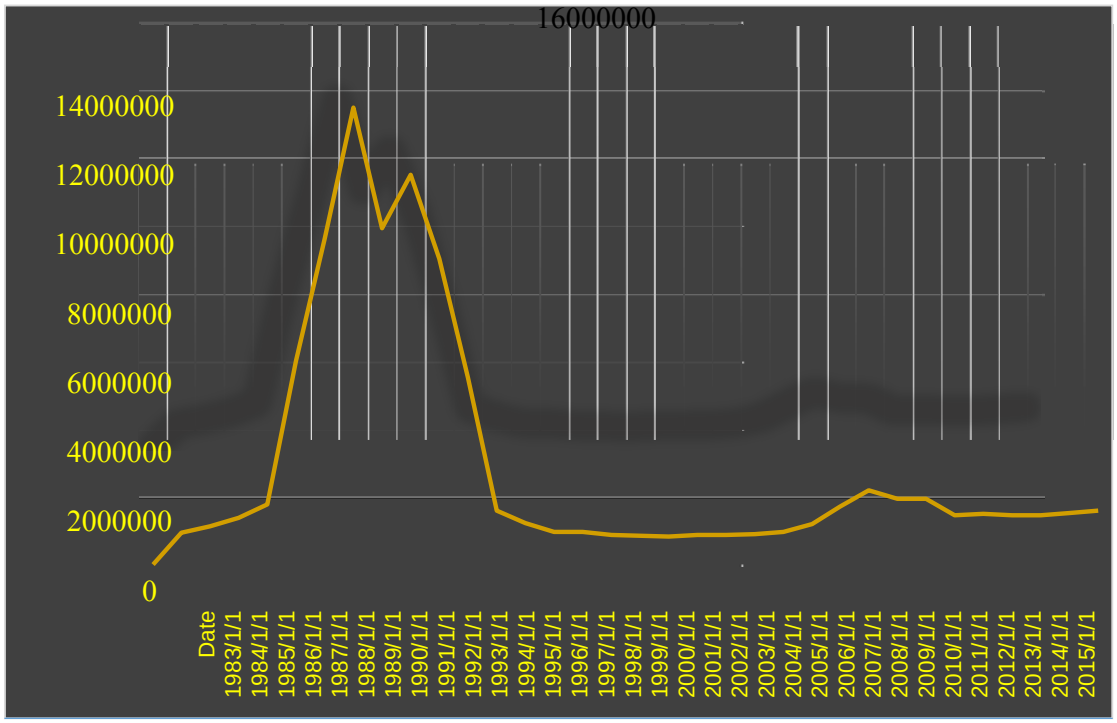
In the 1980s, the bubble economy period, the land price of Omote Sando Street was excessively high. After that, many investors, on the cities of the developing countries, did expect the economic ripple effect to the close alleys in the Jingu Mae. So, some company members of the developer and the investment companies did advise the residents scraped their houses and rebuild the low rise buildings for the shops of upscale clothing and the offices of clothing design. The residents and the developers did raise the high revenue.

In the mid-1980s, some residents who could not pay hefty property tax move out to other areas and sold their land at a high price to the developer. As noted above, the other residents scraped their house and built commer-cial buildings owned by themselves. The tenants of these buildings are bou-tiques, hair salons, and some clothing design firms, and the owners of these buildings are living upper floor. The owners of these buildings are making their living by rental income. However, the setting rent is lower than initially expected. In this way, since the 1990s self-employed clothing designers and the owners of the shops of upscale clothing have established the offices on the close alleys in Jingu Mae.

After the asset inflated bubble burst, the land price of the close alleys of this district is going lower than the late of the 1980's. However, after the accumulations of the office of the clothing design and shops, the land prices make an appreciation. All right, the land price slumped due to the financial crisis (of 2007–08), from 2011, the land price move ups again. The cause of moving up of the land price in this district is the accumulations of the office of the clothing design and shops of the upscale clothing. Also, the investment companies move ups the land price with a design of clothing and fashion and clothing shops.

The designers of upscale clothing have global networks specialized for clothing design. Also, they have cre-ated advanced style with sophisticated knowledge and sophisticated skills (Mita, 2013). So, some large clothing companies, attracted by self-employed designers, made a business alliance with them. In this way, these large companies could buy a new design and sell it as the latest fad clothing. As a result, the close alleys in Jingu Mae have become a global hub for the design of clothing.

Authority: Ministry of Land, Infrastructure, Transport, and Tourism of Japan



Graph 1. The Land Price of the land in Jingu Mae Shibuya Ward Tokyo (JPY) /per 1m^2

Table 1. The Land Price of the land in Jingu Mae Shibuya Ward Tokyo (JPY) /per 1m^2

Date	Price	Date	Price
1983/1/1	940,000	2000/1/1	822,000
1984/1/1	1,120,000	2001/1/1	866,000
1985/1/1	1,370,000	2002/1/1	860,000
1986/1/1	1,772,000	2003/1/1	903,000
1987/1/1	6,000,000	2004/1/1	955,000
1988/1/1	9,620,000	2005/1/1	1,200,000
1989/1/1	13,475,000	2006/1/1	1,700,000
1990/1/1	9,910,000	2007/1/1	2,200,000
1991/1/1	11,500,000	2008/1/1	1,940,000
1992/1/1	9,000,000	2009/1/1	1,940,000
1993/1/1	5,500,000	2010/1/1	1,460,000
1994/1/1	1,600,000	2011/1/1	1,500,000
1995/1/1	1,210,000	2012/1/1	1,460,000
1996/1/1	968,000	2013/1/1	1,460,000
1997/1/1	968,000	2014/1/1	1,530,000
1998/1/1	880,000	2015/1/1	1,580,000
1999/1/1	838,000		

Authority: Ministry of Land, Infrastructure, Transport, and Tourism of Japan

5. The Investment Companies and REIT

Deregulation and the liberalization of trade and investment have laid the foundation for a single world market. From the 2000's the investment companies based on the Tokyo, New York, Paris, Sydney and Sao Paulo has begun to trade the buildings in the close alleys of Jingu Mae with REIT. REIT means "Real Estate Investment Trust." The way of investment is the securitization of land and building. This way banned until 1999. However, easing of regulation in some advanced countries, there is a promotion of securitization of real estate.

So, in 2000, the New York Stock Exchange and Australian Stock Exchange began to make securitization of real estate and maximize their profit margin and make cash dividend to their clients. This way is the unique characteristic of REIT. In 2005, the Financial Services Agency of Japan (FSA), the Securities and Exchange Surveillance Commission and the Tokyo Stock Exchange (TSE) easing of securitization of real estate and maximize their profit margin in 2005 so that some global financial companies began to make securitization of real estate.

Notably, in the greater Tokyo, the railway companies make dormitory suburb and sell the house in the 1970s. So many young people are born in the dormitory suburb in the greater Tokyo. The many people who live in the dormitory suburb in the greater Tokyo, need to go for office or school in the heart of Tokyo. The companies of the railway have built much retail of fashion and food.

For example, in the Shibuya, a heart area of Tokyo, Tokyu Group, the most famous developer and the railway's company in the Kanto district, built the building many buildings around the Shibuya Station in the 1970s. Many young or young adult people live in the suburb of Shibuya (e.g. Setagaya City, the North of Kawasaki City and North of Yokohama City,), Tokyu has developed the dormitory suburb and sell many houses.

And, the Seibu group developed the department store "Ikebukuro Seibu," "Shibuya Seibu," "Ikebukuro Parco," “P’ (dash) Parco,” in the Ikebukuro station, and "Shibuya Parco," the department store for the young adult pursuit for creativity.

The customers of these megastores are living in the house which developed by the Tokyu, Seibu, Keio Company of Railway and development and so on. So, the companies of railway and development succeeded to have many customers who live in the around the station they had developed in the 1970s- 1980s. So, these developers have succeeded not only to raise brand value but also to raise the economic value of the real estate of the heart of Tokyo and the suburb of greater Tokyo. The company of railway and developer of real estate began to focus on the culture of the upscale clothing and investment. So, the companies of railway and development make participation not only in the development but also in the investment.

One of the trends of Tokyo, in 2009, the subway of the sub centre line (The 13th Subway Line of Tokyo) started the operation. The first, this subway line ongoing toward the south side of greater Tokyo on the Tokyu Line and more ongoing to the Waterfront district “MM21” on the subway Line of Yokohama Kanagawa Prefecture (via the waterfront sub centre of Yokohama). The second, the sub centre subway line is ongoing toward the North side of greater Tokyo (e. g., Wako City, Niiza city, Tokorozawa city, Saitama Pref, and Isesaki City, Utsunomiya, Sano, Kurihashi and Kuki City, Nikko City, Tochigi Pref., near of the Fukushima Pref. and Niigata Pref.).

The nearest station of the Jingu Mae is Meiji-Jingu (Harajuku) Station, all the train stops only on holiday. In the day at work, many young adults are going to the office in the heart of Tokyo. In the off days, they are gathering to Jingu Mae District and Omote Sando Street in order to shop with their commuter pass. The Tokyu department company thinks that this station can pull in more customers because all the trains stop on holiday. So, the companies of the railway and development established organizations for investment focusing on the real estate of Meiji-Dori Avenue and Omote Sando Street and made securitization of real estate. With this change, the close alleys of Jingu Mae became associated with a fashionable image and were featured in fashion magazines, which eventually attracted some investment companies.

The companies for investment in real estate on the Tokyo, New York, Paris and Sydney began to trade the articles in the close alleys of Jingu Mae with so called "REIT." REIT means “Real Estate Investment Trust.” From the 2000s, the value of a real estate in the close alleys of Jingu Mae had been rise slowly by the companies for investment in real estate.

For example, the Activia REIT Company, established by Tokyu Group, makes as the Land of Blue Note Tokyo as the target of REIT. ―The fairground of Blue Note is operated by Hanshin Contents Link., Inc (A company of Hankyu Hanshin Toho Group). And this building has the United Allows Boutique as the tenant. This Activia REIT Company, established by Tokyu, elevates the economic value with the bland value of this building. And Sakura REIT Company consists of Galileo (Sydney), and Galileo Japan Trust (Tokyo), make some investments to Minami Aoyama, Azabu, Hiro-o districts. In this way, global REIT Companies focused on the land and building for trendy shops for the upscale clothing on Meiji-Dori Avenue and Omote Sando Street of the heart of Tokyo. Also, Omote Sando Street and Meiji-Dori Avenue are nearest the New National Stadium, the main stadium of the Tokyo Olympic in 2020. So, in the area along the Omote Sando, Meiji-Dori Avenue, and Aoyama-Dori Avenue is the most attractiveness of land as an investment.

Moreover, the nearest Shibuya station and Meiji Jingu Mae station (Harajuku station), there the most buildings for shops of clothes. Because all passenger going to the dormitory suburb (for Yokohama and the Northside of Kawasaki), should board on the subway lines operated by the Public Company of Subway. So, the commuters from the dormitory suburbs where are developed by the companies of railways as the Tokyu, are going to the office around the Shibuya, Harajuku and Omote Sando on Monday to Friday.

Also, they can go to the department store and boutique with their commuter pass on holiday. In weekend, around the Shibuya and Aoyama districts, many young adult commuters who live in the dormitory suburb are the holder of a credit card issued by the companies of railways, subway, developer and real estate, will purchase their commuter pass from their dormitory suburb to the heart of Tokyo with their credit cards issued by them. Because they want to earn “shopping point” and Flight Miles as rewards from the companies’ issue credit card. Also, at the weekend, they would purchase their clothing, furniture and music audio with the same credit card in the department stores operated by the same company as the railway.

So, these customers can get some benefit from the companies of the railway, subway and developer. This business, the company of railway, generates not only the vast economic resources but also the chance of investment to the area of Jingu Mae. So, the railway companies are making some investment in this district themselves.

For example, Tokyu, Seibu, Odakyu, Tobu and the Subway companies make some investment around the Shibuya, Meiji Jingu Mae, Harajuku and Omote Sando stations. Because they are operating directly or at second hand. They think that the investment to around the Shibuya Ward Tokyo is the significant opportunity. Therefore, especially the companies of railway and development make some investment property.

6. Securitization of real estate in the close alleys of Jingu Mae

While on the other hand, there is the REIT Company for the close alleys of Jingu Mae. As previously noted, the economic value of commercial property in the close alleys has been rising slowly from the 2000s until now. They focus not only on commercial properties themselves, but also, they focus on update the fad and the image of Jingu Mae district. Under noted figure indicates the target of the REIT. For example, Japan Retail Investment Company launches the strategies of investment management. This company started by the Mitsubishi Corporation (Tokyo), UBS Real Estate Securities Inc. (New York), and MUFG (Tokyo).

Why the investors focus on the close alleys? Because they focus on adding a touch of class to the buildings and they are refreshing the brand value of the space in close alleys of the Jingu Mae District. They think that if they did so, the price of the commercial properties would be higher. Also, they think that if the close alleys in the Jingu Mae diffused as "the fashionable street" for many young people who are loving the clothing design and loving the shopping of clothing, the close alleys of the Jingu Mae district would be growing demand.

Thereby, the investment companies focus on the close alleys and make investments to the close alleys of the Jingu Mae. In this way, they could get huge margins with dealing the land in the close alleys of Jingu Mae.

As noted previously, in the 1990s, on the close alleys of the Jingu Mae, there were "For Rent" or vacant buildings. The investment company grasped the design office and the small clothing shops opened with low price rent as the power of the rising real estate values. They think if the close alleys in the Jingu Mae, the design offices of clothing and small clothing shops would be opening; the narrow aisles could be focused on by the media (TV and Magazine).

The investment companies bought them buildings with many empty rooms and renovating the space of the rental office. So, the areas and amenities of the rental apartments are immaculate. So that from the early 2000s, many aspirants or candi-dates of the clothing designers or the owners of the upscale clothing shops rent the rooms and opening their Office and the shops in the close alleys of the Jingu Mae. The investment companies operate many of the rental places for the REIT.

Most buildings in the Jingu Mae consist of design offices, clothing shops, and some hair salons. The buildings operated by REIT companies for investment management are increasing. Also, the comradely investment companies sold the building to the other comradely investment more expensive than they bought. If the land price is moving up, the comradely investment companies sold the other comradely investment companies more costly than they purchased. In this way, the controlling investment companies had gotten many economic amounts.

As just described, the close alleys of the Jingu Mae Shibuya Tokyo have transformed from the residential streets to the hub of global networks of clothing design in the 1990s. In the 2000s, the close allays of the Jingu Mae have been the central hub of the investment companies

of real estate and the investment companies for the company of design, manufacturing, retail, and trading.

The close allays of Jingu Mae have been changed from the hub of the global cultural production of clothing to the target of the investment companies. This description indicates the sector of investment based in the cities around the world began to command with money the urban cultural production of the upscale clothing and the downtown retail and the consumer culture of the upscale clothing. Also, the price of the close alleys in the Jingu Mae is higher than the 1990s to the 2000s.

Table 2. The targets of the REIT (e.g. Japan Retail Investment Company)

G Building Minami- Aoyama 02	Minami-Aoyama5	Café, Restaurant and the
G Building Daikanyama01	Ebisu-Nishi 1	Café, Restaurant and the Boutiques
Gyre	Jingu-Mae 5	The Chanel, the Comme des Garcon, Martin Margirela, MOMA and the Japanese most
G Building Kita Aoyama01	Kita-Aoyama 3	Hair salons and bridal salon
G Building Jingu-Mae 02	Jingu-mae 4	Design Sector and the restaurants
G Building OmoteSando01	Jingu-mae6	High Brand Clothing Shops
G Building Jingu-Mae03	Jingu-mae3	High Brand Clothing Shops
G Building Minami-Aoyama01	Minami Aoyama5	Design and High Brand Clothing Shops
La Paul Aoyama	Jingu-Mae 5	The restaurant of the Paris and the Design
G Building Jingu-mae06	Jingu-Mae 6	Design Office and Shops
The Urban Terrace Jingu-Mae	Jingu-Mae 5	Wedding Salon, Design Sector, High Brand Clothing Shops and High-quality restaurants
G Building Omote- Sando 02	Jingu-Mae 4	Design Sector and the Boutiques

Map 3. The main commercial Properties of the Japan Retail Investment Company Home Page of This Company. As of 12 Aug 2015.

Photo6. A Close Allay of the Jingu Mae District

*shooting it by author

7. The change from Global Capital of Upscale Clothes to the Global Investment Capital: The case of LVMH

On the other hand, the large global capital of upscale clothing has knowledge about the sign value and exchange value of urban Space. LVMH has bought many firms around upscale clothes because LVMH wants to get fashionable buildings and the land in the heart of Tokyo. So LVMH makes a specialization of trading real estate with sign value and exchange value of space

of shops and urban space.

LVMH farm out the other small firms for design, manufacture, logistics and retail. So that LVMH, as the large global capital of upscale clothing, has changed from the firm of upscale clothes to the investment company. These companies locate as the retail and branch office in the upscale quarter Omote Sando.

The reason for their focus on the upscale street and close alleys is as follows. Because they focus on adding a touch of class to the buildings and they are refreshing the space of close alleys and upscale street on the Jingu Mae and Minami-Aoyama district.

They think that if they did so, the price of commercial property would be higher. Therefore, the investment companies have been making and update commercial properties in the close alleys of Jingu Mae. Also, the prices of commercial property in the close alleys are rising slowly again until now. With this change, the close alleys of Jingu Mae became associated with a fashionable image and were featured in fashion magazines, which eventually attracted some investment companies.

The reason for their focus on the upscale street and close alley is as follows. Because they focus on adding a touch of class to the buildings and they are refreshing the space of close alleys on the Jingu Mae district. They think that if they did so, the price of commercial property would be higher.

Therefore, the investment companies operated by LVMH have been making and update the design of space for retail in the Omote Sando. Also, the prices of commercial property in the close alleys are rising slowly again until now.

As well, because LVMH specializes in investment, LVMH is outsourcing from design to retail. The design sector is the self-employed small company in the close alleys in Jingu Mae Shibuya Ward. Manufacturing is in two patterns. In the case of the clothes and bag for general customers, products are made in Pudong, Shanghai, with high technology. In the case of clothes and bag for premium members, reserved products are made in Kojima, Kurashiki City, Okayama Pref., Hirokawa Town, Fukuoka Pref., Southside of Nagano Pref., West side of Shizuoka Pref., Aichi Pref. Gifu Pref. and Mie Pref. and so on (Mita, 2014).

As just described, the products made by LVMH are designing and manufacturing in Asian cities. Also, Japanese and Chinese labors are making them. This process is a negative image for the customer of LVMH. Because their customers under the illusion that the products are made in France, Dutch, Germany, or Italy. And the display of every shop is designated by designers from the EU countries. For the unity of images and actuals, LVMH is the outsourcing of unregistering the manufacturing serial number in the small plants operated by Chinese immigrants from Wenzhou in Milan and Bologna, so- called “Third Italy.” The final processes in Italy, these products can be called “Made in Italy.” Upscale looking and serial number certificate the authenticity.

The unity of material authenticity, luxurious looking design of the flag shop, background music used in the Paris Collection and the Milan Collection and offering some concierge services raised the sign value of space of the flag shop on the upscale street.

Also accomplished sign value of space raises the exchange value. In the Omote Sando district, there are around ten affiliated shops of LVMH. The agglomeration of these affiliated

shops for upscale clothes, the design offices of upscale clothes, Keyaki street and smart dressers make the fashionable ambience of the main street in the Omote Sando district. The unity of the style, which the shops for upscale clothes consist of, determines the sign value of urban space and exchange value.

LVMH specializes in research and development of the unity of style. Every design office is in the close alleys in the Omote Sando District. Manufacturing plants are in located in the west side from Shizuoka Pref. Also, large plants are in the Pudong, Shanghai City. The sectors of manufacturing and assembly are in Milan and Bologna. Outsourcing of logistics companies is Federal Express, DHL, Air France KLM, Lufthansa, and so on. The last, outsourced company of retail is Sumitomo Corporation. This global division for the industry of upscale clothes establishes the smooth route for retail and the spatial unity of style. The unity of style determines the sign value of urban space. Also, the sign value determines the exchange value of urban space.

8. The rise of the New Group for Area Management

Furthermore, recently, these residential building owners established a new area management association which consists of residents, owners of new shops, new firms, developers, and a non-profit organization managed by a professor. This association has administered these close alleys in the Jingu Mae as an attractive commercial district for young adult consumers.

The reason for establishing a new association by residents in the Jingu Mae is that they want to live with rental income, and they make a pleasant environment not only for the design offices, the shops of upscale clothing and fad clothing but also for the residents and visitors. For example, the residents need to make maintenance of the buildings together with merchants of cleaning, electronics, a gas company employee, accident, prevention, and so on.

However, the residents who are the owners of the building in the close alleys of Jingu Mae is elderly, so they cannot clean up and check the condition of the building quickly. At which the REIT companies provide service for the building owner maintenance of the building, including the elevator maintenance, checking the security system and the cleaning of the building with consigning to every professional company.

Additionally, the investment company need to take out the building a resident has. So, the investment company takes out the building in the close alleys of the Jingu Mae for a temporary period. So, the investment company can deal with the building in the nearby alleys as the object of the REIT. On these days that the investment company holds the building, they pay a part of the margin to the residents. For residents, they can get margin despite organizing commission and delegating tasks for maintenance of the buildings to the REIT companies.

Seen in this light, the residents in the close alleys of the Jingu Mae are dealing with the investment companies successfully. The residents in the close alleys of Jingu Mae district seem to deal with their building with the investment companies strategically not to have debts but to have an issue.

Thus nowadays, the local community in the Jingu Mae has been composed of the residents, the owner of upscale clothing shops, the firms of the upscale clothing design, the visitors and the investors based on the Tokyo, New York, Paris, Sydney and Sao Paulo. So, the environment for residence has been made better than the past. Especially, residents' plant Keyaki trees on the main street of Omote Sando in order to make a leafy street. So that the main street of

Omote Sando consists of not only stylish buildings and fashionable atmosphere but also natural amenities. So, the main street of Omote Sando is raised of sign value of urban space. Also, it determines the exchange value.

Nowadays, designer of upscale clothes, manufacturing plants, numbering plants, logistic companies and retail sectors are targets for investors. Also, the investors would think that the consumers, staffs of shops, background music, a fad of one season and weather conditions are important composing elements. All the elements relating to the sign value of urban space are targets of investment. So, the field of this research is not only grasped as the upscale street but also grasped as the investment field.

9. Discussion and Conclusion

This paper is uncovering the change of urban space in the close alleys of Jingu Mae Shibuya Ward Tokyo from the standpoint of the Cultural Production and the Investment Company. Also, this paper will discuss this case study from a perspective of urban sociology. More especially, the purpose of the final chapter consists of two issues. The first one is to discuss the cultural production of upscale clothing with an investment of the real estate. Also, the second purpose of this chapter is to discuss the type of change in the Jingu Mae Shibuya Ward Tokyo with comparing the other case studies.

The first, the close alleys in the Jingu Mae Shibuya Ward Tokyo were residential streets until the 1980s. However, from the 1990s, these close alleys changed from the residential streets to the global hub of upscale clothing design.

The second, the change of the close alleys generated a sharp image of the close alleys in the Jingu Mae with the magazine exclusively for fashion. The bright image of the close alleys in the Jingu Mae attracted many investment companies. Especially, from the 2000s, the investment companies are buying the commercial properties in the close alleys of Jingu Mae with operating as the Real Estate Investment Trust (REIT).

The third, investment companies are making some spatial renovation of these buildings and select the tenants to raise the value of these buildings. As a result, the land prices in the close alleys of Jingu Mae is raised slowly until now.

From these three findings, we will make a new theoretical finding. The sharp image of the close alley makes the economic value of it higher. This pattern means that the global cultural production of upscale clothing provides opportunities for raising investment of real estate. In other words, the residents, the global cultural producer of clothing design, and the retailing begin to make a strong connection to the global economy the investment companies lead. Also, it could make sustainable urban growth in the current global economy.

As previously noted, the close alleys in the Jingu Mae Shibuya Ward Tokyo were residential streets until the 1980s. However, from the 1990s, these close alleys changed from the residential streets to the global hub of upscale clothing design. The change of the close alleys generated a sharp image of the close alleys in the Jingu Mae with the magazine exclusively for fashion.

The sharp image of the close alleys in the Jingu Mae attracted many investments. From the 2000s, the investment companies are buying the commercial property in the close alleys of

Jingu Mae with operating as the Real Estate Investment Trust. The investment companies are making renovation of these building and select the fashionable tenants. As a result, the prices of commercial property in the close alleys of Jingu Mae district are raised slowly until now. Also, the land price is rising slowly with REIT.

On case study of this paper, we will make a new finding. The new finding is that the cultural producer of upscale clothes designer renewing the sharp image of urban space, sell their new parts of the design to the large companies; they are making the sign value of clothes and the parts of the sign value of design space, retail space and the urban space of Omote Sando Avenue. As a result, the exchange value of urban space would be raised.

Also, the new investment companies for the design of clothing and the selling of the clothing control the conditions of the urban space. When the cultural producer of upscale clothing is designing it with knowledge about the trend of the global cultural production of clothing, on the other hand, the investor to the fashionable quarter may do so with the knowledge about the real estate.

We present a new hypothesis in which we predict that the sign value of urban space of the Jingu Mae as a fashionable cultural centre due to the presence of the clothing design industry will raise the exchange value of the clothes design and retail space there. Support for this hypothesis would indicate that the cultural production of upscale clothes for a global market provides opportunities for real estate investment with the significant value and exchange value of urban space.

In the Omote Sando district, the local resident, culturally designed clothes, and retail companies will become strongly connected to the global economy, which is already influenced by investment companies. This connection of the sign value of urban space to the global economy could foster sustained urban growth of the fashionable quarters in Jingu Mae.

The Urban Sociology has pursuit the social process of the Urbanization. Robert E. Park, E. Burgess, and Luis Wirth pursuit the social process of the urbanization with the case studies around the inner area of Chicago. However, from the 1970s, due to the Oil Shock, the sector of manufacture on the main cities around the world declined. Also, these sectors getaways and made many enclaves in Asia, North Africa, and South America.

These cases make the large city around the world experience the decline of the city. So, the urban sociologists have pursuit what the power of urban regeneration or redevelopment is. The global economy from the 1980s is proceeding with the securities investment trust (Sassen, 2001).

Also, from the 2000s, by easing of regulation of investment, the companies for investment in the real estate are inaugurated by the sector of global finance (Yabe, 2008). Notably, these companies inaugurated in New York, Sydney, Paris, Tokyo, and so on (Yabe, 2008).

This paper describes that the companies for investment in the real estate began to trade the buildings in the fashionable street of the global city. Because the investment companies think the cultural production and the esthetic urban space make economic resources. If these companies for investment may do, they could get the economic resources and distributes the margin to the clients around the world. Also, we will know that cultural production is grasped

not only as of the power of urban regrowth but also the target of derivative financial instruments global economy leads.

As noted at the beginning, the production of contemporary art is grasped as a power of urban regrowth by "Loft living" (Zukin, 1988). Zukin argued that in the 1960s, the manufacturing buildings on the Lower Manhattan had been closed because manufacturing got out to any other country or area. So Young artists rent the vacant manufacturing buildings, and they were updating the rooms of these buildings. In this regard, the developers bought these buildings from the owners as expensive. These developers swiped the artists and sold the room for wealthy young adults and vibrant white colors. Zukin had been uncovering the agglomeration of an artist in the post industrial city and the change of the resident from the artist to the rich young adult person who has a high wage. Zukin succeeded to watch the process of the gentrification (Zukin, 1988).

A character of gentrification in the United States is a contemporary artist and social class. Richard Lloyd argued that the spatial change of Wicker Park Chicago (Lloyd, 2006). Until the 1980s, The Wicker Park was a wasteland. From the 1980s, Young artists have the skill of digital design were gathering in Wicker Park. They rent the offices for digital design, clothing design, the shops of upscale clothing, and so on. Until 2000s, Wicker Park has been "a farm league" of a professional designer with digital skills (Lloyd, 2006). Lloyd succeeded to uncover the process of the change from the waste street to the hip and quiet street in the inner city of Chicago. Also, Lloyd argues the owner of buildings, the company particularized in the clothing design, and the developers removed the gang and the poor residents from Wicker Park.

In construct, this paper has succeeded in the change of the close alleys from a residential street to the fashionable street. In fact, in the Jingu Mae Shibuya Ward Tokyo, there were many residential owners of the land until the 1980s. The personality of the centre of the capital in the Tokyo Metropolis, many residents, are the owners of the property in the heart of Tokyo. This personality is only in the upscale street, Shibuya, Harajuku and Aoyama districts in Tokyo as a global city.

Under the situation, the City Planning Division of the Shibuya Ward and the Bureau of Urban Development of the Tokyo Metropolitan Government, the Urban Renewal Convention of the Harajuku Jingu Mae but also the companies that are operating the investment companies are upgrading the sharp image of the close alleys in the Jingu Mae and raising the prices of the commercial and residential properties. So, the land price in the Jingu Mae Shibuya Ward Tokyo is rerising slowly from the 2000s expect in the Lehman Shock Crisis in 2008.

So new communities consist of the residential owners, the chiefs in the office for the design of upscale clothing, the owners of the upscale clothing, the professor and the heads in the companies of investments in the real estate. They make relations focus on making improvement of residential environment, the cultural production of upscale clothing and the investment. That, they are working to achieve what was previously thought to be impossible in the upscale quarters on the heart of Tokyo Metropolis.

As just described, from the case study in the close alleys and main street of Omote Sando and close alleys in the back of Omote Sando. It is unidentified of the gentrification that the upper classes boot out the lower classes. Because, in addition to the above case, the residents in the close alleys of Jingu Mae, at the time of the last half 1980s and the first half of the 1990s, were

not booted out but they moved out with command their property for high prices.

The academic significance of urban sociology of this paper is as follows. The previous studies of urban sociology have shown that the transformation from residential neighborhoods into a fashionable commercial district removes residents due to real estate inflation. In construct, this paper has described a new form of area management association mediated by the real estate deal in the fashionable commercial district from the standpoint of the sign value of urban space. This Research uncovers the contemporary investment companies may do with the sign value and exchange value.

Moreover, the investment company has changed from the large firm of upscale clothing. Nowadays, not only the design, manufacturing, logistics and retail of upscale clothing, but also consumers are engines for the investment of real estate. So, this research located in the contemporary urban sociology connecting urban culture of upscale clothes, real estate and the investment leading the global economy.

Especially, this paper described the contradiction that resident who had developed regional activities focusing on improvement of the living environment until the early 1980s has transformed the close alleys into a fashionable commercial district with establishing a new area management association. These descriptions have academic significance for urban sociology today.

However, this paper has some research task near in the future. The research task is to be researching the network of the companies of clothing design, retailing and manufacturing on the global level. So, we could discover the global divisional alliance of the clothing industries from the standpoint of urban sociology.

Also, we will find that the investment companies focus on the trend of global clothing industries and make a new investment for the manufacture of clothing on the local cities of Japan (e.g., Kojima Okayama, Nishiwaki City, Hyogo, Miyoshi Tokushima, Gosen City Niigata Prefecture, and so on). Because at the same time, the investment companies would make a new investment for the large plants on the East Asian Cities.

In the East Asian Cities, there are large plants for the clothing so called Fast Fashion. For example, the plane of fast fashion is in the coastal Jiangsu area, Guangdong area and Shanghai metropolis.

So, this paper should focus on the plants of Asian cities and discuss the case from the standpoint of the urban sociology. In the end, we should uncover and describe the economic gap among the companies of investment in real estate, the large capitals of an upscale brand, the small companies of clothing design, the companies for manufacturing of clothing and the companies for the retailing of the clothing. So, we should survey the ways of a deal the companies of clothing design, the companies of manufacturing for the large capitals of an upscale brand.

With attaining of the new research task previously noted in near the future, we could discover the new academic findings. The new finding is that the investment companies in the real estate control the cultural production of the clothing, manufacturing of the clothing and the consumer culture of the clothing on the global level.

Notes

1) The investment companies are a bogus company. So, the investment companies are administrated by business firm, bank, the companies of railway, developer and so on.
2) The embassies and foreign affiliated banks are located on the Jingu Mae, Akasaka, Minami Aoyama, Mita, Roppon-gi, Hiro-o, and Azabu.
3) The wholesale insurance service companies are located on the Roppon-gi.

   The most famous service company is Allen & Overy LLP is an international law firm, advising national and multinational corporations, financial institutions, and governments. Allen & Overy is a member of the UK's Magic Circle of leading law firms.
4) An office of a Registered Foreign Lawyer is locating in the Roppon-gi: Morgan, Lewis & Bockius LLP.
5) The most familiar example of real estate companies consists of the enterprises of Goldman Sachs Group and the enterprises of West Monte Hospitality Group. There are ten enterprises in Roppon-gi, Azabu and Mita district Minato Ward Tokyo.
6) For example, There are the Embassy of the United states in Akasaka, the Embassy of the Austria locates in Moto-Azabu, the embassy of the France locates in Minami-Azabu and the embassy of the Germany locates in Minami-Azabu, The embassy of Republic, Estonia locates, The embassy of Republic, Turkey locate in the 2 Cho-me Jingu Mae Shibuya Ward Tokyo
7) Huge luxury brand conglomerates, such as LVMH Moet Hennessy Louis Vuitton and Gucci, gave their brands -- and their companies – drastic overhauls, in that they traditionally had been regarded as companies run by individual designers. The core business is investment to other enterprises of the luxury accessories and upscale clothing.
8) MC-UBS Realty and Kanden Realty & Development Corporation made in 2008 co-parent company "MC-UBS Mid City." This co-parent company specialized in the investment to Tokyo, Osaka and Nagoya. Kanden Realty & Development Corporation is a member of the Kansai Electric Power Group, operational area is Osaka, Hyogo, Kyoto, Wakayama, Shiga, Tokushima and Fukui Prefectures, Kansai, partly Shikoku and Hokuriku region of West Japan.

References

Baudrillard. J., 1970, *La Societe de consummation*, Paris: Gallimard.

Bourdieu. P., 1992, *Les regles de l'art: genese et structure du champ litteraire*, Paris: Editions du Seuil.2

Bourdieu. P, 1979, *La Distinction: Critique Sociale du Judgement*, Paris: Editions de Minuit.

Bovone. L., 2005, "Fashionable Quarters in the Postindustrial City: The Ticinese of Milan." *City and Community,* 4-4: 359-380.

Castells. M., 1989, *The Informational City,* Chicago: Blackwell.

Clark, Terry. N., (ed.) 2003. *The City as an Entertainment Machine*, JAI: Elsevier Press.

Crane, D., 1976, "Reward Systems in Art, Science, and Religion," *American Behavioral Scientist,* 19(6): 713-734.

Crane, D., 1992, *the Production of Culture,* Newbury Park, CA: Sage. DiMaggio, P. and P. M. Hirsch, 1976, "Production Organizations in the Arts," *American Behavioral Scientist,* 19(6): 735-752.

Fischer, C. S., 1975. "Toward a Subcultural Theory of Urbanism," *American Journal of Sociology*, (80):1319-1341.

Fischer, C. S., 1984, *the Urban Experience,* New York: Harcourt Brace & Jovanovich.

Florida, R., 2002, *The Rise of the Creative Class: And How It's Transforming Work, Leisure Community and Everyday Life*, Basic Books.

Hirsch, P., 1972, "Processing Fads and Fashions: An Organization-Set of Cultural Industry System," *American Journal of Sociology* 77: 639-659.

———, 1978, "Production and Distribution Roles among Cultural Organizations," *Social Research* 45: 292-314.

Mita T., 2015, Transformation from a Manufacturing Base of School Uniform into a Global Hub for of High-Manufacture Quality Clothing: [in Japanese] The *Annals of Japan Association for Urban Sociology* 2015(33), 71-87.

Mita T., 2013, From Residential Close Alleys into the Global Science Park for Design of Clothing: A Case Study of Jingu Mae District, Shibuya Ward, Tokyo [in Japanese] *The Annals of Japan Association for Urban Sociology* 2013(31), 61-76.

Lloyd, R., 2002, "Neo-Bohemia: Art and Neighborhood Redevelopment in Chicago, *Journal of Urban Affairs* 24: 517-532.

Lloyd, R., 2004, "The Neighborhood in Cultural Production: Material and Symbolic Resources in the New Bohemia" *City and Community* 3-4:343- 372.

Lloyd, R., 2006, Neo-Bohemia: *Art and Commerce in the Postindustrial City*, New York: Routledge.

Olds, K., 1995, ‘‘Globalization and the Production of New Urban Spaces: Pacific

Rim Megaprojects in the late 20th century," *Environment and Planning* A, 27: 1713−1743.

Sassen. S., 2001, *the Global City: New York, London, Tokyo (New Updated Edition).* Princeton, N.J. Princeton University Press.

Weber, R., 2002, "Extracting Value from the City: Neoliberalism and Urban

Redevelopment," *Antipode*, 34 : 519-540.

Wirth, L., 1938, "Urbanism as a Way of Life" *American Journal of Sociology*, 44:1-24.

Yabe, N., 2008, "Impacts of Real Estate Securitization of Land Price Changes in the Inner City of Tokyo since 2001," A Geographically Weighted Regression Analysis," *Geographical Review of Japan*,81: 384−403.

Yabe, N., 2012, "Global Money Flow into the Asset-Backed Securities Market and Real Estate Development in Tokyo," (<Special Issue>Metropolis in the Global Age: Focusing on Tokyo) [in Japanese] *Annals of the Association of Economic Geographers* 54(4): 292-309.

Yabe, N., 2012, "Street Fashion in Ura-Harajuku, Factors in Retail Agglomeration and Effects on Apparel Production," [in Japanese] *Geographical review of Japan* 85(4): 301-323.

Zukin, S., 1988, *Loft Living: Culture and Capital in Urban Change*, New Jersey: Rutgers University Press.

Zukin, S. and E. Kosta, 2004, "Bourdieu Off-Broadway: Managing Distinction on a shopping Block in the East Village," *City and Community*, 3-2: 101- 114.

Zukin, S. et al. 2009, "New Retail Capital and Neighborhood Change: Boutiques and Gentrification in New York City," *City and Community* 8(1): 47-65.

Remarks

Japan Society Promotion of Science (JSPS) supported this work for the Grant- in-Aid for Young Scientists (B). Duration of Support: Arp2016-Mar2021. Estimated Duration of Support: Five years.

Study on Radiation Safety Activities for Health Sector in Myanmar

Aye Aye Thin[1], Nwet Nwet Win[2], Tin Tin Khaing[3]

Abstract

Human health is one of the top priorities for Myanmar. The main uses of radioisotopes in the health sector are for nuclear medicine purposes. Nuclear medicine plays a great role for diagnosis and treatment of cancer and cardiac diseases. Radioiodine (^{131}I) therapy, SPECT gamma camera, SPECT-CT, PET-CT and 18MeV cyclotron provide active clinical uses of Radio-isotopes in Myanmar, improving health-care status. Nuclear related activities, all radiation safety and protection matters such as occupational protection, public protection, medical exposure, radioactive waste are dealt with by the Division of Atomic Energy (DAE). The DAE is charged with the task to develop peaceful applications of radioisotopes under appropriate radiation protection and nuclear safety regime. DAE coordinates with Government and private sector in nuclear medicine to protect the human and environment from radiation hazard. Radiation safety inspections have started for private companies and government hospitals since 1997. National Secondary Standards Dosimetry Laboratory (Phase I, Phase II) and personnel radiation monitoring service has been established to ensure that the workers who exposed directly or indirectly to ionizing radiation are kept within the dose limits recommended by the ICRP and to ensure that nobody is exposed to maximum permissible dose. Disused radium sources from health sector are being stored safely and no cases of overexposure were found in Myanmar. This paper will present brief description of approaches to the radiation safety activities for human health in Myanmar.

Keywords: radioisotopes, radiation safety, protection, nuclear medicine

1. Introduction

The application of ionizing radiation and radioisotopes in various areas of Myanmar has been performed with great momentum for the past sixty years. The various area such as radiotherapy, radio diagnosis, nuclear medicine, medical research, agricultural services, livestock breeding, environmental radiation monitoring, training and research etc., ionizing radiation and radioisotopes have been widely applied in the country. The main uses of radioisotopes and radioactive wastes are in the health sector that uses short-lived radioisotopes (Ra-226) for nuclear medicine purposes. Nuclear medicine plays a great role for diagnosis and treatment of cancer and cardiac diseases, which remain important concerns in the health and welfare of the people in Myanmar [1]. According to the World Health Organization, over 60,000 new cancer cases are estimated to occur each year in Myanmar, with breast cancer the most common among women, and lung cancer the most common among men [2]. Currently, Sr-90, Cs-137 and Co-60 sources are used for radiotherapy and I-131, I- 125 and Tc-99^{m} are the common radiopharmaceuticals. Am-241 and Ba-133 are used for calibration in the field of medicine. Health sector in Myanmar are equipped with SPECT, SPECT/CT, PET/CT, and cyclotron, ^{99m}Tc generators in Yangon General Hospital [3]. IAEA's international basic safety standards (BSS) for protection against ionizing radiation and for the safety of radioactive materials have been developed and issued to restrict radiation risks and to ensure radiological safety [4]. Division of Atomic Energy (DAE),

[1] Deputy Director, Material Science Research Division, Department of Research and Innovation, Ministry of Education, Myanmar ayethin2006@gmail.com
[2] Division of Atomic Energy, Department of Research and Innovation, Ministry of Education, Myanmar win.nwet2@gmail.com
[3] Material Science Research Division, Department of Research and Innovation, Ministry of Education, Myanmar tintinkhaing72@gmail.com

Ministry of Education has been established since 1997 to carry out research, development and training in the field of atomic energy, to ensure the safety of the radiation sources and the protection from nuclear radiation hazards and to promote the applications of nuclear science and technology in Myanmar. DAE has taken the duties to establish the national legal framework and responsibility for regulatory infrastructure of nuclear safety regime [5]. DAE coordinate with Government and private sector in nuclear medicine for the safety of human and environment from radiation hazard.

2. Methods

The Government of Myanmar in collaboration with International Atomic Energy Agency (IAEA) has played a pivotal role not only for successful implementation of DAE's projects, but also for sustainable growth and upgrading of nuclear medicine services in Myanmar [3]. At present, there are six nuclear medicine centers under the Ministry of Health and one in private sector. With IAEA's assistance, the main training fields of DAE include radiation protection, the applications of radiological and nuclear techniques in agriculture, industry and medicine, such as diagnostic radiology, radiotherapy, nuclear medicine, radioimmunoassay techniques. TC Projects have provided assistance and expertise in strengthening the radiotherapy infrastructure and human capacity, safety at the workplace in Myanmar. Currently, for national inventory of source, the software used is RAIS (Regulatory Authority Information System) version 3.3 which is a tool developed by IAEA for regulatory authorities. The list of private clinics and hospitals are collected with the co-operation of DAE and Ministry of Health and Sport. All radioactive sources are registered and licensed by DAE with authorization of Ministry of Education. X-ray machines from Government hospitals and private health sectors are registered. DAE officers have started inspection for private companies and government hospitals since 1997. They also inspect permission licenses prior to importing and re-exporting of equipments from nuclear medicine services shown in Figure 1. Inspection is carried out every Wednesday and Thursday to clinics and hospitals not only radiation leakage but d o quality control of their X-ray machines as voltage accuracy test, timer accuracy test, collimator and beam alignment test, output tube consistency test shown in Figure 2. The Inspectors from DAE also disseminate security culture for radioactive sources to pave way for future use of nuclear security practices among private and government health sectors.

Figure1a. PET/CT and Cyclotron center, b: PET/CT Gemini, TOF,16 slices, c:Cyclotron 18MeV Iba, d: ^{99m}Tc generator, e:^{131}I production fume cupboard

Figure2. Regular inspection active ities and quality control

For occupational exposure control, DAE is extending personnel dosimeter services to the radiation workers on national level. Thermoluminescent dosimetry (TLD) badges and Optically Stimulated Luminescence Dosimetry System (OSLD) are distributed to the workers to wear during their duty hours. OSLD is shown in Figure 3. For internal exposure, depending on type of radionuclide used remedial action is taken as appropriate.

Figure3. Automatic reader 200-unit and dosimeter designation

National Secondary Standard Dosimetry Laboratory (Phase I, Phase II) has been established with the aim of to ensure confidence in the radiation dose for radiation protection, especially given to patients in radiotherapy and radio diagnostics and to calibrate the dosimetry equipment in accordance with international standards and issue calibration certificates and to accredit laboratory according to ISO17025[1].

The procedures of waste management activities are collection, treatment, conditioning, packaging and storage [6]. Division of Atomic Energy is responsible for carrying out research and development in radioactive waste management. The main sources of radioactive wastes in Myanmar are mainly from hospitals that use short-lived radioisotopes for nuclear medicine purposes. The process of conditioning for spent Ra226 from health sector had been performed in DAE shown in Figure 4. The purposes of waste management policy are: the waste is returned to the manufacturers, is stored by licensees, and is sent to National Waste Center [7].

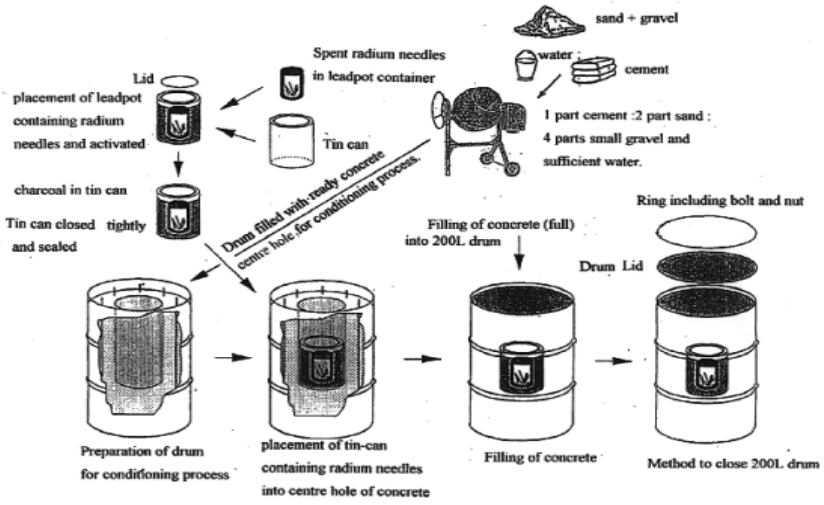


Figure4. Conditioning process for spent radium-226 needles

3. Results and Discussion

It is very important that radiation safety of patients for the reduction of patient doses without losing diagnostic benefits and the exposure should be kept as low as reasonably achievable. According to the hospital-based data, annually, approximately more than 7500 new patients are registered in the four radiotherapy centers (Yangon, Mandalay, Nay Pyi Taw and Taungyi) and radiotherapy is offered to cancer patients for curative and palliative treatment free of charge. Medical equipment's under Ministry of Health and Sport are shown in Table 1. The facilities have be conducted within the framework of a well-established radiation protection programme and personnel monitoring for all radiation workers, whole body or beta sensitive extremity monitoring have be established by cooperation of Division of Atomic Energy, Ministry of Education. Radiation protection training for radiographers from health sector is being conducted each year.

Table1. Division for Human Health DIRAC (Directory of Radiotherapy Centres)

Country	Region	RT Centres	Clinical Accel.	Co-60	CT	Simul.	TPS	LDR Manual	LDR Remote	HDR Ir-192	HDR Co-60
Myanmar	South east Asia	8	15	4	7	1	8	0	0	0	2

Total license issued for radioactive sources and X-ray machined (up to 27 August 2018) is shown in Table 2. The personal doses were periodically analyzed to confirm that radiation working conditions remained unchanged. An average dose of 0.50 mSv was received. All measurements were found to be within acceptable limits of radiation protection. No cases of overexposure were found. The radiation workers in Myanmar are in safe working conditions of radiation protection because radiation safety has been enhanced by improvement in shielding design, good working practices and quality assurance policies.

Table 2. License issued for radioactive sources and x-ray machine

License Issued 1997 to 2018	No. of License Issued		No. of Sources		No. of X-Rays		Dental		No. of Reg
	New License Issued	Renew License Issued	New	Renew	New	Renew	New	Renew	
Total	1442	3819	1191	975	1496	4591	71	176	1600

As Secondary Standards Dosimetry Laboratory, IAEA requirements for SSDL infrastructure have been designed, constructed and accepted during 2014-2015. Then Operational SSDL upgraded. Accredited calibration services provided to end users. Membership in IAEA/ WHO network of SSDLs gained.

Disused radium sources that had been used by Yangon General Hospitals were conditioned for safe storage with the assistance of the experts from the IAEA and Korea. One of the spent Co-60 Gamma Chamber 900A has already been sent back to India. At this time, radioactive wastes in Myanmar are being stored safely shown in Figure 5.

Figure5. Waste storages

4. Conclusions

The safety of human life and the environment, against harmful effects of ionizing radiation, enhancing the national nuclear medicine and radiotherapy infrastructure, training of professional and assistance to improve QA/QC and safety of the patients and the staff at the workplace to improve precision of cancer diagnosis and an increased quality of cancer therapy are important activities in the Republic of the Union of Myanmar. All the departments using ionizing radiation sources have followed the safety rules and standard with care and caution, no radiation hazard or accident or incident has ever occurred at all. Safety and radiation protections are being taken as much as possible to comply with relevant IAEA regulations. As accuracy in radiation dosimetry is required in every application of radiation technology, Myanmar needs to provide calibration services, improve dosimetric accuracy and provide training in radiation measurement and calibration techniques in National Secondary Standard Dosimetry Laboratory. The project will be of immense benefit to radiation workers and the general public in view of the availability of high quality control in radiation processing, more accurate calibration services for radiation measurement instruments and personal dosimetry services. DAE has already adopted transparency on any nuclear activities by implementing obligations contained in several international and regional legal instruments and is also cooperative in the human resource development programme

connection with Ministry of Health and Sport for standards, applications and quality assurance in medical radiation dosimeter activities.

Acknowledgements

The author acknowledges deeply grateful to our Director General, Department of Research and Innovation and thanks to Deputy Director General, Material Science Research Division, colleagues at Division of Atomic Energy, Ministry of Education for help of writing this paper, for fruitful discussions and valuable suggestions. The author deeply thank to all of person who for co-operation and implementation for this paper. I would like to give special thanks to Myanmar Academy of Arts and Science, organizing committee for giving a chance to participate 19th SCA conference.

References

[1] IAEA-Myanmar Country Programme Framework 2016-2021.

[2] Bangladesh J. Nucl. Med. Vol. 20 No. 1 January 2017, "Current status of Nuclear Medicine services in Myanmar"**,** Professor Kyin Myint, President, Myanmar Nuclear Medicine Society.

[3] Asia Ocean J Nucl Med Biol. 2018 Winter; 6(1): 68–74. "History and Perspectives of Nuclear Medicine in Myanmar", Win Mar

[4] International Basic Safety Standards (BSS) for radiation protection against ionizing radiation and the safety of radiation sources, IAEA, Safety Series No.115-1.1995.

[5] Myanma Nuclear Law, The Pyidaungsu Hluttaw Law No. -- / 2016.

[6] IAEA, "Handling, Conditioning and Disposal of Spent Sealed Sources", IAEA-TECDOC-548, Vienna (1990)

[7] IAEA, "Nature and Magnitude of the Problem of Spent Radiation Sources", IAEA-TECDOC-620.

Challenging Inequalities for Rural Communities in Thailand

The Decentralized Hands-on Program Exhibition (D-HOPE) as an Alternative Rural Development Approach

Yumiko Okabe[1]

Abstract

The Decentralized Hands-on Program Exhibition (D-HOPE) is designed as an alternative rural development approach using the concept of experience economy. The technical cooperation project between the governments of Japan and Thailand used the approach in nine provinces of Thailand. Since 2018, D-HOPE fostered the grassroots economy through the initiatives of Community Development Department of Ministry of Interior. The purpose of this paper is to describe the dynamics of implementing activities and examine the D-HOPE approach from participation, facilitation, Appreciative Inquiry, and description point of views through action research. The project supported 967 entrepreneurs from nine provinces and elevated the economic and social conditions of rural people. The D-HOPE approach is currently under implementation as a main pillar of the Thailand's community-based tourism policy with plans to expand nationwide. D-HOPE is an effective approach in terms of group process concept and community capacity. The approach contributes to the SDGs as an innovative, practical and replicable approach in terms of women empowerment as well as inequality.

Keywords: D-HOPE, SDGs, Experience Economy, Empowerment

1. Introduction

Mainstream rural development is typically concentrated on infrastructure and sector-oriented development where a vast amount of resources has been invested. Despite poverty rates had declining in the past decades, extreme poverty and social inequalities are still the global community's vital responsibility as described in the Sustainable Development Goals (SDGs) along with other essential issues such as gender, peace building and environment (UNDP, 2015). There has been much research on sustainable livelihood approaches and microfinance schemes targeting socially vulnerable people such as low-income level women, producers and farmers, examining their effectiveness and impacts for rural development and poverty eradication. Toyama (2015) reveals the apparent limitation on conventional approaches and claims that the specific technical assistances alone cannot solve the issue of poverty. Furthermore, Collier (2008) suggests "policies for rural development must be adopted to local circumstances and so require a much larger investment in local knowledge (p62)."

Historically, rural development discourse reflects the international agenda "right from 'intellectual idealism' to 'techno-bureaucracy', and eventually to the present 'participatory development'" even though many of the implemented policies and programs have been short-lived (Behera, 2006, p7). The problem is not how long one approach is used in this ever-changing world, but it matters how to appropriately adapt an approach for what needs to be done for the benefit of rural communities at the time. As evidenced from SDGs 5 and 10 on inequality, it is required to construct alternative approaches that are effective and innovative. However, the integration of theory and practice is a universal challenge for policy-makers and development practitioners for a democratic change. In this connection, this paper presents action research,

[1] Executive Director, Institute for Community Design, yumimekko@mac.com

which 'brings together action and reflection, theory and practice, in the pursuit of practical solutions to issues of pressing concern' (Bradbury, 2015, p1) in the field of rural development.

Community Development Department (CDD) of the Ministry of Interior, the royal government of Thailand, has been implementing the One Tambon One Product (OTOP) policy since 2001. OTOP supports people in villages on product development and marketing through the OTOP exhibitions along with other economic related policies to increase income. As of 2018, the number of registered OTOP group is 61,582, which includes a total of 817,056 individuals. The exhibitions became the foundation of economic development nationwide and had contributed to the rural communities because of increased sales year to year (Data Center management System for Managing, Storing and Utilizing of CDD, 2019).

While there are excellent OTOP entrepreneurs, there are producers and service providers who do not gain much income generation due to a lack of capacity in finding appropriate market or need to shift their production or service based on the market needs. The CDD statistics in 2018 indicates that most of the total sales are only shared by top 17% while the remaining 83% have little sales. There is a limitation to a product-oriented approach and display-oriented marketing for vulnerable producers to be a part of the driving force in economic development.

Without emphasizing the grassroots economy, there will be more inequality, which affects the achievement of the country's mission to create a stable country through income distribution and village capacity with strong networks and trust among community members. Strategic economic policy needs to be open, inclusive, and participatory for vulnerable producers and service providers without hurdles.

The technical cooperation project 'the Project for Community-based Entrepreneurship Promotion' (The D-HOPE Project[1]) between the governments of Japan and Thailand was established for promoting community-based entrepreneurs in rural Thailand based on the concept of experience economy through diversification of economic opportunities while focusing on village capacity development. The first year of the project implementation in nine provinces was from May 2018 until June 2019. The project supported 967 entrepreneurs[2] in total. Therefore, the purpose of this paper is to describe the dynamics of implementing activities and examine the D-HOPE approach including the aspects of participation, facilitation, Appreciative Inquiry and participants' point of view through action research.

1. Framework of the D-HOPE Approach

The Decentralized Hands-on Program Exhibition (D-HOPE) Approach

The Decentralized Hands-on Program Exhibition (D-HOPE) is designed as an alternative rural development approach to promote community capacity and rural development. One of the main issues of rural development is the scarcity of human, capital, and material resources. Although there are potential resources available, they are not fully utilized by the people. Thus, rural or community development projects tend to become big, high cost projects to bring in outside resources, which is not replicable in many cases.

D-HOPE embodies the experience economy (Pine and Gilmore, 2011), which is the modern economic concept that describes a shift of economic value from commodity, product, and services into experiences. Therefore, the concept benefits rural communities in terms of using

existing resources, which leads to differentiation in experience between communities. This results in an increase of competitiveness in the market. These experiences are the mechanism for development of small business and social changes in people because D-HOPE provides an opportunity for them to foster mutual effects with markets and consumers in order to improve their capacity as an entrepreneur. The experience economy benefits rural communities because they do not to imitate urban development, but find their own path to economic development from a rural community point of view based on the local knowledge.

D-HOPE is an exhibition where small-scale producers, groups, and micro-enterprises offer small hands-on programs to visitors, tourists or local people in their own place. Doing so reduces costs much less than traditional exhibitions and typical market creations, which are held in one place where people gather and exhibit products for sales and promotion. The implementation organization of D-HOPE publishes the catalogue of all collected hands-on programs and widely promote it as an event to "sell" hands-on programs normally for one to a couple of months. The visitors choose the ones they want to participate in and make a reservation directly with program providers. Each visitor goes to the program location on the reserved day by themselves and enjoy the activities.

D-HOPE primarily aims at indicating the mid and long-term direction of local economic development by promoting overlooked small local activities through small-scale producers, groups, and micro-enterprises. It is a place to encourage potential entrepreneurs to be innovative increasing their local attractions through the participation of strategic workshops and the event. D-HOPE also aims at social change in terms of strengthen networks among people.

D-HOPE Implementation

Before implementing the D-HOPE approach at the provincial level, the project organizes three day central workshops in Bangkok where all the target provinces gather and develop action plans. D-HOPE implementation includes the collective activity of the strategic workshops in order to develop community capacity through enhancing relational capital between people. The workshop is a place where people learn by doing rather than instructional seminars or meetings. D-HOPE projects need to be logically well designed for local people to find their interests or benefits through the activities. D-HOPE steps are localized into each community's context with the project concept and purpose naturally being shared by practicing project activities. D-HOPE brings communities to consensus facilitating development results.

The strategic workshops also emphasize on bringing different people from various fields together to generate new knowledge and networks. It envisions a social movement where people gather spontaneously for the same purposes or goals. Mobilization of local stakeholders is often a discussion in development. If we organize fun, open, and dynamic workshops that are fundamentally beneficial for local people, people will naturally gather to engage. The strategic workshops must be public and localized so participants can exercise personal choice for participating in the projects. If participants choose to leave a project, they should be welcomed back with open arms.

The first strategic workshop aims at identifying potential champions by making a resource list. The second strategic workshop invites potential champions identified in the previous workshop to design hands-on programs. One part of the activity is to design hands-on programs through group discussions. Champions then implement the idea and discuss further

issues such as price, time, activity contents, and promotion at the site. The third strategic workshop develops the catalog of activities and plans promotion. This workshop focuses on identifying the community identity with all the collected champions. Then the D-HOPE catalog is published publicly, and each champion conducts their hands-on programs with their registered visitors as part of an event within a specific period. The last strategic workshop is for empowerment evaluation. This evaluation is intended for project stakeholders to conduct self-evaluation through reflecting on activities.

Each activity is designed based on four perspectives; facilitation; participation; appreciative inquiry; and description with a specific outcome as shown in table 1. As a project implementer, facilitation is the key component to making the workshop a place where people can deeply engage in activities. This will secure participation and attitude and behavior changes in participants. Appreciative Inquiry is used as a facilitation tool to identify positive-core resources in people and communities (Cooperider, Whitney, & Stavros, 2008). Furthermore, using sticky notes allows participants to give their voices as descriptions and encourages participation from those in the community who may be less vocal or hindered by power dynamics. In this connection, all the participants are divided into groups of six to eight people so that everyone has an opportunity to give a voice in the workshop with sticky notes. The facilitators encourage them to write whatever they want. It is a brainstorming tool so that anyone can participate easily.

Table1. Stage and Nature of the D-HOPE Approach

Stage	**Approach**				**Outcome**
	Facilitation	**Participation**	**Appreciative Inquiry**	**Description**	
Strategic Workshop I: Identification of potential champions	・Organization of workshop ・Encouragement of local people and their wisdoms	・Group discussion	・Identification of potential champions	・Description of potential champions	・Sharing local resources focusing on human resources
Strategic Workshop II: Designing of Hands-on programs	・Organization of workshops and hands-on program testing	・Group discussion ・Hands-on program experience training	・Examination of own strength	・Description of own resources	・Recognition of own resources
Strategic Workshop III: Preparation of catalog and promotion	・Organization of workshops ・Encouragement of description of own story	・Presentation of own hands-on program	・Presentation of own strength	・Description of own story	・Creation of own story
Implementation of D-HOPE event	・Encouragement of enjoying hands-on program	・Organization and implementation of own hands-on program as a main player	・Identification of good experiences in implementation of hands-on program	・Description of own story through implementation of hands-on program	・Provision of own story
Strategic Workshop IV: Empowerment evaluation	・Encouragement of own story of the hands-on program	・Presentation of good experience of hands-on program	・Sharing of good experiences	・Description of good experiences ・Photo elicitation	・Recognition and confidence of own life

3. Implementation Results and Discussion

Table 2 indicates the total output of each activity in the D-HOPE process in nine provinces. Due to the budget availability in the project, each workshop had a limited number of participants and the workshop was held at the provincial level. Although some people had to travel far, many provinces had participation from all over the province.

Table2. Activity Output

		No. of Participants	**Output of the Activity**
1	Strategic Workshop I	847	2,520 champions identified
2	Strategic Workshop II	1,499	1,379 hands-on programs designed
3	Strategic Workshop III	242 (due to another urgent policy implementation, only 2 provinces conducted this activity)	9 catalogs developed 967 champions
4	D-HOPE Event	- (due to another urgent policy implementation, only 2 provinces conducted this activity)	-
5	Strategic Workshop IV	714	9 empowerment evaluation conducted 9 questionnaire survey conducted

Note: due to another urgent policy implementation, only 2 provinces conducted activity 3 and none of the 4 was implemented.

Facilitation, Participation, Appreciative Inquiry and Description and Empowerment

The number of participants in the workshop indicates that the project target group was appropriate and most of them found this project beneficial in terms of opportunity cost. The group discussion method in the strategic workshop encouraged people to engage in the discussions, as well as hands-on activities in the village. A participant from Chonburi province spoke about her experience from the workshop as follows:

> **"**We found out more about our village and our people, how we own so many good things, including human and material resources. And also that these things are professionally valuable. We never knew how much potential we had until we went to the workshop. We used our knowledge from the D-HOPE approach and we connected with many of our village members and we believe that as of this moment our village is quite successful in terms of career, development, and we will create more income. Our people developed themselves more as well."

Table 2 is the summary of all the descriptions in Chonburi province from empowerment evaluation workshop, which is categorized as 4-A changes; appreciation (I love/like); affirmation (I can); acknowledgement (I learned); and aspirations (I want to). In the empowerment evaluation

workshop, many people discussed the new method of learning where “everyone is thinking”. The strong reflection was revealed in the strategic workshops that they could “develop knowledge” and “change the mindset” through discussions. One participant spoke in the workshop saying “in the past, we said we don’t like to attend a meeting. It’s boring. But now we really like it because we get to meet many people, exchange and obtain knowledge. We smile and we are happy. We learned many things.” The activity gave them an opportunity to gain confidence and the champions recognized the benefit of the group discussion as an opportunity to transform themselves. Furthermore, hands-on program training at the village level was clearly a popular activity in every province. From the description of the empowerment evaluation, the program testing was a place to “make us realize and improve” through having the “real commenter” who “provides feedback”. There was another description saying, “seeing is better than hearing”.

Thus, this gave the project the clear idea on what to elaborate on and budget reallocation for future implementation. The champions did not expect that learning could occur among community members. The meaning of good participation for them is to engage in something themselves rather than listening to lectures and make decisions by themselves without even recognizing it. Moreover, getting know someone new was also something they appreciated a lot and they learned from each other. They took full control in designing hands-on programs from these learnings, which is interactive participation (Cornwall, 2008). At the end of the workshop, each champion made plans based on the experiences shared among them. The discussion led to immediate action. People committed their time and many said, “I can do it right after the workshop”. These attitudinal changes in people were the immediate effects of the workshop.

Table 3. Keywords of 4-A Changes in Chonburi Province

Appreciation (I love/like)	**Affirmation (I can)**	**Acknowledgment (I learned)**	**Aspirations (I want to)**
• Environmental value • Tourist visit • Local lifestyle • Nature + people •Friendliness •Income generation •Participation •Good collaboration •Tourist happiness •Tourism development •Identity of Chonburi •Brainstorming •Learning method	•Bring the result •Access to local resource •Conserve natural resource •Income generation from tourism using a local resource •Conducting tourism activity •Change of mindset •Alternative promotion	• Local resource recognition • Ownership for development •Tourism development •Teamwork •Marketing • Environmental conservation •Way of thinking •Way of learning •Way of improving	•Product (hands-on program, product, activity) development •Environmental conservation •Participation •Motivation •Village development •Challenge spirit to try something new

Source: Created by Okabe

Concept of Group Process

The D-HOPE approach has shown the effectiveness of the group process from four different approaches that are appreciation, affirmation, acknowledgement, and aspirations as evidenced from the number of hands-on programs developed as well as the newly entrepreneurs created. Appreciative Inquiry encouraged workshop participants to come up with new ideas and way of thinking, which affected their behaviors and attitudes changes as well.

Community Capacity Development

This kind of group process enhanced networking among people in terms of relational capital. People recognized their core value and the value in other people, which is embodied in the individual hands-on programs. This positive thinking led to increased trust among community members, which is a foundation of capacity development.

SDGs' innovative contribution

When discussing inequality, it is necessary to bring a perspective of how to make vulnerable people stronger. As Cornwall (2018) claims, participation solely is not enough to bring empowerment in people. The D-HOPE process with four approaches brought a kind of innovative contribution in terms of practical methods towards a holistic rural development subsequent to mobilize resources and people empower themselves. This is a contribution to the SDG's goal on poverty issue specifically to the goal 1.a, 1.b as well as inequality, specifically to the goal 10.1, 10.2 and 10.3 (UNDP, 2017).

Furthermore, the project achieved to women empowerment to some extent. Many active participants in the workshops were women and they were taking initiatives in activities. As a result, women entrepreneurs accounted for 71% from the D-HOPE catalogue in nine provinces. This is a contribution to the SDG's goal on gender equality and empowerment, specifically to the goal 5.1, 5.5 and 5.a (UNDP, 2017).

Deepening the D-HOPE approach

The strategic workshops were effective in many ways. One participant commented that "D-HOPE is like a role model. It helped us developed more with other small groups of projects. D-HOPE helped us a lot, especially the workshop." Each strategic workshop was incorporated into different policies, programs, and projects at different levels. These workshops are now incorporated individually into other Thai policies. For instance, empowerment evaluation for human resource development for officials as well as community leaders is now being, Each D-HOPE component can inform other policies, programs or projects.

4. Conclusions

This case study has shown that rural communities can be independent and capable of carrying out economic activity without much investment. The first year of the project resulted in 967 community-based entrepreneurs involved in the new type of economic activity, the experience economy, and 71% of them were women. The strategic workshops influenced the attitudinal changes in participants that increased confidence, which is a crucial to retain people in rural communities and maintain their livelihoods. Without economic activities and diversification, rural disparity deteriorates even further. The D-HOPE approach shows that this

kind of approach contributes to the SDGs as an innovative and practical approach that is replicable. The key for rural development is to smoothly and effectively introduce economic activities for sustainably where people in the community are empowered. This case study shows the effectiveness of the D-HOPE approach in terms of sustainability and independent economic activities.

Acknowledgements

I would like to thank all the people who are involved in the project from the nine provinces. Without their participation in the project, this research and project would not be possible. Also, thank you to my counterpart, CDD for support of the project implementation, as well as JICA for the financial support on this project. However, this paper has been prepared by the author and it is not representing the views of the D-HOPE project nor organization's opinion.

References

[1] United Nations (2015). *The Millennium Development Goals Report 2015. Retrieved from* https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf

[2] Toyama, K. (2015). Geek Heresy: Rescuing Social Change from the Cult of Technology. PublicAffairs.

[3] Collier, P. (2008). The Bottom Billion: Why the poorest countries are failing and what can be done about it. [Kindle version] Retrieved from http://amazon.co.jp

[4] Behera, M.C. (2006). Globalizing Rural Development: Competing Paradigms and Emerging Realities. Oxford University Press.

[5] Bradbury, H. (2015). Introduction: How to Situate and Define Action Research. In Bradbury, H. Editor, *The Sage Handbook of Action Research* (pp.1-9) [Kindle version] Retrieved from http://amazon.co.jp

[6] Data Center Management System for Managing, Storing and Utilizing of Community Development Department, Ministry of Interior (2019). Retrieved from http://logi.cdd.go.th/cddcenter/cdd_report/otop_r06.php?year=2562

[7] Pine, B. J., & Gilmore, J. H. (2011). *The Experience Economy, Updated Edition.* Harvard Business School Publishing.

[8] Cooper rider, D. L., Whitney, D., & Stavros, J. M. (2008). *Appreciative Inquiry Handbook: For Leaders of Change, Second Edition.* [Kindle version] Retrieved from http://amazon.co.jp

[9] Cornwall, A. (2008). Unpacking 'Participation': models, meanings and practices. *Community Development Journal, 43 (3), 269-283.* doi:10.1093/cdj/bsn010

Effect of Scattering Layer on Photovoltaic Performance of Solid-state Dye-sensitized Solar Cells (ssDSSCs) using Red Spinach Dye Extracts

Nan Kyi Kyi Thein[1], Than Zaw Oo[2]

Abstract

Solid-state dye-sensitized solar cells (ssDSSC) were fabricated using red spinach dye extracts and its photovoltaic performance was examined. The efficiency of red Spinach device (extracted at 45 °C in ethanol (EtOH)) is 0.11 %. An additional TiO2 scattering layer was integrated in the red Spinach device. Unexpectedly, the device efficiency decreased from 0.11 % to 0.01 % despite having absorption enhancement with scattering layer. Electrochemical impedance measurement pointed out that this efficiency detraction (mainly contributed from photocurrent) is attributed to an increase in charge transfer resistances at the TiO2–related interfaces despite having more rapid electron transport (longer electron lifetime) with scattering layer.

Keywords: red Spinach dye, TiO2 scattering layer, solid-state dye-sensitized solar cells

1. Introduction

Dye sensitized solar cell (DSSC) is one of the most promising photovoltaic technologies. Liquid electrolyte-based DSSCs have reached efficiencies as high as 11.1% [1]. However, these liquid based DSSCs suffer from potential leakage and corrosion which have sparked research in solid state hole transport materials (HTMs) instead of liquid electrolytes [2]. One of the most widely-used HTMs is spiro-OMeTAD (2,2',7,7'-tetrakis-(N,N-di-p-methoxyphenylamine) -9,9'-spirobifluorene) [3]. Solid-state dye-sensitized solar cells (ssDSSCs) with spiro-OMeTAD as HTM have attained efficiencies exceeding 5%, which is still far below the efficiency of liquid electrolyte DSSCs [4]. The lower efficiency is primarily a consequence of incomplete light harvesting. The highest-performing ssDSSCs to date have a 2-3 μm thick active layer [5], far thinner than the thickness needed to achieve good optical absorption. There are two factors that limit the ssDSSCs from being more efficient at thicknesses > 2 μm: electron-hole recombination and incomplete filling of the mesoporous TiO_2 films with spiro-OMeTAD. Studies on recombination show that recombination in ssDSSCs is two orders of magnitude faster than in liquid DSSCs [6] and the electron diffusion length (L_D) in mesoporous TiO_2 is 6-12 μm, much larger than the optimized 2 μm film thickness [7].

Since metal oxide nanoparticles [zinc oxide (ZnO) and titanium dioxide (TiO_2)] have been used in DSSC as the photoelectrode sensitized by organic dyes. They have several approaches to improve light-harvesting efficiencies and cell performance: developing photoelectrodes with larger surface areas that could adsorb large amount of dye and synthesizing dyes with broader absorption ranges [8]. In addition, the incorporation of TiO_2 scattering layer on top of mesoporous TiO_2 photoanode is also a promising strategy to realize an improved device performance. It can increase the path length of incident light and dye absorption that is usually weak in low energy region due to low absorption coefficient of dye. Simulation results show that the scattering effect is especially observed in low energy region (650-900 nm) as the multiple

[1] Dr. Assistant Lecturer, Materials Science Research Laboratory, Department of Physics, University of Mandalay, nankyikyithein@gmail.com
[2] Dr. thanzawoo06@gmail.com

reflection of low energy light by scattering layer is improved. In addition, the reverse saturation current in the device can be minimized by a functional layer and a light scattering layer introduced over the inorganic oxide layer. As a consequence, the reduced reverse current and increased dye absorption collectively enhance the photocurrent, thereby increasing the overall efficiency of the device [9].

2. Materials and Methods

This section details about the preparation of red spinach dye-sensitizer, fabrication of solid-state dye-sensitized solar cells (ssDSSCs) and device efficiency measurement.

Preparation of Red Spinach Dye-sensitizer

The natural dye solution was extracted from red Spinach leave. The fresh red Spinach leaves were washed with distilled water, crushed into pieces using a mortar and pestle. Those red spinach pieces were immersed and stirred in 10 ml EtOH (95 % absolute ethanol) at room temperature for 45 min. The solid residues in solution were then filtrated out, and the filtrates were concentrated for the use as sensitizer.

Fabrication of Solid-state Dye-sensitized Solar Cells

(i) Substrate Preparation

Fluorine-doped SnO_2 (FTO) coated glasses (2 cm x 10 cm) were etched with zinc powder and HCl (2M) to obtain the required electrode pattern. They were pre-treated with a 1M aqueous $TiCl_4$ at 70 °C for 30 min followed by washing with detergent (2% Hellmanex in water), distilled water, ethanol and acetone for 15 min each. Finally, they were blown with N_2 gas for drying purpose and treated under UV Ozone for 20 min for removing the last traces of organic residues. The FTO sheets were subsequently coated with a compact layer of TiO_2 by aerosol spray pyrolysis deposition at 450°C using a commercial titanium diisopropoxide bis (acetylacetonate) solution (75% in 2-propanol, Sigma-Aldrich) diluted in ethanol (volume ratio of 1:9) as precursor and oxygen as carrier gas. After cooling to room temperature they were treated in a 1M aqueous solution $TiCl_4$ for 30 min at 70°C, rinsed with distilled water and dried at 500°C for 30 min.

(ii) Formation of Mesoporous TiO_2 Photoanode and TiO_2 Scattering Layer

The mesoporous TiO_2 layer was developed to be used as working electrode in ssDSSC. A 3-μm-thick mesoporous TiO_2 layer composed of 30-nm-sized particles was deposited by screen printing using a commercial TiO_2 paste (Dyesol 18NRT, Dyesol). Mesoporous TiO_2 films were slowly heated to 500°C (ramped over 30 min) and baked at this temperature for 30 min using tap control hot plate. The last step is to allow the TiO_2 films to cool down naturally to room temperature. Mesoporous TiO_2 paste was screen printed on the FTO glass to make a thickness of 3 μm on the top of which the TiO_2 paste composed of ~250-nm-sized particles (Dyesol 18NR-AO, Dyesol) was screen printed again, resulting in a light scattering TiO_2 film of 3 μm, and total thickness of 6 μm. TiO_2 scattering layer on top of the mesoporous TiO_2 photoanode was then sintered over the same heating profile as previously employed. They were cut into the dimension of 2×1.5 cm and rinsed with distilled water and ethanol each. They were blown with N_2 gas and treated under UV Ozone for 20 min. Prior to their use as electrode, they were again dried at 500°C for 30 min using heat-blower.

(iii) Infiltration of Dye and Hole-transporting Materials (HTM)

In order to load the dye on the TiO_2 mesoporous electrode, the film electrodes were submerged in 3ml of a dye solution at room temperature for 12 hr in a dark place. The dye-adsorbed TiO_2 thin film was rinsed gently with distilled water to remove unwanted solids, and then with the ethanol which serves to remove water from the porous TiO_2. The dyed films were rinsed briefly in acetonitrile and dried in air for 1 min. The HTM was then deposited by spin coating at 4000 r.p.m. for 30 s in nitrogen atmosphere. The 2, 2', 7, 7'-tetrakis(N,N-di-p-methoxyphenyamine)-9,9'-spirobifluorene (spiro-OMeTAD) was dissolved in 1 ml chlorobenzene. After fully dissolving the hole transporter, 4-tert-butylpyridine (TBP) was added with a volume-to-mass ratio of 1:26 µl mg^{-1} TBP: spiro-OMeTAD. Lithium bis (trifluoromethylsulfonyl) imide salt (Li-TFSI) was pre-dissolved in acetonitrile at 170 mg ml^{-1} and added to the hole transporter solution at 1:12 µl mg^{-1} of Li-TFSI solution: spiro-OMeTAD. The spin coating formulation was prepared by dissolving 180 mg (spiro-OMeTAD), 6.92 µl 4-tert-butylpyridine, 14.99 µl of a stock solution of 170 mg ml^{-1} lithium bis (trifluoromethylsulphonyl)imide in acetonitrile and 2.88 µl of a stock solution of 320 mg ml^{-1} tris(2-(1H-pyrazol-1-yl)-4-tert-butylpyridine) cobalt (III) bis(trifluoromethylsulphonyl)imide (FK102) in acetonitrile in 1 ml chlorobenzene.

The concentration of spiro-OMeTAD in the solution, so that the ratio of spiro-OMeTAD to TBP, Li-TFSI and FK102 was kept constant. For spin-coating, a small quantity of the hole transporter solution (50 µl) was dispensed onto each substrate and left to wet the films for 5s before spin-coating. After spiro-OMeTAD infiltration, a chlorobenzene-soaked cotton swab was used the substrate that was not on top of the mesoporous TiO_2 film to remove the excess spiro-OMeTAD.

(iv) Deposition of Gold Electrode

The films were left overnight in an air atmosphere before placing them in a thermal evaporator (EDWARDS AUTO 306) where 180-nm-thick gold electrodes were deposited through a shadow mask under high vacuum (10^{-6} mbar). The active areas of the devices were defined by metal optical masks with 0.4 cm × 0.5 cm apertures.

Characterization and Efficiency Measurement

The characterization methods used are UV-vis spectrophotometry, field-emission scanning electron microscopy, cyclic voltammetry and electrochemical impedance spectroscopy. Power conversion efficiency of the device under white light (AM 1.5 solar illumination) and incident photon to current conversion efficiency of the device under monochromatic light were evaluated.

Optical and Physical Characterization

(i) UV-vis Spectrophotometry

The optical transmission properties of multilayered TiO_2 and dye solution were measured by UV-vis spectrophotometry. The scanned range of is from 300 nm to 900 nm with step interval of 0.5 nm. The UV-vis spectra were recorded with respect to an uncoated clean glass of the same type as the reference for solid samples and to the solvent used as the reference for solution samples.

(ii) Field-Emission Scanning Electron Microscopy (FESEM)

The morphological features of TiO_2 films were observed by field-emission scanning electron microscopy. It is a compact field emission scanning electron microscope ((JEOL JSM-7600F FE-SEM) for imaging a variety of nanoscale objects and materials. It is controlled by a desktop computer that is connected to the system via a USB cable. The FESEM software runs on this computer and provides point-and-click operation, configuration and status monitoring of the FESEM. The images were obtained at a voltage of 5.0 kV and a current of 2.2 A.

(iii) Cyclic Voltammetry

The electrochemical energy levels of TiO_2 photoanode was investigated by using cyclic voltammetry (CV). Cyclic voltammetry measurements were carried out in three-electrode systems consisting of a TiO_2 film as working electrode, platinum counter electrode, and Ag/AgCl reference electrode at a scan rate of 50mV/s. The potential scanned range is from 1 V to -1 V with step interval of 0.001 V. The supporting electrolyte was 0.1M KNO_3 in distilled water.

Measurement of the Device Efficiency and Electrochemical Impedance

The power conversion efficiencies (PCE) of DSSCs were evaluated by recording J-V characteristics of the device. It was measured using a computer-controlled digital source meter (Keithley 2400) under illumination with a Newport solar simulator (AM 1.5, 1000 W/m^2). A Keithley source meter was used to supply an input voltage and measure the output current of DSSCs. The light source was a 450 W xenon lamp (Oriel) equipped with a Schott K113 Tempax sunlight filter (Praezisions Glas & Optik GmbH) to match the emission spectrum of the lamp to the AM 1.5 G standards. Before each measurement, the exact light intensity was determined using a calibrated Si reference diode.

The incident-photon-to-current conversion efficiency (IPCE) spectra were recorded as functions of wavelength under a constant white light bias of approximately 5 $mWcm^{-2}$ supplied by an array of white light-emitting diodes. The excitation beam coming from a 300 W xenon lamp (ILC Technology) was focused through a Gemini-180 double monochromator (Jobin Yvon Ltd) and chopped at approximately 2 Hz. The signal was recorded using a Model SR830 DSP Lock-In Amplifier (Stanford Research Systems). All measurements were conducted using a non-reflective metal aperture of 0.2 cm^2 to define the active area of the device and avoid light scattering through the sides.

In addition, electrochemical impedance spectroscopy (EIS) is used to analyze the charge transport resistance and associated charge recombination process in the ssDSSCs. The photoelectrochemical characteristics and the AC impedance measurements of the ssDSSCs were recorded with a potentiostat/galvanostat (AUTOLAB PGSTAT) under constant light illumination of 1000 W/m^2. The applied bias voltage and AC amplitude were set at open-circuit voltage of the ssDSSCs at 0.7 V between the Au counter electrode and the FTO-TiO_2-dye working electrode, respectively, starting from the short-circuit condition. AC impedance spectrum of ssDSSCs was acquired in the frequency range from 1.429×10^5Hz to 2.099 Hz. All measurements were carried out with the NOVA software. The resultant impedance spectrum was analyzed using the Z view software.

3. Results and Discussion

The section mainly discusses the effect of scattering layer on photovoltaic performance of solid-state dye-sensitized solar cells (ssDSSCs) using red spinach dye extracts.

The incorporation of TiO_2 scattering layer on top of mesoporous TiO_2 photoanode is a promising strategy to realize an improved device performance. The mesoporous photoanodes used in ssDSSC are composed of (20-30 nm) sized TiO_2 nanoparticles. These electrodes are essentially transparent since visible light is not scattered for TiO_2 nanoparticles of sizes on the order of the few tens of nanometers. The incorporation of TiO_2 scattering layer can increase the path length of incident light (light harvesting efficiency), thereby increasing dye absorption due to the multiple reflection of light by scattering layer. A porous network connection between both layers is needed to allow the dye loading and a proper diffusion of the charge carriers.

First we studied the effect of scattering layer on dye absorption at TiO_2 photoanode. Figure 1. shows the absorption spectra of red Spinach dye adsorbed on TiO_2 photoanode with and without TiO_2 scattering layer. The absorption peak maximums are almost invariant at 670 nm upon incorporation TiO_2 scattering layer. However peak intensities is higher in the sample with TiO_2 scattering layer indicating the dye-absorption enhancement with TiO_2 scattering layer. Addition of TiO_2 scattering layer with the large nanoparticles (200-300 nm) ensures adequate light trapping due to the increase of absorption path length of photons and optical confinement. Taking advantage of dye-absorption enhancement with TiO_2 scattering layer, the TiO_2 scattering layer of the thickness 3 μm were incorporated in the ssDSSC devices with red Spinach dyes as photosensitizer.

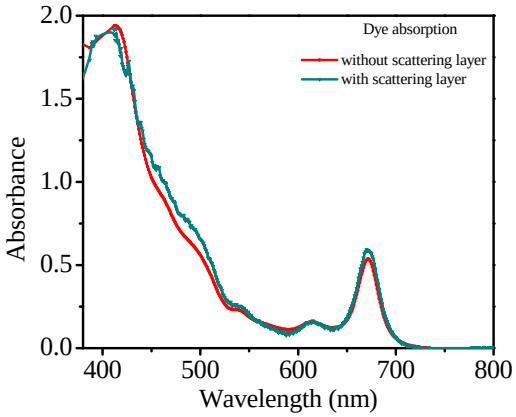


Figure1. Optical absorption spectra of red spinach dye on TiO_2 photoanode with and without additional TiO_2 scattering layer.

Figure2. (a) shows J-V characteristics of ssDSSCs under illumination with and without scattering layer. The photovoltaic device parameters are summarized in Table 1. Despite expecting an enhanced device efficiency via dye absorption enhancement, the efficiency measurement showed that the device efficiency decreased from 0.11 % to 0.01 %. A decreased efficiency is contributed from the detraction of all device parameters, V_{OC}, J_{SC} and FF. As seen in Table 1, the V_{OC} decreased from 0.61 V to 0.58 V, the J_{SC} from 0.34 mA/cm^2 to 0.03 mA/cm^2 and the FF from 0.55 to 0.40.

Figure 2. (b) shows the plot of IPCE (Incident Photon to Current Conversion Efficiency) as the function of wavelength and the increased in the J_{SC} is verified using IPCE measurements. The quantum efficiency at 345 nm and 395 nm for ssDSSC with a scattering layer was lower than ssDSSC without a scattering layer. One can observe that the IPCE in the longer wavelength regime (425–600 nm) for the ssDSSC with scattering layer was significantly improved compared over that of the ssDSSC without scattering layer. The integrated current under the IPCE spectra (350 – 800 nm) are consistent with the observed J_{SC} in the photovoltaic J-V measurement.

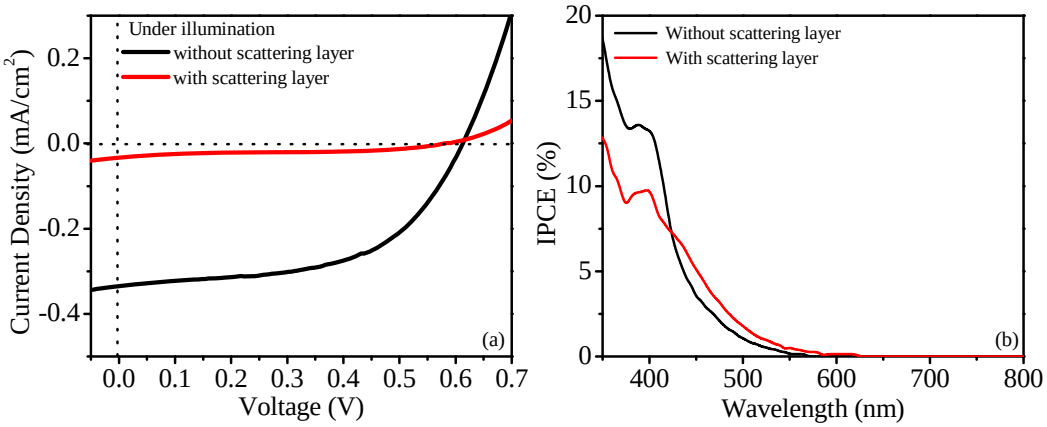


Figure2. (a) Current-voltage (J-V) characteristics of red Spinach ssDSSCs with and without 7scattering layer and (b) incident photo to current conversion efficiency (IPCE) of the same devices.

The FESEM micrograph (cross sectional view) of solid-state dye-sensitized solar cell is shown in Figure 3. The mesoporous TiO_2 film had an optimized thickness of around 3 μm and was infiltrated with the local dyes using the soaking method. The HTM was subsequently deposited by spin coating. It also infiltrates into the TiO_2 film. A thin gold layer was thermally evaporated under vacuum onto the HTM, forming the back contact of the device. The thin TiO_2 compact layer that has been deposited on top of the FTO substrate to avoid direct contact to the HTM is not resolved in the SEM image depicted in figure.

As mentioned previously, with scattering layer, the open circuit voltage (V_{OC}) slightly reduced from 0.61 V to 0.58 V. The open circuit voltage in ssDSSC is related to the highest occupied molecular orbit (HOMO) level of redox mediator/hole transporter and the lowest unoccupied molecular orbital (LUMO) level of dye (or) the Fermi level of TiO_2 electrode [10]. We determined the LUMO of dye loaded TiO_2 using cyclic voltammetry. The cyclic voltammograms (CV) of dye loaded TiO_2 photoanode with and without scattering layer are shown in Figure 4. The position of LUMO level has been determined from the analysis of reduction potential behavior observed in cyclic voltammogram curves, using the following equation: E_{LUMO}=-e (E_{red}^{onset} + 4.4 V) where E_{red}^{onset} is the onset potentials of reduction. The onset potentials are determined from the intersection of the two tangents drawn at the rising current and baseline charging current of the CV traces. From the cyclic voltammograms, the onset potentials for the reduction of TiO_2 photoanode with and without scattering layer were found to be -0.585 V and -0.610 V respectively. The LUMO of dye loaded TiO_2 with and without scattering layer are -3.82 eV and -3.79 eV respectively. Thus the slightly lowered V_{OC} with scattering layer is likely due to the lower LUMO energy level (-3.82 eV) of dye loaded TiO_2.

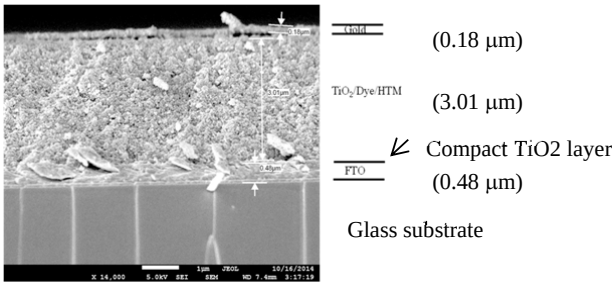


Figure3. Cross-sectional field-emission scanning electron microscopy (FESEM) image of solid-state dye-sensitized solar cell. Please note that the thin compact TiO_2 layer that has been deposited on top of the FTO is not resolved in the image.

Table1. Device parameters of red Spinach ssDSSCs with and without additional scattering layer. Red Spinach dyes were extracted in ethanol at 45 ^{o}C.

Red Spinach ssDSSC	V_{OC} (V)	J_{SC} (mA/cm^2)	FF	PCE (%)
Reference device (without scattering layer)	0.61	0.34	0.55	0.11
Device with scattering layer	0.58	0.03	0.40	0.01

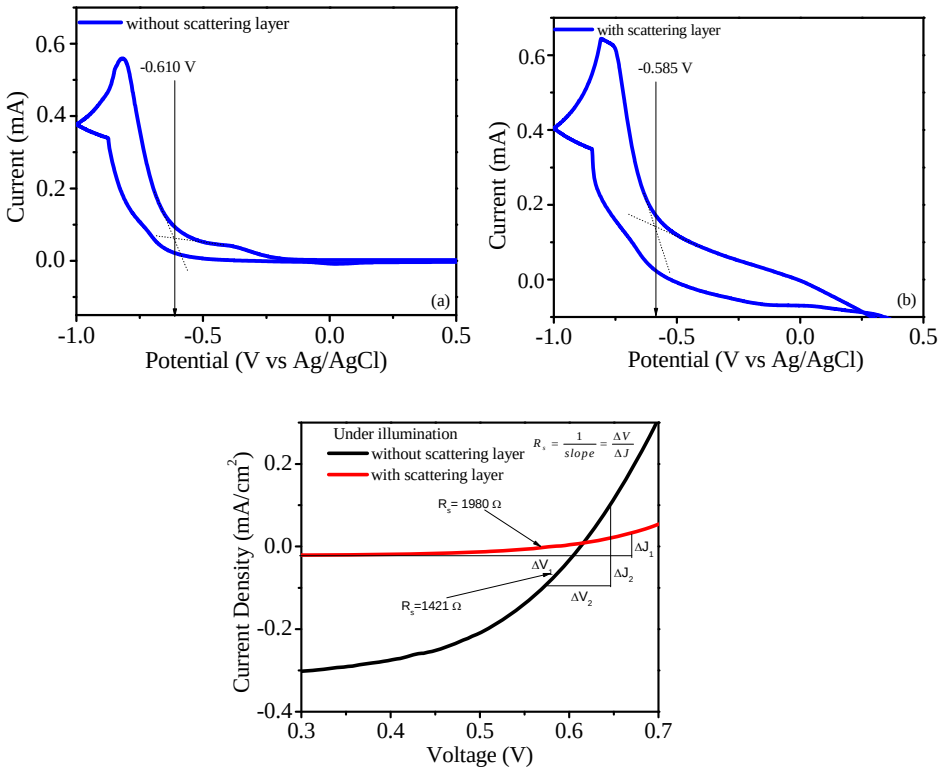


Figure 5. J-V characteristic of the DSSCs at the open circuit point with and without scattering layer. The series resistance of DSSCs is calculated from the slope of the linear region of J-V curve.

Table 2. EIS data of ssDSSCs without and with TiO_2 scattering layer.

Samples	R_h (Ω)	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_s (Ω)	τ_e(μs)
Mesoporous TiO_2 (3 μm)	215.59	233.83	609.28	285.9	1345	0.794
Mesoporous TiO_2 + Scattering layer (6 μm)	225.62	270.38	809.40	568.20	1874	1.634

FF is sensitive to the morphology and the series resistance (R_s) of the device [10]. The R_s should be minimized to achieve higher FF. A decrease in FF with scattering layer (from 0.55 to 0.40) is thus related to a change in R_s. The R_s of the devices was estimated from the slope of the linear region of J-V curve near the open circuit point. The reciprocal of the slope ($R_s = \frac{1}{slope} = \frac{\Delta V}{\Delta J}$) is the series resistance of the device. Detailed calculation of R_s is depicted in Figure 5. The calculated R_s are 1980 Ω and 1421 Ω for the devices with and without scattering layer. A lower FF of 0.40 generated from the ssDSSC with TiO_2 scattering layer is attributed to the higher R_s of the device.

The short circuit current (J_{SC}) mainly depends on the charge carrier's density and the mobility of charge carriers. The density of charge carriers would be correlated to the photo-induced electron excitation (photo response of the materials to visible light), exhibited by the dye-sensitized TiO_2 film [11]. Although the dye absorption increased with scattering layer, the J_{SC} decreased from 0.34 mA/cm^2 and 0.03 mA/cm^2. It may be due to the limit of charge transfer, charge transport and charge recombination inside the ssDSSCs. Thus the charge transport and associated charge recombination process in the ssDSSCs were investigated by electrochemical impedance spectroscopy.

In electrochemical impedance spectroscopy (EIS) measurement, AC impedance spectrum of ssDSSCs was acquired in the frequency range from1.429 × 10^{5}Hz to 2.099 Hz. The schematic diagram of the internal resistance related to the charge transfer kinetics in the ssDSSCs is shown in Fig. 4.16. Figure7. (a) Shows the electrochemical impedance Nyquist plot under illumination for the red spinach ssDSSCs with and without scattering layer. It exhibited three semicircles which depend on the ssDSSCs with and without TiO_2 scattering layer. The three semicircles are attributed to the HTM at counter electrode (Z_1) in the high-frequency region, the electron transfer at the TiO_2/dye/HTM interface (Z_2) in the mid-frequency region, and carrier transport by ions within the HTM (Z_3) in the low-frequency region. The resistance elements R_1, R_2, and R_3 are described as the real parts of Z_1, Z_2, and Z_3, respectively. Z_1 is parallel combination of R_1 and C_1, Z_2 is parallel combination of R_2 and C_2, and Z_3 is parallel combination of R_3 and C_3. The first semicircle represents the resistance at the Au (counter electrode)/HTM interface (R_1) corresponding to the high frequency region. The second semicircle covers the resistance from the conduction band of TiO_2 film to HTM interface (R_2) corresponding to the intermediate-frequency regime. The third semicircle represents the resistance (R_3) is associated with the Nernstain diffusion within the HTM corresponding to the low frequency region. The capacitance used in the model is regarded as double layer capacitance due to the porous surface of the photoelectrode [12].

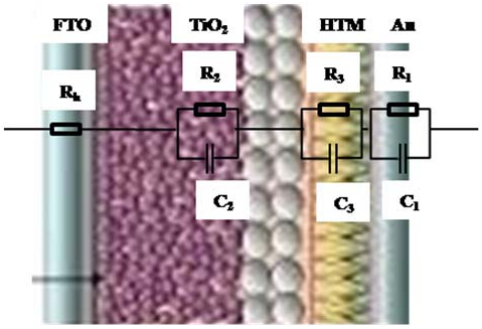


Figure 6. The schematic diagram of the internal resistance related to the charge transfer kinetics in the ssDSSCs.

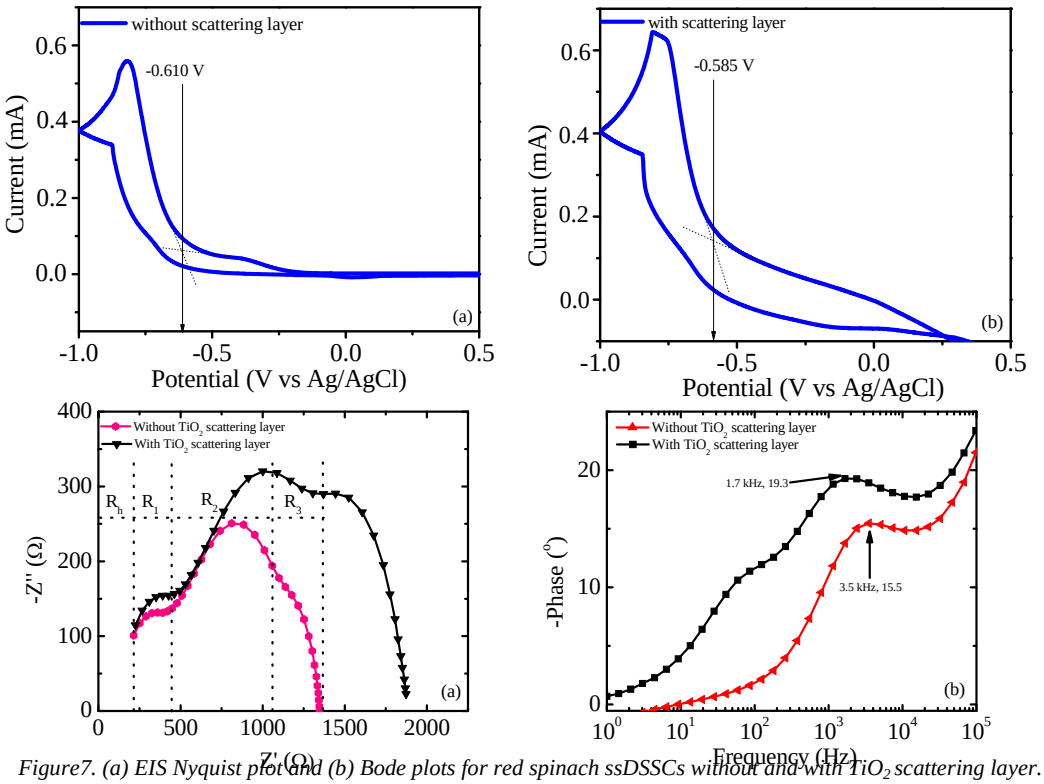


Figure7. (a) EIS Nyquist plot and (b) Bode plots for red spinach ssDSSCs without and with TiO_2 scattering layer.

Finally, the ohmic serial resistance (R_s) is associated with the series resistance of the HTM and electric contacts in the ssDSSCs. The series resistance R_s can be written as

$$R_s = R_h + R_1 + R_2 + R_3$$

where R_h is the sheet resistance of FTO glass substrate.

The observed resistances (R_s, R_1, R_2 and R_3) at various interfaces are listed in Table 2. The charge transport resistance R_1 is 233.83 and 270.38 Ω, R_2 is 609.28 and 809.40 Ω, and R_3 is 285.90 and 568.20 Ω for ssDSSC without and with TiO_2 scattering layer, respectively. ssDSSC with TiO_2 scattering layer appeared to have higher total resistances in the current path across the device than those without TiO_2 scattering layer. The increased of R_2 with the decrease of the ssDSSC efficiency indicates that electron generation and transfer at the TiO_2/dye/HTM interface are decreased with low absorption and use of the incident photons [13]. This result revealed that electron transfer difficultly occurred over ssDSSC withTiO_2 scattering layer, and thereby decreasing the photocurrent and power conversion efficiency of ssDSSC.

The electron lifetime for the recombination (τ_e) is determined by the charge recombination between the injection electrons transported within the TiO_2 film and HTM [14]. The Bode phase plots of EIS spectra Fig. 7 (b) display the frequency peaks of the charge transfer process at different interfaces for the two devices with and without scattering layer. The characteristic low-frequency peak (f_{max}) of the cell with TiO_2 scattering layer shifts slightly to a lower frequency (1.7 kHz) compared with the ssDSSC without TiO_2 scattering layer (3.5kHz).The peak shift from high frequency to low frequency reveals a more rapid electron transport process. These results indicate that the introduction of the TiO_2 scattering layer favors the electron transfer and suppresses electron recombination. The lifetime of electrons within the TiO_2 photoanode (τ_e) was estimated from the maximum angular frequency (ω_{max}) of the impedance semicircle arc at middle frequencies, according to the relation:

$$\tau_e = \frac{1}{\omega_{max}} = \frac{1}{2\pi f_{max}}$$

where f_{max} is the maximum frequency of the mid-frequency peak [15].τ_e increased from 0.794 μs to 1.634 μs when scattering layer was incorporated on top of mesoporous TiO_2 photonode. Integration of scattering layer enabled to increase the charge transfer resistances at the interfaces of the device and extended the electron lifetime.

4. Summary and Conclusion

In this work, taking the advantage of dye-absorption enhancement with TiO_2 scattering layer, the TiO_2 scattering layer of the thickness 3 μm were incorporated in the ssDSSC devices with red Spinach dyes as photosentizer and the effect of scattering layer on the device performance were evaluated. Unexpectedly, the device efficiency decreased from 0.11 % to 0.01 % despite having absorption enhancement with scattering layer. Electrochemical impedance measurement pointed out that this efficiency detraction (mainly contributed from photocurrent) is attributed to an increase in charge transfer resistances at the TiO_2–related interfaces despite having more rapid electron transport (longer electron lifetime) with scattering layer.

Acknowledgements

One of the authors (Nan Kyi Kyi Thein) gratefully acknowledges Associate Professor Nripan Mathews for the measurements including field-emission scanning electron microscopy (FESEM), electrochemical impedance spectroscopy (EIS) and device efficiencies during her internship at Energy Research Institute @ NTU (ERI@N), Nanyang Technological University, Singapore.

References

[1] F. Gao *et al.,* J. Am. Chem. Soc. 130, (2008) 10720.
[2] H. J. Snaith and L. Schmidt-Mende, Adv. Mater 19, (2007) 3187.
[3] U. Bach *et al*., Nature 395, (1998) 583.
[4] H. J. Snaith *et al.,* Nano Lett. **7**, (2007) 3372.
[5] L. Schmidt-Mende *et al*., Appl. Phys. Lett. 86, (2005) 013504.
[6] F. Fabregat-Santiago *et al.,* J. Am. Chem. Soc. 131, (2009) 558.
[7] H. J. Snaith and M. Gratzel, Adv. Mater. 19, (2007) 3643.
[8] S. Anderson *et al*., Nature 280, (1979) 571.
[9] Y.W. Jang *et al*., J. Chem. 11, (2011) 1.
[10] S. Gunes *et al.,* Chem. Rev. 107(4), (2007) 1330.
[11] J. M. Shyla *et al.,* Arch. Appl. Sci. Res., 4(5), (2012) 2126.
[12] S. Agarwala *et al*., J. Power Sources 196,(2011) 1651.
[13] H. Kim et al., Mater. Chem. Phys. 117, (2009) 26.
[14] G. D. Sharma *et al*., J. Power Sources 195, (2010) 2053.
[15] R. Sastrawan *et al*., Electrochim. Acta 4**7**, (2002) 4213.

Simulation System of Heat Acclimation in Each Working Environment Focusing on the Evaluation of Acclimation by Birthplace and Working Wear

Hiroyuki Wariishi[1], Takehiro Tanaka[2]

Abstract

Over several years, the authors have developed the evaluation system about prediction of heatstroke occurrence and simulation of heat acclimation. The occurrence of heatstroke depends on environmental factors such as temperature and Over several years, the authors have developed the evaluation system about prediction of heatstroke occurrence and simulation of heat acclimation. The occurrence of heatstroke depends on environmental factors such as temperature and humidity. However, the occurrence of heatstroke significantly varies depending on individual attributes such as body weight, blood pressure, and physical condition. This evaluation system is the system that evaluates the possibility of occurrence of heatstroke based on WBGT values by inputting environmental factors such as temperature and humidity of the working area, physical attributes of individuals, and kinds of clothes. In this thesis, the prediction of heatstroke occurrence and simulation of heat acclimation in Asian regions are evaluated by the newly developed evaluation system. And it evaluates the heat acclimation in the labor environment of each major city in Asia. The results will help to prevent heatstroke and acclimate heat in the work environment.

Keywords: Labor working environment, Risk analysis, Heat acclimation

1. Introduction

Few researches and studies have been conducted in such fields as safety activities, trainings/exercises, danger/risk prevention measures and analysis/evaluation methods for labor working environment. Under these circumstances, the purpose of this study is to examine safety and quality improvement technique for labor working environment. To study the measures for the heatstroke prevention is indispensable for labor working environment. Also, it has been found out that the number of heatstroke cases has increased due to aging among workers, and global warming under the influence of abnormal weather and other factors. The rainy season particular to Japan and the summer season also have some impact. It is hoped to take appropriate methods for the prediction of heatstroke occurrence and simulation of heat acclimation in labor working environment in Asian regions. Over several years, the authors have developed the evaluation system about prediction of heatstroke occurrence and simulation of heat acclimation. The occurrence of heatstroke depends on environmental factors such as temperature and humidity. However, the occurrence of heatstroke significantly varies depending on individual attributes such as body weight, blood pressure, and physical condition. This evaluation system is the system that evaluates the possibility of occurrence of heatstroke based on WBGT values by inputting environmental factors such as temperature and humidity of the working area, physical attributes of individuals, and kinds of clothes. In this thesis, the prediction of heatstroke occurrence and simulation of heat acclimation in Asian regions are evaluated by the newly developed evaluation system. And it evaluates the heat acclimation in the labor environment of each major city in Asia. The results will help to prevent heatstroke and acclimate heat stroke in the work environment.

[1] Postgraduate Student, *Toyo University, Kanto Polytechnic College, whtaan@nifty.comm,* 049-239-1827
[2] Toyo University, tanaka@toyo.jp

2. Heatstroke and heat acclimation

Humans possess inherent adaptability to seasonal changes. A process of the human body becoming accustomed to the heated environment (hot season) is called “heat acclimation.” Heat acclimation promotes perspiration even if a body temperature is low, increasing a sweat rate of an adapted person even at a same body temperature and raising a maximum sweat rate. Furthermore, it stimulates the circulation of blood under the skin. Because the body heat is released fast, a rise of body temperature (core temperature) is controlled. As a result, people are able to stay in the heated environment at ease. With the successful heat acclimation, the efficiency of salt reabsorption into the body increases and the salt content in sweat is reduced.

Heatstroke is a generic term for physical disorders which occur when the water and sodium balance in the body system fails or the body is no longer able to regulate its internal temperature in a climate of high temperature and high humidity. Its symptoms include dizziness, faint, muscle pains/cramps, excessive perspiration, headache, indisposition, nausea, vomiting, fatigue, despondency, consciousness disorder, convulsion, limb movement disorder, and hyperthermia.

Table 1**.** Relations between WBGT, temperature and relative humidity Relative humidity (%)

	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
40	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43	44
39	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43
38	28	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42
37	27	28	29	29	30	31	32	33	34	35	35	36	37	38	39	40	41
36	26	27	28	29	29	30	31	32	33	34	34	35	36	37	38	39	39
35	25	26	27	28	29	29	30	31	32	33	33	34	35	36	37	38	38
34	25	25	26	27	28	29	29	30	31	32	33	33	34	35	36	37	37
33	24	25	25	26	27	28	28	29	30	31	32	32	33	34	35	36	36
32	23	24	25	25	26	27	28	28	29	30	31	31	32	33	34	35	35
31	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	34	34
30	21	22	23	24	24	25	26	27	27	28	29	29	30	31	32	32	33
29	21	21	22	23	24	24	25	26	26	27	28	29	29	30	31	31	32
28	20	21	21	22	23	23	24	25	25	26	27	28	28	29	30	30	31
27	19	20	21	21	22	23	23	24	25	25	26	27	27	28	29	29	30
26	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29
25	18	18	19	20	20	21	22	22	23	23	24	25	25	26	27	27	28
24	17	18	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27
23	16	17	17	18	19	19	20	20	21	22	22	23	23	24	25	25	26
22	15	16	17	17	18	18	19	19	20	21	21	22	22	23	24	24	25
21	15	15	16	16	17	17	18	19	19	20	20	21	21	22	23	23	24

(Dry-bylb temperature)
Temperature (°C)

Table 2. WBGT index

Risk level (WBGT)	Intensity of physical activity related to heat illness	Remarks
Hazardous (31ºC<)	Any physical activities	An old person is susceptible to heat illness even though he/she stays still. Avoid going out, and stay in a cool room.
Stern warning (28ºC-31ºC)		Avoid going out under a blazing sun. Beware of increase in room temperature.
Warning (25ºC-28ºC)	Medium and heavy physical activities	When intensive physical activity is required, take a rest regularly.
Caution (<25ºC)	Heavy physical activities	The risk is low, but heavy and intensive physical activity might cause the onset of heat illness.

3. Input data into the simulation system for evaluation of heat acclimation

Input data into the simulation system for evaluation of heat acclimation proposed by the authors are introduced in this section. This simulation system for evaluation of heat acclimation predicts how long it takes for a given worker from a particular birthplace (city) to become acclimated to heat in a given working place (city) and in what period or month he/she easily catches heatstroke.

Figure 1 presents sample data to be put into the simulation system for evaluation of heat acclimation proposed by the authors. Figure 2 shows some items for which input data need to be corrected or weighted. As Figure 1 illustrates, there are nine items to be completed in this system. The following are detailed input information for each of the nine items, including corrections and weights shown in Figure 2.

1. Time period: People in Asia suffer heatstroke more frequently between April and October because of the rise in temperature. In this simulation system, users are allowed to arbitrarily put in the month and time period.
2. Working area: This simulation system for evaluation of heat acclimation predicts how long it takes for a given worker from a particular birthplace (city) to become acclimated to heat in a given working place (city) and in what period or month he/she easily catches heatstroke. Thus, the place name (city) where the work is actually taken place is entered in the second item. The name of a nearby city can be put in as a working area surveyed.
3. Physical workload: The physical workload is defined as the degree of heaviness of a certain work on the human body. In Japan, the Labor Standards Bureau in the Ministry of Health, Labour and Welfare issued a notification regarding “the WBGT heat index in response to the physical workload.” In its guidelines, temperature control is suggested in accordance with the metabolic rate (i.e. rest, light, moderate, heavy, and very heavy) for

both heat-acclimated and non-heat-acclimated workers. Furthermore, in the environment with heavy and very heavy metabolic rates, temperature is adjusted depending on whether airflow is felt or not. In this regard, the authors provided finely divided correction values to be put in this simulation system for evaluation of heat acclimation.

4. Clothing: Workers are clothed appropriately according to work site conditions. In this simulation system, the following six categories are set up for clothing: ordinary working wear (long-sleeved shirt and slacks); fabric (woven) overalls; two-layered fabric (woven) clothes; polypropylene overalls; and special purpose airtight overalls. Correction values are also provided to feed detailed information.

5. Age: In consideration of actual working sites, the age of a worker was made to range from teens to eighties with additional correction factors. The input of age data under ten and over ninety is also possible.

6. BMI: Body Mass Index (BMI) is defined as the body weight (kg) divided by the square of the body height (m).

   In addition to "weight" and "height," six categories of physiques were also made available by adding correction factors: underweight; normal weight; obesity class I; obesity class II; obesity class III; and obesity class IV. These six categories are based on the definition provided by the World Health Organization (WHO).

7. Blood pressure: Blood pressure is one of major factors which trigger heatstroke. In this simulation for evaluation of heat acclimation, the systolic blood pressure or maximal BP (unit: mmHg) is put in, and six categories of blood pressures are used by adding correction factors: optimum (<120); normal (<130); high normal (<140); hypertension stage I (<160); hypertension stage II (<180); and hypertension stage III (180≦).

   These six categories are based on the definition provided by the World Health Organization (WHO).

8. Birthplace (within Japan): This simulation system for evaluation of heat acclimation predicts how long it takes for a given worker from a particular birthplace (city) to become acclimated to heat in a given working place (city) and in what period or month he/she easily catches heatstroke.

   To complete this item, the name of native city if within Japan is put in. The name of a nearby city can be also put in as a birthplace surveyed.

9. Birthplace (overseas): If the birthplace is in a foreign country, the name of the country (city) is put in. The name of a nearby city can be entered as a birthplace surveyed. In addition, it is optional for a user to put in temperature (℃) and relative humidity (%) of the birthplace. A user is required to complete either Item (8) or (9) depending on whether his/her birthplace is within Japan or overseas.

One example of the simulation result for evaluation of heat acclimation

The WBGT values of workers, who had come from Tokyo, Singapore, Myanmar, New York, Alaska and Moscow, and worked in the five work sites of Tokyo, Hokkaido, Osaka, Fukuoka and Okinawa, wearing (1) an ordinary working wear, (2) an SMS polypropylene wear, or (3) a limited-use vapor-barrier coverall, were compared. (Other attributes include height:

170cm, age: 30s and 50s, weight: 50kg and 100kg, and blood pressure (BP): 110mmHg and 160mmHg.)

The results are shown in Tables 3 to 5.

Table 3 indicates the monthly WBGT values of workers at their age of 30s, weighing 50kg with a blood pressure of 110mmHg, when they worked in Sapporo, Tokyo, Osaka, Fukuoka and Okinawa, having an ordinary working wear on. Their birthplaces are Tokyo, Myanmar, Singapore, New York, Alaska and Moscow in a descending order.

The following findings are drawn up from Table 3.

The workers coming from high latitudes showed high WBGT values no matter which Japanese cities they worked in. For instance, the difference among workers working in Tokyo in September is colored conspicuously. The result of the one fromAlaska (58.3°N) is colored in light red meaning “stern warning” under the WBGT standard while that of the one from Moscow (55.8°N) is given “warning” in yellow. Under comparison among the work sites, any workers working in cities at lower latitudes have higher WBGT values. Particularly in April, their WBGT values are colored in white calling for “caution” to prevent heatstroke in all the cities except for Okinawa where the WBGT is yellowed giving “warning” to all workers no matter where they were from.

Table3. Ordinary working wear

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	11.26	20.90	24.04	29.33	29.41	21.56	19.32
Myanmar (Naypyidaw: 19.8° N)	11.26	20.90	24.04	29.33	29.41	21.56	19.32
Singapore (Singapore: 1.4° N)	11.26	20.90	24.04	29.33	29.41	21.56	19.32
New York (42.6° N)	11.26	20.90	24.04	31.53	31.61	21.56	19.32
Alaska (Juneau: 58.3° N)	11.26	20.90	26.24	31.53	31.61	21.56	19.32
Russia (Moscow: 55.8° N)	11.26	20.90	24.04	31.53	31.61	21.56	19.32
Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	18.49	27.06	29.61	34.39	35.08	25.87	26.96
Myanmar (Naypyidaw: 19.8° N)	18.49	27.06	29.61	34.39	37.28	25.87	26.96
Singapore (Singapore: 1.4° N)	18.49	27.06	29.61	34.39	35.08	25.87	26.96
New York (42.6° N)	18.49	27.06	31.81	36.59	37.28	25.87	26.96
Alaska (Juneau: 58.3° N)	18.49	29.26	31.81	36.59	37.28	28.07	29.16
Russia (Moscow: 55.8° N)	18.49	29.26	31.81	36.59	37.28	25.87	29.16
Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	16.66	25.26	28.51	33.52	34.77	25.46	26.73
Myanmar (Naypyidaw: 19.8° N)	16.66	25.26	28.51	33.52	36.97	25.46	26.73
Singapore (Singapore: 1.4° N)	16.66	25.26	28.51	33.52	34.77	25.46	26.73
New York (42.6° N)	16.66	25.26	30.71	35.72	36.97	25.46	26.73
Alaska (Juneau: 58.3° N)	16.66	27.46	30.71	35.72	36.97	27.66	28.93
Russia (Moscow: 55.8° N)	16.66	25.26	30.71	35.72	36.97	25.46	28.93
Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	19.74	27.88	31.01	37.98	38.76	27.00	28.71
Myanmar (Naypyidaw: 19.8° N)	19.74	27.88	31.01	37.98	38.76	27.00	28.71
Singapore (Singapore: 1.4° N)	19.74	27.88	31.01	35.78	36.56	27.00	28.71
New York (42.6° N)	19.74	30.08	33.21	37.98	38.76	27.00	30.91
Alaska (Juneau: 58.3° N)	19.74	30.08	33.21	37.98	38.76	29.20	30.91
Russia (Moscow: 55.8° N)	19.74	30.08	33.21	37.98	38.76	29.20	30.91
Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	25.56	30.68	33.88	37.52	37.67	28.93	31.43
Myanmar (Naypyidaw: 19.8° N)	25.56	30.68	33.88	37.52	37.67	28.93	31.43
Singapore (Singapore: 1.4° N)	25.56	30.68	33.88	35.32	35.47	28.93	31.43
New York (42.6° N)	25.56	32.88	36.08	37.52	37.67	31.13	33.63
Alaska (Juneau: 58.3° N)	27.76	32.88	36.08	37.52	37.67	31.13	33.63
Russia (Moscow: 55.8° N)	25.56	32.88	36.08	37.52	37.67	31.13	33.63

Table 4 shows the WBGT values of the workers wearing an SMS polypropylene wear. When they worked wearing an SMS polypropylene wear which is thicker than an ordinary working wear, their WBGT values increased no matter where they were from. A rise in risk level requires workers to take precautions against heatstroke more in an SMS polypropylene wear than in an ordinary working wear.

Table 4. SMS polypropylene wear

Age: 30s Weight: 50kg	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	11.81	21.45	24.59	29.88	29.96	22.11	19.87
Myanmar (Naypyidaw: 19.8° N)	11.81	21.45	24.59	29.88	29.96	22.11	19.87
Singapore (Singapore: 1.4° N)	11.81	21.45	24.59	29.88	29.96	22.11	19.87
New York (42.6° N)	11.81	21.45	24.59	32.08	32.16	22.11	19.87
Alaska (Juneau: 58.3° N)	11.81	21.45	26.79	32.08	32.16	22.11	19.87
Russia (Moscow: 55.8° N)	11.81	21.45	24.59	32.08	32.16	22.11	19.87
Age: 30s Weight: 50kg BP:	Work site: Tokyo						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	19.04	27.61	30.16	34.94	37.83	26.42	27.51
Myanmar (Naypyidaw: 19.8° N)	19.04	27.61	30.16	37.14	37.83	26.42	27.51
Singapore (Singapore: 1.4° N)	19.04	27.61	30.16	34.94	35.63	26.42	27.51
New York (42.6° N)	19.04	27.61	32.36	37.14	37.83	26.42	27.51
Alaska (Juneau: 58.3° N)	19.04	29.81	32.36	37.14	37.83	28.62	29.71
Russia (Moscow: 55.8° N)	19.04	29.81	32.36	37.14	37.83	28.62	29.71
Age: 30s Weight: 50kg BP:	Work site: Osaka						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	17.21	25.81	29.06	34.07	37.52	26.01	27.28
Myanmar (Naypyidaw: 19.8° N)	17.21	25.81	29.06	34.07	37.52	26.01	27.28
Singapore (Singapore: 1.4° N)	17.21	25.81	29.06	34.07	35.32	26.01	27.28
New York (42.6° N)	17.21	25.81	31.26	36.27	37.52	26.01	27.28
Alaska (Juneau: 58.3° N)	17.21	28.01	31.26	36.27	37.52	28.21	29.48
Russia (Moscow: 55.8° N)	17.21	25.81	31.26	36.27	37.52	26.01	29.48
Age: 30s Weight: 50kg BP:	Work site: Fukuoka						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	20.29	28.43	31.56	38.53	39.31	27.55	29.26
Myanmar (Naypyidaw: 19.8° N)	20.29	28.43	31.56	38.53	39.31	27.55	29.26
Singapore (Singapore: 1.4° N)	20.29	28.43	31.56	36.33	37.11	27.55	29.26
New York (42.6° N)	20.29	30.63	33.76	38.53	39.31	27.55	31.46
Alaska (Juneau: 58.3° N)	20.29	30.63	33.76	38.53	39.31	29.75	31.46
Russia (Moscow: 55.8° N)	20.29	30.63	33.76	38.53	39.31	29.75	31.46
Age: 30s Weight: 50kg BP:	Work site: Naha						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	26.66	31.78	34.98	38.62	38.77	30.03	32.53
Myanmar (Naypyidaw: 19.8° N)	26.11	31.23	34.43	38.07	38.22	29.48	31.98
Singapore (Singapore: 1.4° N)	26.11	31.23	34.43	35.87	36.02	29.48	31.98
New York (42.6° N)	26.11	33.43	36.63	38.07	38.22	31.68	34.18
Alaska (Juneau: 58.3° N)	28.31	33.43	36.63	38.07	38.22	31.68	34.18
Russia (Moscow: 55.8° N)	26.11	33.43	36.63	38.07	38.22	31.68	34.18

Finally in Table 5, the WBGT values of the workers wearing a limited-use vapor-barrier coverall are indicated. Workers wearing a limited- use vapor-barrier coverall are advised to take precautions against heatstroke in any work sites almost throughout the period except April in

Sapporo as the WBGT points out “hazardous” more stringently than when wearing an above mentioned SMS polypropylene wear.

Limited-use vapor-barrier overall

Table 5**.** Limited-use vapor-barrier coverall

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	23.36	33.00	38.34	43.63	43.71	33.66	31.42
Myanmar (Naypyidaw: 19.8° N)	23.36	33.00	38.34	43.63	43.71	33.66	31.42
Singapore (Singapore: 1.4° N)	23.36	33.00	36.14	43.63	43.71	33.66	31.42
New York (42.6° N)	23.36	35.20	38.34	43.63	43.71	35.86	33.62
Alaska (Juneau: 58.3° N)	23.36	35.20	38.34	43.63	43.71	35.86	33.62
Russia (Moscow: 55.8° N)	23.36	35.20	38.34	43.63	43.71	35.86	33.62

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	30.59	41.36	43.91	48.69	49.38	40.17	41.26
Myanmar (Naypyidaw: 19.8° N)	30.59	41.36	43.91	48.69	49.38	40.17	41.26
Singapore (Singapore: 1.4° N)	30.59	39.16	43.91	48.69	49.38	37.97	39.06
New York (42.6° N)	32.79	41.36	43.91	48.69	49.38	40.17	41.26
Alaska (Juneau: 58.3° N)	32.79	41.36	43.91	48.69	49.38	40.17	41.26
Russia (Moscow: 55.8° N)	32.79	41.36	43.91	48.69	49.38	40.17	41.26

Age: 30s Weight: 50kg BP: 110mmHg	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	28.76	39.56	42.81	47.82	49.07	39.76	41.03
Myanmar (Naypyidaw: 19.8° N)	28.76	39.56	42.81	47.82	49.07	39.76	41.03
Singapore (Singapore: 1.4° N)	28.76	37.36	42.81	47.82	49.07	37.56	38.83
New York (42.6° N)	30.96	39.56	42.81	47.82	49.07	39.76	41.03
Alaska (Juneau: 58.3° N)	30.96	39.56	42.81	47.82	49.07	39.76	41.03
Russia (Moscow: 55.8° N)	30.96	39.56	42.81	47.82	49.07	39.76	41.03

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	31.84	42.18	45.31	50.08	50.86	41.30	43.01
Myanmar (Naypyidaw: 19.8° N)	31.84	42.18	45.31	50.08	50.86	41.30	43.01
Singapore (Singapore: 1.4° N)	31.84	42.18	45.31	50.08	50.86	39.10	43.01
New York (42.6° N)	34.04	42.18	45.31	50.08	50.86	41.30	43.01
Alaska (Juneau: 58.3° N)	34.04	42.18	45.31	50.08	50.86	41.30	43.01
Russia (Moscow: 55.8° N)	34.04	42.18	45.31	50.08	50.86	41.30	43.01

Age: 30s Weight: 50kg BP:	Work site:						
	4	5	6	7	8	9	
Tokyo (Tokyo: 35.7° N)	39.86	44.98	48.18	49.62	49.77	43.23	45.73
Myanmar (Naypyidaw: 19.8° N)	39.86	44.98	48.18	49.62	49.77	43.23	45.73
Singapore (Singapore: 1.4° N)	37.66	44.98	48.18	49.62	49.77	43.23	45.73
New York (42.6° N)	39.86	44.98	48.18	49.62	49.77	43.23	45.73
Alaska (Juneau: 58.3° N)	39.86	44.98	48.18	49.62	49.77	43.23	45.73
Russia (Moscow: 55.8° N)	39.86	44.98	48.18	49.62	49.77	43.23	45.73

4. Conclusion

As discussed above, it is assumed that the WBGT value is subject to the latitude of work sites and that heat acclimation may be largely accounted for by the latitude of a worker’s birthplace. In addition, heat insulation and humidity conditioning properties of clothing have some influence on the WBGT value.

References

[1] The Japan Construction Occupational Safety and Health Association, Statistics in Web site (www.kensaibou.or.jp).

[2] Tanaka, T., and Warmish, H. Toyo University. Heat acclimation evaluation tool. Heat acclimation evaluation method.. Computer program for evaluation of heat acclimation and computer readable recording medium. Patent application #2018-13474.

Basic Study on the Foundation Pile Length Setting System and its 3D Display Technique from the Viewpoint of Geo-environmental Engineering

Naito Tanji[1] et al

Abstract

In this study, fundamental investigations on the foundation pile length setting system and its 3D display technique are carried out from the viewpoint of geo-environmental engineering. To promote the study, the foundation pile length setting system was built in accordance with the following procedure. (1) Digitization of ground data Geologic columnar section data to be digitized were retrieved mainly from the official websites of the Ministry of Land, Infrastructure, Transport and Tourism and other Japanese administrative organs. Pile lengths were estimated based on the data obtained from the points within the concentric circles of radii 100m, 300m, 500m and 1km around a given center. (2) Five model areas were selected from Japan's capital region (i.e. Tokyo, Saitama and Yokohama) and 20 places for each area were analyzed. (3) Major construction methods adopted in Japan were compared.

Keywords: Geo-environmental, 3D Display, Digitization, Foundation Pile

1. Introduction

The importance of "ground" as one of the environmental components has come to be keenly recognized while social issues concerning environment, disaster prevention, and waste disposal have presented themselves more seriously. The ground is precious assets to the human race, which must be handed down to the next generation, as it essentially carries out multiple functions (*i.e.* bearing load; holding water; venting air; purifying filth; storing nutrients; absorbing shock, etc.) and plays concomitant crucial roles (*i.e.* places where living and social facilities are built; various organisms inhabit; groundwater develops; foods are produced; and waste materials are deposited, etc.) However, human activities have exploited the ground to install living, social and industrial infrastructures and facilities by placing a premium on economy and efficiency without paying due attention to the ground's multifaceted functions and roles in the history of development. As a result, the geo-environment has been conspicuously deteriorating.

Not to spoil the potential of future generations for sustainable development, it is inevitable to use the ground in harmony with environment[1)], and the discipline dedicated to the above issues is geo-environmental engineering, which is considered an old-yet-new field of learning.

In this study, fundamental investigations on the foundation pile length setting system and its 3D display technique are carried out from the viewpoint of geo-environmental engineering.

2. Definition of geo-environmental engineering

Geotechnical engineering is the study aiming to build basic social infrastructures

[1] Undergraduate Student, Tanaka Laboratory, Toyo University, s16f01601287@toyo.jp
2.Ryoma Komuro, 3.Takehiro Tanaka, 4. Kojiro Yanaura, 5.Haruo Takeda, 6. Yasuhiro Goto

necessary for enriching human life by dynamically safe and economical methods in such fields as civil engineering, architecture, mining, and agriculture. Through the efforts devoted over past several decades, the study has been systematized and developed as a basic compulsory subject. As a consequence, ground behavior has come to be successfully described through technical investigation of soil characteristics and their numerical analyses. Because the ground is indispensable for any structures to be founded on, geotechnical engineering as one conventional engineering subject has contributed significantly to the improvement of safe and secured infrastructure and the designing and execution for disaster prevention in actual construction sites and infrastructure managements, in keeping with soil mechanics, foundation engineering, and agricultural engineering.

In the year of 2000, the Science Council of Japan presented a proposal to establish and organize “geo-environmental engineering” as a new engineering domain. Geo-environmental engineering is granted status as the integrated science aiming at creating the best suited social system, founded on the conventional dynamics-based geotechnical engineering, to which such subjects as soil engineering, microbiology, chemistry, chemical engineering, ecological and environmental engineering, and toxicology, are applied, and social sciences and humanities are widely related.

Ground-related engineering is interdisciplinary in the first place, which has a history of having extended its domain to meet social demands. Accordingly, its name has changed from soil engineering and soil mechanics and foundation engineering togeotechnical engineering. The newly advocated geo-environmental engineering covers a considerably wide range, as it involves the conventional geotechnical engineering and further deals with various environmental issues.

In recent years, issues on global environment have been highlighted as critical problems. The changes in natural as well as social environments urge the society of civil engineers as a whole to make its paradigm shift. After the age of continuously growing socioeconomic development supported by mass production and mass consumption, the establishment of low carbon societies and sustainable societies is being called for, naturally requiring people to change their lifestyles and the managerial principle of social infrastructure to be reformed.

In the field of geo-environmental engineering as well, its priorities have changed substantially. Pertaining to the above mentioned paradigm shift in the management of social infrastructure, elements in the context of geo-environmental preservation have become more important. Furthermore, it has become much crucial to improve social infrastructure for safe and secured life of people by taking natural environment into consideration. While geo-environmental engineering contains the disciplines of conventional geotechnical engineering and soil mechanics to maintain the balance with natural as well as social environments in a broad sense, environmental geo-technics is a narrower academic discipline established specifically to solve environmental problems from the viewpoint of geotechnical engineering.

Issues to be dealt with in environmental geo-technics are those related to restoration of contaminated land; treatment of waste materials (hazardous and non-hazardous); storage and treatment of nuclear wastes; acid rain and acid soil; prevention of desertification; sea-level rise and social infrastructure; substances of concern circulated across ground; water cycle; and geo-environment related to biology and ecology. It covers a considerably wide range of issues, even though it is regarded as a narrower academic discipline.

Internationally, the subject was taken up as one of the major themes at the 9th Tokyo Conference of the International

Society for Soil Mechanics and Foundation Engineering (ISSMFE) in 1977 and since then discussed extensively in its regional conference held every four years. In 1994, the first International Congress on Environmental Geo-technics (ICEG) was called in Edmonton, Canada. Then, the second conference was held in Osaka, Japan, in 1996, followed by the third in Lisbon, Portugal, in 1998. Their contributions were reflected in the activities of Technical Committees (TC) of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), TC5 in particular. Since then, ICEG has been continuously held every four years, convening the 2002 fourth conference in Rio de Janeiro, Brazil, and the 2006 fifth conference in Cardiff, UK. Their scientific solutions specific to geo-environmental issues would be regarded as achievements in the study of environmental geo-technics.

In summary, the following four aspects are key approaches of geo-environmental engineering.

(1) Management and restoration of social infrastructure: as for the management of social infrastructure in the aged society with a low birth rate, it is necessary to build hubs of international economics and disaster prevention activities in wide areas by making more efficient capital investment and developing technologies to maintain and restore existing social infrastructure.

(2) Establishment of sustainable societies: to successfully implement 3R approaches (reducing, reusing and recycling) to cope with waste materials, their acceptance as ground materials would be contributory to solving the problem. Appropriatem treatment of waste materials is one of the most crucial missions of geo-environmental engineering. To build sustainable decarbonized societies by recycling energies, efforts need to be dedicated to the achievement of urban functions in harmony with nature.

(3) Preservation of natural environment: people are required to reconfirm that ground and ecosystem react in close association and take measures to sustain the linkage of forests, rivers, cities, and seas.

(4) Commitment to preservation of global environment: efforts must be exerted to realize co-development of human societies with nature and secure biodiversity worldwide.

3. Procedure to build the foundation pile length setting system

The foundation pile length setting system was built in accordance with the following procedure. (1) Digitization of ground data. Geologic columnar section data were retrieved mostly from the official websites and then digitized. Figure-1 shows a part of Shinjuku, the sub-center of Tokyo. Pile lengths were estimated based on the data obtained from the points within the concentric circles of radii 100m, 300m, 500m and 1km around a given target center as Figure-1 indicates. (2) Model areas in this study

The following four areas were selected as model areas, where analytical investigation was carried out at 20 points each.

① Sunshine City in Toshima-district, Tokyo (Ikebukuro area) (analytical result is partially shown in Table-1)

② Fuji TV office building site at Odaiba area, Koto-district, Tokyo (analytical result is partially shown in Table-2)

③ Tokyo Metropolitan Government office building site, Shinjuku-district, Tokyo

④ Sakuragicho Sta. Naka-district, Yokohama, Kanagawa

(3) Methods examined in this study

① Rotational pile construction method (EAZET method)

② Pre-boring and enlarged foot protection method (HiFB method)

③ Rotational pile construction method with soil cement (ATT column method)

4. Outlines of the construction methods examined in this study

The features of the three construction methods introduced in this study, namely the EAZET method, the HiFB method, and the ATT column method, are outlined below.

(1) EAZET method

The EAZET method is a pile installation technique by rotating and burying a steel pipe equipped with a spiral plate at the tip. By embedding the spiral plate expanding 1.87 to 3 times the steel pipe width into a bearing layer, the significant bearing capacity is obtained. The method is environmentally friendly, producing no waste. By selecting the compact operation machine, work can be completed even in the very restricted and confined situation.

(2) HiFB method

The HiFB method is a bored pile construction method, a kind of pre-boring and enlarged foot protection method. Drilling fluid is poured into construction ground while a borehole is created down to a specified depth by an excavator. At the specified depth (near the bearing layer), foot protection fluid is poured in and a foot protection bulb is created at the bottom. As the excavator is being pulled up, circumference fixation liquid is poured in to build a soil cement borehole.

(3) ATT column method

The ATT column method is a hybrid of a soil improvement column and a winged steel pipe. The integration of a column and a winged steel pipe enhances vertical bearing capacity, pullout bearing capacity, and horizontal resistance. Because not only end bearing capacity but also frictional force is large, appropriate design planning can be made according to the type of ground. Construction can be done with a compact machine in an environmentally friendly manner making low noise, low vibration, and little surplus soil.

5. Summary

(1) In this study, the foundation pile length setting system was newly developed, under which four areas treated with the three construction methods were analyzed. As a result, the

system was found prospective and applicable for wider use, demonstrating its capabilities of choosing a proper method and making an adequate judgment for a target site.

(2) Regarding the construction method, each of the three methods, namely EAZET, HiFB and ATT column, has its own advantages and disadvantages, from among which the method suitable to a target site could be chosen. Partially though, they were three-dimensionally visualized and successfully implemented.

(3) The allowable vertical bearing capacity and the pile length in the four districts with the three methods were surveyed under the foundation pile length setting system. The survey results are reviewed below. The ground under Ikebukuro area seems stable, where the three construction methods displayed steady bearing capacity. Among the three, ATT column and HiFB presented the bearing capacity overpoweringly higher than EAZET. Nevertheless, EAZET also exhibited fairly high bearing capacity, suitable for the construction in a narrow space and a residential area. Thus, these three methods can be used for different places.

Shinjuku, similarly to Ikebukuro area, stands on the stable ground, where the three methods exhibited steady outcomes. Thus, the proper method should be selected according to the location.

Finally, the ground of Odaiba area proximity of the sea is not thoroughly solid, where EAZET is not applicable because of its short pile length. For this reason, the method must be selected from between HiFB and ATT column depending on the location. The ATT column is compact, producing low noise, little surplus soil, and low vibration, which is suitable for the construction in a narrow area and a residential district.

References

[1] Science Council of Japan. (2000). Geo-environmental engineering in the 21st century--Toward the creation of new disciplines. *Report of Geo-environmental Engineering Special Committee, Socioenvironmental Engineering Working Liaison Committee*.

[2] Kamon, M., Omine, K., & Katsumi, K. (2010). *Geo-environmental Engineering*. Tokyo: Kyoritsu Shuppan.

Socio-Economic Technique Changes in Myanmar (1953-1964)

Khin Khin Si[1]

Abstract

The first effective contacts with western civilization were commercial. Beginning of the nineteenth century money economy meant a change in the level of aspiration of the Burmese who had to learn to want and value material things. There were a few aspects of the transformation of British Burma between 1861 and 1885 as a result of the opening of the Suez Canal. It was during this period that the whole machinery of administration took on its modern character. Everything happened after 1885 up to the introduction of constitutional reforms in 1923 or even up to the time of the Japanese invasion, was merely a development of conditions already in existence in 1885. Apart from the execution of development projects there is a wide range of social and economic functions which a Socialist Government must perform. The present civil service system, administrative set-up and procedures are vestiges of the past colonial regime, of the past laissez faire economy. When social, economic and technical ministries and departments have sprung up, as they have done in Burma lately, and especially when they have to be built up from very foundation, expert professional and technical knowledge has become indispensable. In agriculture, the first steps were to be the redistribution of land with a view to eliminating landlordism and promoting modern methods in cultivation. After World War II the forests in Burma became entirely State owned and all organized forestry became the responsibility of the Forest Department. A State Timber Board was set up to look after economic exploitation, commercial transactions and exports concerned with the resources of the entire reserve forests. Burma is an overwhelmingly agricultural country. The main farming areas are concentrated in the alluvial lands of the delta and in the valley lands of the prominent rivers, particularly the Irrawaddy, Chindwin and Sittang. There are approximately 25 million acres of land in the country which can ultimately be brought under cultivation by means of irrigation or drainage works.

Keywords**:** social change affairs, economic change affairs, economic position, forest techniques' changes

1. Introduction

The industrial policy of the Government was made known in a resolution of the Economic Council which was subsequently laid on the tables of Parliament on 28th September 1949. Production of atomic energy and manufacture of arms and ammunitions were reserved for development as State enterprises and/or monopolies. But until such time as the State can undertake sufficient production private enterprise shall be permitted to develop them either on their own or in partnership with the State, on terms and conditions to be settled with each enterprise. Industries not included in the preceding two categories were to be open to development by private enterprise. The resolution also indicated the terms and conditions on which foreign capital may be accepted for the rehabilitation or development of industries in Burma.

Apart from the execution of development projects there is a wide range of social and economic functions which a Socialist Government must perform. The Government has, of course, gone ahead with or is contemplating a number of reforms. Devolution of power, democratization of the administrative machinery etc., which were recently announced at the

[1] Dr Professor, Department of History, University of Pathein, Myanmar, drkhinsi2017@gmail.com

Welfare State Conference in Rangoon, are certainly very commendable and necessary reforms. The present civil service system, administrative set-up and procedures are vestiges of the past colonial regime, of the past laissez faire economy. Secretaries to the Government, able but amateur all the same, may be able to run with reasonable efficiency a government machinery already established and consisting for the most part of housekeeping departments. But when social, economic and technical ministries and departments have sprung up, as they have done in Burma lately, and especially when they have to be built up from the very foundation, expert professional and technical knowledge has become indispensable.

2. Methodology

Research design is Historical Method. It writes research paper according to the present Myanmar Era. There rise step by step on changes of events. The cause of happening will be inspected. The basic principle was discussed. It put forward coming into being of events. Consequence and offense were criticized and considered.

Objectives of the study

The Republic of Myanmar is a developing country and agriculture is the main stream of its economy. Agricultural products are also the most prominent items over total exports. As shown in the “Four economic objectives” of the political slogan, development of agriculture should be the basis for economic development in this country. In particular, agriculture-related industries such as fertilizer, agricultural machinery and equipment and others should be strategically developed to improve agricultural productivity and raise farmers’ income. Therefore, the best way to develop the economy in Myanmar is to engineer a framework based on the agricultural development and agricultural development must be the engine for economic and rural development.

3. Result

Myanmar opened its doors to the rest of the world in the midst of a period of globalization and regionalization. Consequently, the open-door policy drastically changed Myanmar’s external sector. As the volume of trade grew, Myanmar expanded its trade relations with neighboring countries, having become integrated into the regional markets. The commodity composition of both exports and imports also changed throughout the transitional period.

Discussion

Social change affairs (1861-1923)

Under contact with the West, deep changes such as immigration and commercial cultivation of land made the first move. The heaviness of population upon land in certain areas became a background condition for a kind of poverty and unrest. In the past, government had been a matter of guidance and arbitration, the introduction of government by legal precedent and direct executive decision was difficult for Burmese and Western administrators alike. The

presence of the "sphere of villages" under the administration of one headman looked like and was converted into a district form of administration. The Burmese had only a personal affiliation to this head man and their leader by heredity.[1]

Burmese culture was a culture of differences, confusing to administrators used to the models of European or other Asiatic cultures. Although the everyday life of the people was simple, a large proportion of the men in the villages learned to read. The official religion was Buddhism. The literacy was associated with religion and the reading of sacred texts and knowledge of the contemporary world outside Burma was not absorbed. The literacy and complication of the Burmese belied the simplicity of their economy. There was a money economy. Their personal autonomy contradicted the pattern of interdependence of young children on parents and old parents on children.[2]

The first effective contacts with western civilization were commercial.[3] Teak was exported and cotton goods were imported. At the beginning of nineteenth century, money economy meant a change in the level of aspiration of the Burmese who had to learn to want and value material things instead of concentrating on immediate states of being, to spend their money for foreign goods and their labor in making money to buy these goods rather than devoting their small traditional redundancies to religious donations that would increase their personal merit.[4] Law and orderly social behavior had been based on an accepted pattern of living which only incidentally, not directly, was seen as related to village welfare. A man acted with what amounted to honesty and uprightness because that was the way to act rather than out of social responsibility, or out of concern for others. When the organic unity of the village was shattered, when external authority with penal sanctions was substituted for the authority inherent in a traditional way of life, the traditional guiding principle of social conduct was destroyed and there was nothing to take its place. With the increase in population, and the breakdown of traditional patterns of behavior, new lands which had been set aside for communal grazing or fuel or sanitary arrangements were appropriated by individual villagers, and individual villagers interfered, for instance, with the irrigation system with a view to their own profit only, even when this caused damage to the whole village.

Administrative affairs

There were a few aspects of the transformation of British Burma between 1861 and 1885 as a result of the opening of the Suez Canal .It was during this period that the whole machinery of administration took on its modern character. Everything happened after 1885 up to the introduction of constitutional reforms in 1923, or even up to the time of the Japanese invasion, was merely a development of conditions already in existence in 1885.It was during this period that the system of land revenue assumed the characteristic features which distinguished it from land revenue in India generally. The system which originated in the days when *taungya* (hill-side cultivation) cultivation prevailed in the rice plains of the delta was subsequently applied, though it was quite unsuitable, to upper Burma. During the same period, forest administration procured

[1] Margaret Mead, Cultural patterns and technical change, printed by the IJse press, ltd Deventer (Holland), published in 1953 by the United Nations, p.43,44(Hereafter cited as Margaret, technical change)
[2] Ibid,p.44
[3] Myanmar socialist course party's economic affair No.3,sa pei bei hman press, first print ,September 1965.pp.85,87
[4] Ibid,pp.44,45

its later features and the working of the forests was passed from Burmans and Karen to foreign firms. It was also then that there were the first experiments in so-called self-government in municipalities, which throw much light on the development of local government after 1923. There are still instructive with reference to local administration at the present day. [5]In Burma, attitude against the accumulation of capital, the tendency to spend much money for religious purposes, the tenet that a Buddhist cannot make a valid will, all militate against the creation of capital needed for industrial enterprise of any major scope. However, small mills and small plants in rural areas have been increasing and fit into Burmese pattern.

Economic change affairs after 1923

Apart from the execution of development projects there is a wide series of social and economic functions which a Socialist Government must perform. The present administrative machinery was not adequate to the proper discharge of these functions. Really the government has gone ahead with or is considerate a number of reforms. Devolution of power, democratization of the administrative machinery etc., which were recently announced at the Welfare State Conference in Rangoon, are certainly very commendable and necessary reforms. It is said that along with decentralization and democratization, there should be rationalization of the administrative machinery. The present civil service system, administrative set-up and procedures are remnants of the past colonial regime, of the past laissez faire economy.[6] Secretaries to the Government are able men but amateur all the same, may be able to rush with reasonable well-organized a government machinery already established and consisted for the most part of housekeeping department. But when social, economic and technical ministries and departments have sprung up, as they have done in Burma lately, and especially when they have to be built up from very foundation, expert professional and technical knowledge has become indispensable. It is said that either the present civil service system should go or professional men should be allowed to hold the posts of secretaries or as another alternative the method of recruitment and training of the civil service men should be radically changed. Some knowledge of social science should be required as part of the qualification of entrants to the service or imparted to new recruits in their probationary period. Furthermore, professional and technical services of the Government should be upgraded to the same level of importance and power as the civil service. A new service should also be established for the increasing number of government employees in the expanding state enterprises.[7] Although every country tries to move toward in creating an information-oriented society, through the world, Myanmar seems to have barricaded itself to the world, and the introduction of advanced technology is delayed and regulated. The economy of the Union of Myanmar had market-oriented economy from 1948 to 1962, when this country was a parliamentary democratic country just after its regain of independence from the Great Britain. However, the economy was under the centrally planned system from 1962 to 1988, which is called the Burmese Way of Socialism.

---

[5] J.S. Furnivall, Safety first- A study in the economic history of Burma,Copyright©1998-Myanmar Book Centre & Book Promotion & Service ltd, Bangkok, Thailand, p.35

[6] Khin Maung Kyi, U, Western Enterprise and Economic Development in Burma, JBRS, Liii,I,June1970, Copyright©1998-Myanmar book Centre &Book promotion &Service lid, Bangkok, Thailand,p.30

[7] Thet Tun,U, B.A.(Rgn) B.sc.(London), Outline of a socialist economy for Burma, Copyright©1998-Myanmar Book Centre & Book Promotion & Service ltd, Bangkok, Thailand, p.75

Background of economic position in postwar period

On the eve of World War II, agriculture was still backward and tradition relievable and remained in the hold of the money lender. Industry and transportation were mainly in foreign hands and the majority of the industrial labor force was also non-Burman. About 70 percent of the working population was engaged in agriculture and extractive pursuits. World War II had disastrous results for Burma. There was interruption in all branches of the national economy. Before the war there were 1,027 factories employing 83,383 workers. In 1946, about a year after the cessation of hostilities, only 355 factories were in operation, employing 31,521 workers. [8]

The economy of the new state was planned upon principles of socialism and the country was consigned to the concept of a welfare state. A Two-Year- Plan of Economic Development was ready in April 1948. The great significance of the plan was that until 1969, it was the only attempt at broad economic planning made by Burma without the assistance of foreign advisors. It continued to shape and influence basic agricultural and industrial planning and policy for several years. Indeed, the planners were conscious of the fact that the pattern of the colonial economy could not be altered within a period of two years and that numerous limitations stood in the way of measurable success, but they felt it was essential to make a beginning. [9]It is essential to a Socialist Economy and of the machinery of execution which is no less important. There define a desirable attitude towards Burmese business. It is a well-known fact that business in Burma in pre-war days was an almost exclusive monopoly of the non-Burmans. But during and after the war, a large number of Burmans has taken to business, small or big, industrial or commercial.

Forest techniques' changes

In agriculture, the first steps were to be the redistribution of land with a view to eliminating landlordism and promoting modern methods in cultivation. After proper survey, all basic industries were to be established and developed as state enterprises. Other proposals were for: complete nationalization of electric power generation, development of all forms of transportation, the nationalization of inland water transport services and employment of Burmans in all of them. Fishing and fisheries were to be encouraged and organized along modern lines.[10]

After World War II the forests in Burma became entirely State owned and all organized forestry became the responsibility of the Forest Department. A State Timber Board was set up to look after economic exploitation, commercial transactions and exports concerned with the resources of the entire reserve forests. Around 1955-56, the Board employed over 4,200 permanent workers in its saw mills and over 15,000 seasonal workers in logging camps. In October 1963, the State Timber Board assumed sole responsibility for extracting, converting and distributing all kinds of timber. All shops in the country dealing in timber have been nationalized and reorganized into 250 People's Timber Shops.

Burma's production of timber as well as export trade in timber declined after World War II. But in recent years, slow yet steady recovery has been maintained.(See Table XX).

In 1952-53, the foreign consultants of the KTA(Knappen Tippetts Abbett Engineering Company, New York, were invited by the Burmese Govt. in 1951 to prepare a report on planning

[8] Nafis Ahmad, Economic resources of the Union of Burma, Earth Sciences Laboratory, U.S. Army Natick Laboratories, Natick, Massachusetts 01760, May 1971, p. 13(Hereafter cited as Nafis, Economic resources)
[9] Ibid, p.13,14
[10] Nafis, Economic resources,p.14

economic development of Burma. They made recommendations in a Preliminary Report and 2 Vols. Of detailed reports.) Did not go fully into the question of the forest resources of Burma, but made a number of useful general suggestions for improvement. These included the stepping up of teak girdling in the forest, emphasis on mechanized traction, and the gradual replacement of elephant power. KTA also recommended a greater utilizing of Burma's forest resources by the establishment of six factories at a total cost of K 77million, of these; the largest was to be a bamboo pulp and paper mill, estimated to cost K 66million. Other plants recommended were a saw mill, a wallboard plant, a plywood plant, a joinery plant and a furniture factory. Table XX (Burma: production of timber) [11]

The newly constituted State Timber Board made some interim recommendations to the implementation Conference of the *Pyidawtha*. These were implemented by the government. Designs were prepared for the proposed Forest Research Institute in 1958 but the major forest-industries recommendations of the KTA consultants were not carried out. One of the chief deterrents in extending extraction and expanding production and processing was the insecurity experienced by the Forest Department due to the continued insurgency. However, during 1955-57, the rate of girdling teak trees was raised and in 1963-64 it stood at 24,000 six to seven times that of 1954.The loss of elephants were partly met by the employment of buffaloes. In 1957-58, the three mechanical timber extraction units added about 20,000 tons each to the volume of extraction. The work of the State Timber Board was made more difficult by the obsolescence and limited capacity of the six existing mills. Thus, improved quality exports required for the United Kingdom and other European markets were not easy to achieve.[12] Apart from the execution of development projects there is a wide range of social and economic functions which a Socialist Government must perform. The Government has, of course, gone ahead with or is contemplating a number of reforms. Devolution of power, democratization of the administrative machinery etc., which were announced at the Welfare State Conference in Rangoon, are certainly very commendable and necessary reforms. But in my opinion along with decentralization and democratization, there should be rationalization of the administrative machinery. Our present civil service system, administrative set-up and procedures are vestiges of the past colonial regime, of the past laissez faire economy.

4. Conclusion

Although every country tries to move toward in creating an information-oriented society through the world, Myanmar seems to have barricaded itself to the world, and the introduction of advanced technology is delayed and regulated. The economy of the Union of Myanmar had a market-oriented economy from 1948 to 1962, when this country was a parliamentary democratic country just after its regain of independence from the Great Britain. However, the economy was under the centrally planned system from 1962 to 1988, which is called the Burmese Way of Socialism. The changes planned will undoubtedly affect many areas of activity- sanitation, nutrition, wages and conditions of labor, agricultural techniques, pediatrics, obstetrics, preventive medicine, etc. In the past the introduction of new techniques and practices into the life of so-called under- developed peoples has usually been undertaken without adequate consideration of the effects of such changes on mental health and social adjustment. Burma must be industrialized and must change to a predominantly cash crop economy if it is to be able to support its growing

[11] Nafis, Economic resources,p.80
[12] Ibid,p.82

population, and to raise its standard of living. There is a practical problem of how best to reconcile cultural pattern with technical changes. In general, mechanization can have an overwhelming effect on human welfare by rupturing the nourishing continuity of man with the land, with his own body rhythms, and with his traditional past.

Acknowledgements

I would like to thank to them that the data required for this paper have been mainly collected from National library of Yangon and universities' Central library.

TABLE XX

BURMA: PRODUCTION OF TIMBER*
(In cubic tons of round logs)

Type of Wood	1936-37 to 1939-40 Average	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64 Revised Estimates
Teak	453,481	237,183	249,834	292,724	282,886	313,829	340,317
State Timber Board	...	199,905	220,299	260,053	237,824	285,169	340,317
Private and others +	453,481	37,283	29,535	32,671	45,062	28,660	...
Non-teak	501,866	597,711	574,751	671,480	693,737	779,471	660,726
Pyinkado	117,823	133,701	133,630	135,700	151,761	212,054	n.a.
Padauk	6,714	9,008	9,767	11,370	9,893	9,766	n.a.
Thitya-Ingyin	24,574	37,945	36,744	63,292	48,765	34,376	n.a.
In-Kanyin	176,712	246,395	275,411	291,712	305,604	350,108	n.a.
Pyinma	7,437	4,922	3,779	3,472	3,214	5,705	n.a.
Matchwood	168,606	9,600	10,221	15,873	11,615	17,456	n.a.
Other Timber	...	156,140	125,199	150,061	162,935	149,966	n.a.
TOTAL	955,347	834,899	824,585	964,204	976,673	1,093,330	1,001,043

*Measured at royalty collecting stations (F.D.) for years up to 1962-63 and arrivals at Main River Depots (STB) for 1963-64.

+Includes small amounts extracted by the Forest Department.

n.a. -- not available

SOURCE: (1) Office of the Chief Conservator of Forests.
(2) State Timber Board. See Econ, Surv. Burma, Rangoon, 1964, Table 13, p. 21.

Source : Nafis Ahmad, Economic resources of the Union of Burma, Earth Sciences, Laboratory, U.S Army Natick Laboratories, Natick, Massachusetts 01760, P .81

References

1. J.S. Furnivall (1998) Safety first- A study in the economic history of Burma, Copyright ©1998-Myanmar Book Centre& Book Promotion &Service ltd, Bangkok, Thailand

2. Khin Maung Kyi, U (1970) Western Enterprise and Economic Development in Burma, JBRS, Liii, I, June, Copyright©1998-Myanmar book Centre &Book promotion &Service lid, Bangkok, Thailand

3. Margaret Mead (1953) Cultural patterns and technical change, printed by the IJse press, ltd Deventen (Holland), published in the United Nations

4. (1965) Myanmar socialist course party's economic affair No.3, sa pei bei hman press, first press, September 1965.

5. Nafis Ahmad (1971) Economic resources of the Union of Burma, Earth Sciences Laboratory, U.S. Army Natick Laboratories, Natick, Massachusetts 01760, May

6. Thet Tun, U, B.A.(Rgn) B.Sc. (London) (1998)Outline of a socialist economy for Burma, Copyright©1998-Myanmar Book Centre & Book Promotion & Service ltd, Bangkok, Thailand

Factors Influencing on Operational Sustainability of Selected Cooperative Microfinance in Southern Shan State

Kyar Ngon Sann[1]

Abstract

Access and efficient provision of microcredit can enable the poor to smooth their consumption, develop their micro enterprises, and improve quality of life. The main objectives of the study are to examine clients' socioeconomic conditions and the influencing factors on sustainability. This study uses both primary and secondary data. Primary data are collected from 33 primary cooperative societies and 20% of total clients from those cooperatives in Southern Shan State. In-depth interview are also conducted with responsible persons of Union of Southern Shan State Cooperative Syndicates, and chairman and committee members of primary cooperative societies. Secondary data are available from journals, books, articles, and reports issued by Cooperative Syndicates. This study uses both descriptive and analytical research methods. The result shows that there are increases in socioeconomic conditions of clients. The influencing factors of providers on sustainability are organization and management, development in human resource, and supporting activities. Improvements in economic conditions of clients have significantly decreased sustainability. However, improvements in social conditions have significantly increased sustainability. Clients' experience, participation in social, types of investments, and frequency of taking loan have a significant influence on sustainability. Thus, both providers and clients are the governing body of sustainability of microfinance.

Keywords: Improvement in socioeconomic conditions, sustainability, cooperative microfinance

1. Introduction

Microfinance institutions (MFIs) that promote commercial microfinance can attain wide outreach sustainably and profitably whereas Microfinance institutions that operate with subsidized loan portfolios cannot achieve wide outreach. In the field of microfinance, sustainability means the institution's ability to continue as a going concern by providing financial services to a wide range of clients who are disregarded by the regular financial institutions. Sustainable microfinance institutions means that the ability to continue operating as a development financial institution for the rural poor. As a poverty reduction tool, Microfinance programme has been introduced in Shan State since 1997. Union of Southern Shan State Cooperative Syndicates began Microfinance operations in 2011 according to the newly enacted law. It provided loans to fifteen townships including 480 cooperatives with the amount of 3329.22 million kyats covering its operation costs on Microfinance operations (Union of Southern Shan State Cooperative Syndicates, 2016).

Previous researchers conducted research on factors affecting operational sustainability and financial sustainability (Aderaw and Manjit, 2015; Lawrence et al., 2012; Rahman and Mazlan, 2014; Tehulu, 2013). These studies found that operational sustainability depends on such factors as the number of borrowers, good governance, cost allocation, size of microfinance institutions, and cost per borrower. In order to achieve sustainability, microfinance program needs to be managed in a rigorous and professional manner, tight credit control procedures and follow-up on defaulters. Operational sustainability measures operating revenue as a percentage of

[1] Dr, Lecturer, Department of Commerce, Meiktila University of Economic, Myanmar. kyarngon@iuj.ac.jp

operating and financial expenses, including loan loss provision expense and the like. If this ratio is greater than 100 percent, the MFI is covering all of its costs through own operations and is not relying on contributions or subsidies from donors to survive (Guntz, 2011). According to Anh and Tam (2013), Microfinance institutions are considered to be in sustainable operation if Operational Self-sufficiency (OSS) > 100%, but international practices show that, to achieve the sustainable long-term operation, the OSS must be more than 120%.

Okumu (2007) studied the microfinance industry in Uganda with sustainability, outreach and regulation. The result indicated that sustainability is positively and significantly driven by real effective lending rates and age of an MFI, and negatively by the ratio of gross outstanding loan portfolio to total assets, the ratio of average loan size to the national per capita income, the unit cost of loans disbursed, and a group-based delivery mechanism compared to an individual-based delivery mechanism. Lawrence et.al, (2012) studied the factors affecting sustainability of microfinance institution. It is found that financial regulations, number of clients served, financial coverage and volume of credit transacted were the factors that highly affected the sustainability of microfinance institutions. Tehulu (2013) conducted empirical study on the determinants of financial sustainability of microfinance institutions in East Africa. Research found that MFI's financial sustainability is positively and significantly driven by loans intensity and size. Management inefficiency and portfolio at risk have a negative and significant impact on financial sustainability. Breath of outreach, and deposit mobilization are not important determinants of financial sustainability.

Schafer and Fukasawa (2011) also studied the factors best describing a microfinance institution's (MFI's) operational self-sufficiency (OSS). This study found that the number of borrowers, the write-off ratio, and the depositors/borrowers ratio were found to be important factors determining the sustainability of an MFI. Rahman and Mazlan (2014) described the determinants of Operational Efficiency of Microfinance Institutions in Bangladesh. The regression result revealed that size of MFIs, cost per borrower and personnel productivity ratio positively explain the financial self-sufficiency of MFIs in Bangladesh. On the other hand, variables of average loan balance per borrowers, age of MFIs, debt to equity ratio, operating expense ratio, and number of active borrowers have a negative effect on the financial self-sufficiency at a significant level of FSS of MFIs in Bangladesh whereas the yield on gross loan portfolio of MFIs is also positive but not at a significant level. According to the literature, several researchers studied factors influencing on sustainability in different ways. Most of the study focused on providers' point of view of influencing factors on sustainability. The independent variables used in literature are mostly quantitative measures such as number of clients served, loans intensity and size, breath of outreach, deposit mobilization, staff productivity, age of microfinance, depth of outreach, etc. In this study, both sides of microfinance operations, providers and clients, are used for factors influencing on sustainability. It is assumed that sustainability cannot be attained only by the performance of providers, the characteristics of clients are also important to attain sustainability. Thus, the independent variables such as elements of sustainable microfinance providers, characteristics of clients and improvements in clients' economic and social conditions are used in this study.

The objectives of this study are to examine the improvements in economic and social conditions of clients and to analyze the influencing factors on sustainability of cooperative microfinance.

2. Methods

This study focuses on microfinance operations provided by cooperatives in Southern Shan State, namely Ywarngan Township Cooperative Syndicates, Nyaungshwe Township Cooperative Syndicates, and Yatsauk Township Cooperative Syndicates. This study uses convenience sampling method. First, three townships are selected based on the portion of villages included and the number of cooperatives. Second, 15 primary cooperative societies in Ywarngan Township, 12 primary cooperative societies in Nyaungshwe Township, and 6 primary cooperative societies in Yatsauk Townships which have started microfinance operations in 2011 are selected. There are altogether 1650 clients in those 33 primary cooperative societies because each primary cooperative society includes about 50 clients. Third, 20% of total clients (330 clients) are selected again as the respondents of this study to answer the questionnaires for clients.

This study uses both primary and secondary data. Primary data are collected from responsible persons of Union of Southern Shan State Cooperative Syndicates, chairman of three selected township cooperatives, chairman and committee members of respective primary cooperative societies, and clients from those primary cooperative societies. Secondary sources of data are available from journals, books, articles, and reports and periodicals issued by Union of Southern Shan State Cooperative Syndicates.

Types of data used in this study are both qualitative and quantitative data. Data analysis is conducted in both descriptive and analytical research method. For analytical procedure, STATA 10 is used. Based on questions with five-point Likert scale, the extent of improvements in economic and social conditions of clients is explored. The influencing factors on sustainability are determined by using binary logistic regression analysis. The dependent variable, "Sustainability", is a dichotomous variable, 0 and 1. If the cooperative is sustainable, the dependent variable is 1 and otherwise, the dependent variable is 0. The independent variables in this study are "Elements of Sustainable Cooperative Microfinance Providers", "Improvements in economic conditions and social conditions of clients", and "Characteristics of Clients". Elements of sustainable microfinance providers (cooperatives) are knowledge, institutional ownership, organization and management, development in human resource, cooperate philosophy, and supporting activities. This is modified by the work done by Robinson (2001). Characteristics of clients in this study include demographic, experiences, ability, participation in social, types of investments, and frequency of taking loan. This is modified by the work done by Mazumder and Wencong (2013), and Quach et al., (2005).

3. Results and Discussion

According to survey result, the overall mean value of economic conditions of clients gets 3.89 and this result highlights that there is a strong agreement on` improvements in economic conditions of clients. Improvements in social conditions are analyzed in accordance with the social variables such as children education, household health condition, sanitary condition, sources of drinking water, and self-confidence, skills, and knowledge of clients. The overall mean value of social conditions of clients gets 4.04 and it can be said that there is an agreement on the level of improvements in social conditions of clients.

According to regression analysis, Sustainability = *-5.00 + 4.81(Org&mgt)- 6.42(HR) + 2.56(Support)* + ε . It shows that the log odds for sustainability would increase by 4.81for every unit change in organization and management when all others variables are constant. It means that if providers have good management and organization, the sustainability of cooperative microfinance will increase. Consistent to this finding, Tehulu (2013) also found that management inefficiency has a negative impact on the financial sustainability of microfinance institutions. The logistic coefficient for development in human resource is -6.42. It can be said that the log odds for sustainability would decrease by 6.42 for every unit change in development of human resources when all others variables are constant. The result shows that there is negative relationship between development of human resource and sustainability at 1% significant. The logistic coefficient for supporting activities is 2.56. It means that the log odds for sustainability would increase by 2.56 for every unit change in supporting activities when all others variables are constant. This implies that providing supporting activities to clients increases sustainability of cooperative microfinance at 5% significant.

Factors influencing of social and economic conditions of client on sustainability shows that:

Sustainability = -1.84 – 1.04(economic)+ *1.41(social)*+ ε. It means that improvements in social conditions of clients have positive relationship with sustainability whereas improvements in economic conditions of clients have negative relationship with sustainability. Improvement in social conditions such as having good communication skills, having business skills, having decision making roles, and having knowledge about family planning enable clients to have business network and business opportunities. With the help of microfinance, clients have more income and make repayment of loan and interest. Thus, there are increases in sustainability. On the other hand, since clients have improvement in economic conditions, clients do not rely on microfinance. Thus, there are decreases in sustainability. With the evidence of successful story of old clients, new clients come in and there are increases in sustainability as well.

The result also shows that Sustainability = *-3.84* -0.48(experience)+ *0.45(social) + 0.78(investment) +0.19(frequency)* + ε. It shows that there is negative relationship between experiences and sustainability at 5% significant. This implies that having working experiences reduces sustainability of cooperative microfinance. It may also be true that clients can earn more money since they have working experiences. Clients' economic conditions may also be improved. They can make investments with their own income and they do not rely on microfinance. Thus, there is decrease in sustainability. This finding is consistent with the previous finding that the improvements in economic conditions of clients decreased sustainability. In addition, the log odds for sustainability would increase by 0.45 for every unit change in participation in social when all others variables are constant. The result shows that there is positive relationship between participation in community social welfare and sustainability of cooperative microfinance at 5% significant. It is true that participation in social makes clients more confident and have wider social network, have more business partners, and increase in income. Thus, clients make repayment of loan and interest to cooperatives and there is no default rate. This leads to increase in sustainability. The log odds for sustainability would also increase by 0.78 if clients made investment in small business, husbandry, and agriculture rather than used in education and basic necessities. This means that there is positive relationship between productive businesses and sustainability of cooperative microfinance at 1% significant.

According to survey results, most clients conduct productive businesses such as agriculture, small businesses, and husbandry. Hence, clients get higher income and make repayment of loan and interest. It leads to increases in sustainability. The log odds for sustainability would increase by 0.19 as well for every unit change in frequency of loan when all other variables are constant. It shows that there is positive relationship between frequency of loan and sustainability at 5% significant. This implies that the larger the frequency of taking loan, the higher the level of sustainability of cooperative microfinance.

4. Conclusion

The study confirmed that clients' economic conditions have improved in terms of starting new businesses, increases in savings and income, and the improvement in financial situation of the family. Likewise, the study found that clients' social conditions have improved in terms of social skills such as communication skills and business skills. Moreover, clients have improved in their knowledge about family planning, nutrition, health care and water supply. However, due to limited infrastructure and limited knowledge available in rural areas, microfinance is found to have lesser impact on improvement in life style, living standard, healthcare and education. The results of logistic regression on Elements of Sustainable Cooperative Microfinance Providers and Sustainability shows that all independent variables (organization and management, development in human resource, and supporting activities) have a significant influence on sustainability. Among these variables, organization and management, and supporting activities significantly increased sustainability. However, development in human resource significantly decreased sustainability. The results of logistic regression on Clients' Economic and Social Conditions and Sustainability shows that all independent variables (economic conditions and social conditions) have a significant influence on sustainability. Improvements in economic conditions significantly decreased sustainability. However, improvements in social conditions significantly increased sustainability due to the fact that clients have better social status. For example, good communication skills, business skills, and good at decision making, have more social awareness and eager to make payment on interest and principal according to the terms and conditions. The results of logistic regression on Clients' Characteristics and Sustainability show that all independent variables (experience, participation in social, types of investments, and frequency of taking loan) have a significant influence on sustainability. Among these variables, participation in social, types of investments, and frequency of taking loan significantly increased sustainability. However, experience significantly decreased sustainability.

It is suggested that primary cooperative societies should practice good organization and management system such as effective asset-liability management, high-quality supervision, internal control and internal audit system. In addition, primary cooperative societies should provide not only financial assistance but also technical and operational assistance to clients. Likewise, clients should invest their loan on productive business activities. It results in getting higher income and standing themselves without the support of loan in near future.

Acknowledgements

I would like to acknowledge my heartfelt thanks to responsible persons from Union of Southern Shan State Cooperative Syndicates, Township Cooperatives, and Primary Cooperative Societies for their patient and enthusiastic supports on my data collection periods. I also gratefully acknowledge to my students for their active participation throughout the research work.

References

[1] Aderaw, G. and Manjit, S. (2015). Factors that Affect Financial Sustainability of Microfinance Institutions: Literature Review. *European Journal of Business Management, 7*(7)*.*

[2] Anh, N. K., and Tam, L. T. (2013). The Sustainability of Microfinance Institutions in Vietnam: Circumstances and Implications. *Transport Publishing House. Hanoi*, 2013.

[3] Guntz, S. (2011). Sustainability and Profitability of Microfinance Institutions. *Research paper in International Finance and Economics. Research paper 4/2011.*

[4] Lawrence, N. K., John, M. K., and Grace, W. N. (2012). Factors Influencing the Sustainability of Microfinance Institutions in Murang'a Municipality. *International Journal of Business and Commerce, 1* (10).

[5] Mazumder, M. S. U., and Wencong, L. (2013). Micro-Credit and Poverty Reduction, A Case of Bangladesh, *Prague Economic Papers*,3, 2013

[6] Okumu, L. J. (2007). *The microfinance industry in Uganda: sustainability, outreach and regulation.* Dissertation, Doctor of Philosophy (Economics) at the University of Stellenbosch, 2007.

[7] Quach, M. H., Mullineux, A. W., and Murinde, V. (2005). Access to Credit and Household Poverty Reduction in Rural Vietnam: A Cross sectional Study

[8] Rahman, M. A., and Mazlan, A. R. (2014). Determinants of Financial Sustainability of Microfinance Institutions in Bangladesh. *International Journal of Economics and Finance*, *6* (9).

[9] Robinson, M. S. (2001). *The Microfinance Revolution. Sustainable Finance for the Poor*. The World Bank.

[10] Schafer, K., and Fukasawa, Y. (2011). Factors Determining the Operational Self-Sufficiency Among Microfinance Institutions. *Advances in Business Research*, *2* (1), 172-178.

[11] Tehulu, T. A. (2013), "Determinants of Financial Sustainability of Microfiance Institutions in East Africa", *European Journal of Business and Management*, *5* (17).

Sustainable Rural Development: Significance of Geographical Indications (Gis) in Ayeyarwardy Delta

Htun Ko[1], Aung Swe[2]

Abstract

Sustainable rural development is a popular term in rural areas of Myanmar that over 70 % of people is lived in rural areas. Sustainable rural development is not merely the long-term economic viability of rural areas but rather an enduring balance of economic growth, social stability and environmental protection within localized areas. In Myanmar, most of the people designated the Ayeyarwady Delta as a Myanma Rice Bowl. It is referred and pointed out that Ayeyarwady Delta has possessed the vast fertile cultivated lands, good agriculture practices and good agro-economic opportunities. After 1988, the attraction of open-market economy became the changing of agricultural practices in Ayeyarwady Region. Double cropping, Multi-cropping practices can be found in everywhere. Unsystematic uses of fertilizer and pesticide in paddy cultivation are accompanied with above mentioned intensive agriculture. Local people has been received the Land degradation, water and air pollution and scarcity of the skilled and interested local people. World Trade Organization (WTO) defines GIs as: "indications that identify a good as originating in the territory of a particular country, or a region or a locality in that country, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin". This study investigates the relationship between GIs and sustainable rural development in Ayeyarwady Delta area, considering Government Roles and Producers' Strategies. The quantitative approach like image classification will be used to evaluate the land cover changing which can be detected to land degradation. Especially, structure interview method with expert sampling procedure will also be used to evaluate the trend and future prospect of agro-base economic activities and to reach the sustainable economic development.

Keywords: Geographic Indications (GIs), Ayeyarwady Delta, sustainable rural development, intensive agriculture, Land degradation, geographic origin.

1. Introduction

Calboli (2015) stated that geographical Indication is a name or a sign used on products which relate to a specific geographical location or origin. The major objectives of Geographic Indication have provided to identify the quality of local products which are accompanied with geographic locational characteristics, promote brand identify and increasing the job opportunities in rural areas. Actually, implementing the geographical indications have not fully approved to commercial as well as legal instrument. GIs promote the rural development that offer profitable system of geographic characteristics in rural areas.

In Myanmar, most of the people designated the Ayeyarwady Delta as a Myanma Rice Bowl. It is referred and pointed out that Ayeyarwady Delta has possessed the vast fertile cultivated lands, good agriculture practices and good agro-economic opportunities. After 1988, the attraction of open-market economy became the changing of agricultural practices in Ayeyarwady Region. Double cropping, Multi-cropping practices can be found in everywhere. Being increased yield per acre fully overwhelmed in most of the farmers because of the improved

[1] Dr, Professor and Head of Geography Department, University of Yangon, (htunko66@gmail.com)
[2] Dr, Associate Professor, Department of Geography, University of Yangon (aungswegeog.70@gmail.com)

urban facilities and upgrading social standard. Unsystematic uses of fertilizer and pesticide in paddy cultivation are accompanied with above mentioned intensive agriculture. Local people has been received the land degradation, water and air pollution and scarcity of the skilled and interested local people. Therefore, rural farmers in Ayeyarwady delta faced with economic and social defective.

However, some people had created the alternative economic activities to support the decreasing family income earning from paddy cultivation. This paper also study on how they implement and create new economic opportunity by using plenty local raw material being geographic origin? how they provide to improve from small scale to large scale economy? The quantitative approach like image classification will be used to evaluate the land cover changing which can be detected to land degradation. Especially, structure interview method with expert sampling procedure will also be used to evaluate the trend and future prospect of agro-base economic activities and to reach the sustainable economic development.

Study Area

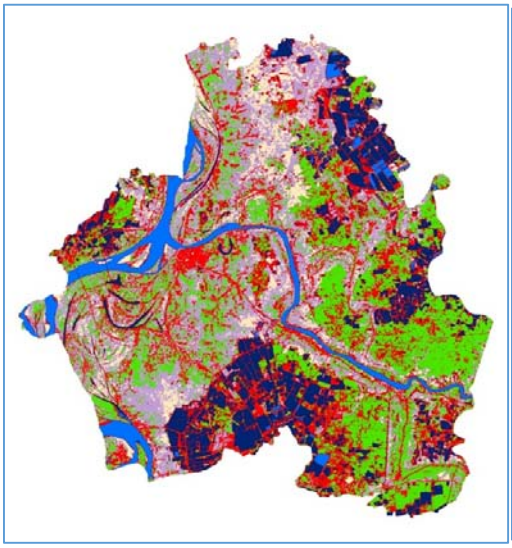
Nyaungdon Township is one of the township in Maubin District, Ayeyarwady Region. Apart from southeastern boundary, it has entirely been bounded by Ayeyarwady River and Panhlaing River. Bank erosion, riverine flooding and flash flooding have experienced in this area since ancient time. While the new alluvial plains are emerging by changing the river course of Ayeyarwady and loading the sedimentation in western part of the township, the matured lands in northeastern part of the township have been collapsed by bank erosion and fluctuation of the thalweg line of Panhlaing River. As the economic activity, agriculture especially paddy cultivation is still as a major activity but arable crop lands are gradually decreasing by flooding the crop land, land degradation and salinity effects in crop land which are impacted by abrupt growth of fish farming.

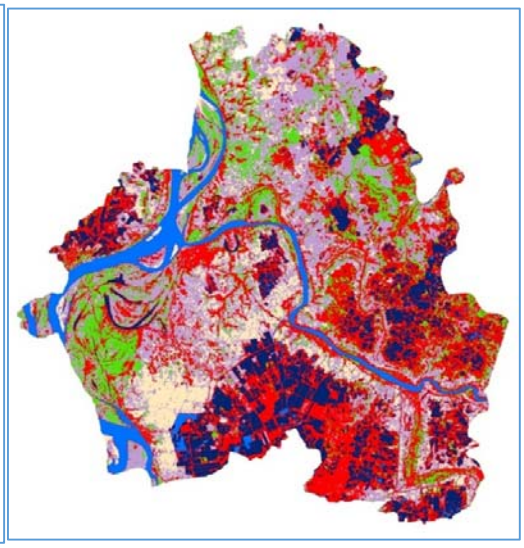
Fish Farming is historically experienced in Nyaungdon Township and a lot of fish ponds had been existed in the Dabay Kalar, Ma Letto, and Hsa Malout villages in southern part of township since ancient time. After decreasing the yield per acreage in paddy cultivation, losing the cultivable lands by bank erosion and flooding of Ayeyarwady and Panhlaing rivers, and missing the balance of traditional cultivated system and paddy seed, the fish farming industry is also quickly increase in those areas. Before 1975, there have 93 fish ponds and are increase to 2400 fish ponds in 2010. (Township reports of GAD). However, construction and increasing the fish ponds and changing the land utilization from cultivation to fish farming become to the salinity of farm lands in surrounding areas.

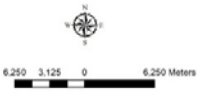
Because of the huge investment enterprise, almost of owners in fish farming are entrepreneurs who came from other regions like Yangon. They have already possessed the cold storage plants which are setting up in the fringe of Yangon. So, they are more interest their business than regional development. As the nature of fish farming, they cannot contribute the employment creation for local people.

As the figure (1), the significant landuse change can be found in crop land. Former crop land area have been changed to fish ponds, saturated crop land, built up area and some bare land. According to the climate change impact since 1990, Nyaungdon situated as the islands in the confluence of Ayeyarwady and Panhlaing rivers has been faced with annual riverine flooding,

bank erosion and dynamic situation of cultivated lands and settlement area by changing the river courses.







Land use Category	1995 (Acre)	2017 (Acre)
Built up Area	62424.23	69230.85
Bare Land	14337.57	18493.69
Crop Land	53979.90	26716.96
Lake and Pond	20081.14	27698.39
River and stream	10834.85	12914.02

Figure1. Land cover changes in Nyaungdon Township.

Note: The calculation of land cover changes is based on Landsat data (1995 and 2017) and pixel based image classification with minimum distance classifier have been used.

After decreasing the yield per acreage in paddy cultivation, losing the cultivable lands by bank erosion and flooding of Ayeyarwady and Panhlaing rivers, and missing the balance of traditional cultivated system and paddy seed, the fish farming industry is also quickly increase in those areas. Fish Farming is historically experienced in Nyaungdon Township and a lot of fish ponds had been existed in the Dabay Kalar, Ma Letto, and Hsa Malout villages in southern part of township since ancient time. Before 1975, there have 93 fish ponds and are increase to 2400 fish ponds in 2010. (Township reports of GAD). However, construction and increasing the fish ponds and changing the land utilization from cultivation to fish farming become to the salinity of farm lands in surrounding areas. Because of the huge investment enterprise, almost of owners in fish farming are entrepreneurs who came from other regions like Yangon. They have already possessed the cold storage plants which are setting up in the fringe of Yangon. So, they are more interest their business than regional development. As the nature of fish farming, they cannot contribute the employment creation for local people.

3. Sustainable Rural Development and Geographic Indication

Nyaungdon Township is a one of the vulnerable areas in Ayeyarwady delta by impact of natural and anthropogenic factors. Local people from south and southeastern part of the township where natural lakes and ponds with fish farming had the habit of banana cultivation in all banks or levees of fishery ponds for their extra income and family consumption. Moreover, Most of the farmers from Nyaungdon and its hinterland areas nearby confluence of Ayeyarwdy and Panhlaing rivers had cultivated the banana in their not appropriate lands for paddy cultivation. Their banana product exported to main market: Yangon for major material of offertory in Myanmar cultural and religious ceremony. They produced the surplus materials as the dried banana for their family consumption in former time but later, they had changed this as the marketed products. The banana cultivation had been experienced in Nyaungdon area since last 50s years ago.

In 1990s, some people (intelligent person) from Has Malaut Village upgraded their traditional banana industry and products to reach the marketability (commercialize) banana snacks based on consumer preference and expend the items of product. Actually, Banana Snack culture and habit are not new one in Nyaungdon. As the result documentations of in depth interview, banana snack production had been started since 1970s. They can change their traditional dried banana product to fried green plantains and fried ripe plantains. They can set up their traditional snack with banana to the firm industry surrounded by new packing system, health oriented product processing, existing cultural style and media supporting. At present, banana snack industry can be stand as legendable economic activities in Nyaungdon and surrounding areas by clustering with banana cultivation, production of fried plantains and sale the banana snacks.

Suggestions and Recommendations

Nowadays, the banana snack industry have already reached in the matured stage of economic activities in Myanmar. Why they have stand as the success model industry in Myanmar? How do their future prospect? Actually, they had an entrepreneur sprit. Moreover, they had the fitting time to alter their product from traditional small scale foodstuff industry to marketable economic activities. Because, in that time, 1990, is transition period from closed door policy to open door economic policy. So, most of the people were longing for new items for their foodstuffs. They can right choice their industry and products based on main raw materials of geographic origin. This paper would like to suggest upon banana snack industry of Nyaungdon based on interview results for their future prospect as following:

Strengthening	Challenges
• Accessible situation of Nyaungdon (Geographic Origin) • Available land for Banana Cultivation • Skill labour for banana snack production • Entrepreneurship Sprit	• Increasing rate of Fish Farming Ponds • Substitution of modern production system as well as systematic cultivation • Lack of government policy with GI principle

4. Conclusion

When the sustainable rural development has been implemented in Ayeyarwady delta, lifelong industry appropriated with legendable economy should be promote by supporting above suggestions. There are fried banana snack in Nyaungdon Township, Thin mat which is one of the types of cane in Pantanaw Township, prepaid dried fish in Phapon Township, rice noddle snack in Myaungmya Township and so on. All of the main raw materials of those economic activities are based on geographic origin of those areas. If the fried banana production will have GI properties, under appropriate conditions, GI can contribute to development in rural areas because the scope of this industry harmonize between GI centers and hinterland areas .The entitlement to use a GI generally lies with regional producers and the added value generated by the GI accrues to all such producers. They can contribute to local employment creation, which ultimately may help to prevent rural exodus to urban.

Acknowledgements

The major issue of this study is mainly focused on qualitative assessment of group discussion and in depth interview with local entrepreneurs. Therefore, we would like to special thanks to CDT teams of social studies from CREATE team and U Kyaw Lwin Oo, Lecturer of Geography Department, YUOE, for their valuable efforts in interviewing processing.

References

Calboli Irene. (2015). Geographical indications of origin at the cross roads of local development, consumer protection and marketing strategies. International review of intellectual property and competition law. 47 (7). 760-780.

GAD (Nyaungdon Township) (2017). General Township Report

Ojha Megha. (2017). geographical indications and rural development; opportunities and economic impact of protection of fruit crops in India. International Research Journal of Human Resources and Social Sciences. 4. (11). 12

GCMS Analysis and Antimicrobial Activity of Ginger (*Zingiber officinale*) Essential Oil

Myo Min[1], Pyae Phyo Kyaw[2], Nyi Moe Lwin[3]

Abstract

The present research deals with the preparation and identification of Ginger essential oil and its antimicrobial activity. Many essential oils are effective against harmful organisms. Essential oils are commonly used in aromatherapy and health benefits. Therefore, the essential oil was prepared to study the chemical compositions and antimicrobial activity from ginger. The fresh ginger were cleaned and cut into small sample size. Then, the essential oil from ginger sample was prepared by hydro-distillation method. The ginger oil was identified by GCMS method. By GCMS method, the ginger oil could be deduced as α- Phellandrene, Cineole, α - Citral, Nerol acetate, Zingiberene and α-farnesene. The observed compounds of essential oil by GCMS were monoterpene and sesquiterpene which can be used in aromatherapy. Aromatherapy uses essential oils to improve quality of life and reduce unpleasant side effects of aggressive therapies and health conditions. The antimicrobial activity of ginger oil was also investigated by agar well diffusion method. From antimicrobial screening, the microorganisms such as *Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus pumilus, Candida albicans* and *E.coli* were used. According to antimicrobial screening, the ginger oil possesses the antimicrobial activities. Therefore, the ginger oil may be used in medicinal formulation of human health.

Keywords: Antimicrobial activity, Ginger essential oil, GCMS method, Hydro-distillation method, Human health

1. Introduction

Figure1. Plants and rhizome of ginger (*Zingiber officinale)*

Essential Oil of Ginger

Ginger essential oil is derived from the rhizomes of the *Zingiber officinale* herb, better known as Ginger. [1] In Ayurvedic medicine, Ginger Oil has traditionally been believed to soothe emotional difficulties such as nervousness, sadness, low self-confidence, and a lack of enthusiasm. The health benefits of Ginger Oil are the same as that of the herb from which it originates, with the oil even being considered to be more beneficial due to its higher Gingerol content, a constituent that is mostly reputable for its antioxidant and anti-inflammatory properties. With a warm, sweet, woody, and spicy scent that has an energizing effect, especially

[1] Associate Professor, Department of Chemistry, West Yangon University
[2] Captain, Assistant Lecturer, Department of Chemistry, Defence Services Academy
[3] Captain, Department of Chemistry, Defence Services Academy

when used in aromatherapy, ginger oil has earned the nickname "The Oil of Empowerment" for the feeling of confidence that it is known to inspire. [2]

2. Materials and Methods

The ginger samples were collected from Pyin Oo Lwin Township, Mandalay Region, Myanmar. The essential oil of fresh ginger was prepared by hydro distillation method. The prepared ginger oil was identified by GCMS method. The antimicrobial activity of ginger oil was investigated by agar well diffusion method. [3]

(A) (B)

Figure2A. Preparation of ginger essential oil by hydro distillation method
B. Analysis of ginger oil by GCMS Autosampler

3. Results and Discussion

Preparation and Identification of Ginger Essential Oil

The fresh ginger was used for the preparation of essential oil by hydro distillation method. From the essential oil of ginger, α - citral was observed as the highest composition. According to literature, it can prove to have anticancer properties in various human cancer cells lines and useful in treating gastro-intestinal infections, including *heliobacter pylori*, which is responsible for many cases of gastric ulcer. From the essential oil of ginger, Zingiberene was present at 7.77 min. It is a carminative herbal compound. So, it can help fight infections caused by virus, protect against stomach ulcers, and ease the pain and discomfort caused by stomach gas. GC-MS analyzed data are shown in Figure 3, 4, 5, 6, 7, 8, 9 and 10.

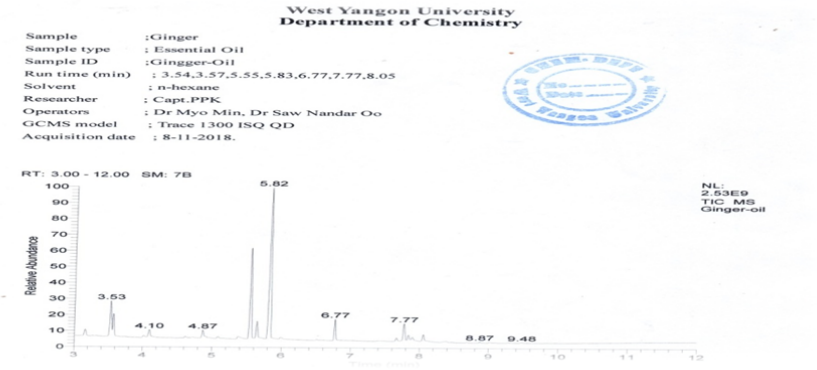


Figure3. Total Ion Chromatogram of Essential Oil from Ginger

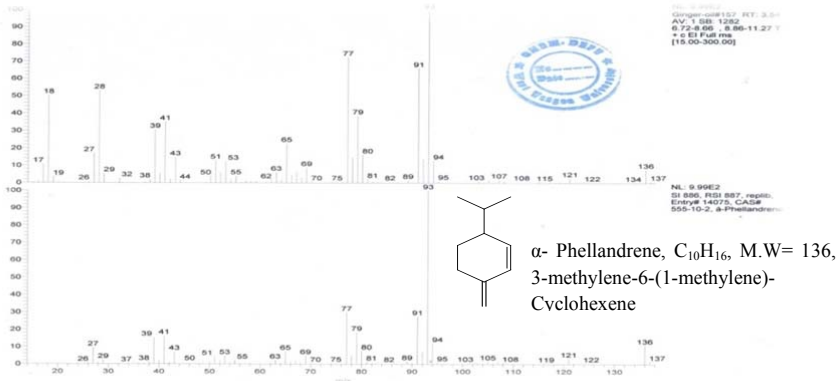


Figure4. Matching of the Mass Fragmentation Patterns of Prepared Compound at 3.54 min and that of α- Phellandrene from GC-MS Data Library

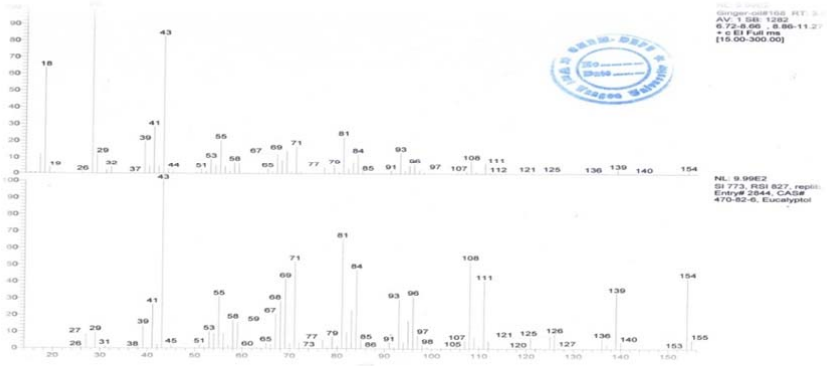


Figure5. Matching of the Mass Fragmentation Patterns of Prepared Compound at 3.57 min and that of Cineole from GC-MS Data Library

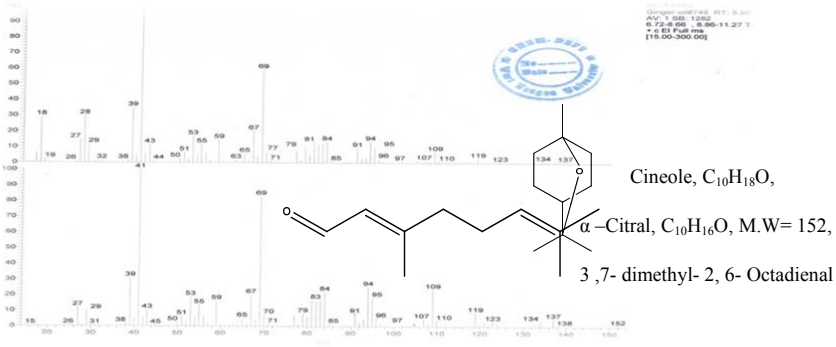


Figure6. Matching of the Mass Fragmentation Patterns of Prepared Compound at 5.55 min and that of α –Citral from GC-MS Data Library

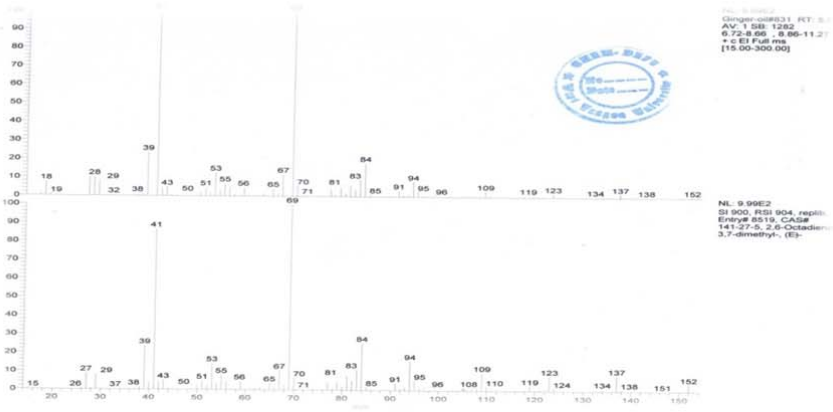


Figure7. Matching of the Mass Fragmentation Patterns of Prepared Compound at 5.83 min and that of α - Citral from GC-MS Data Library

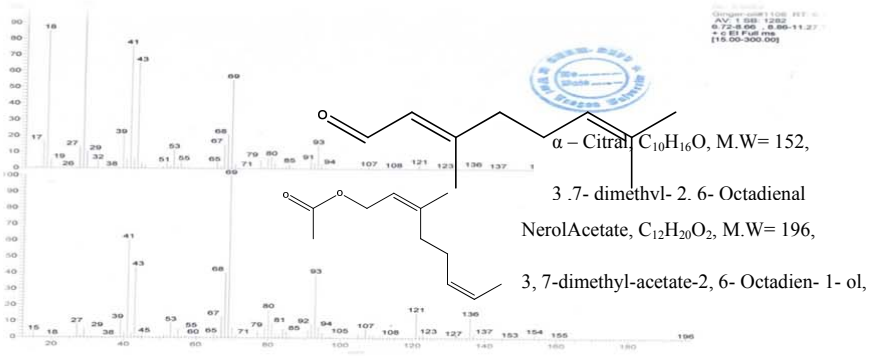


Figure8. Matching of the Mass Fragmentation Patterns of Prepared Compound at 6.77 min and that of Nerolacetate from GC-MS Data Library

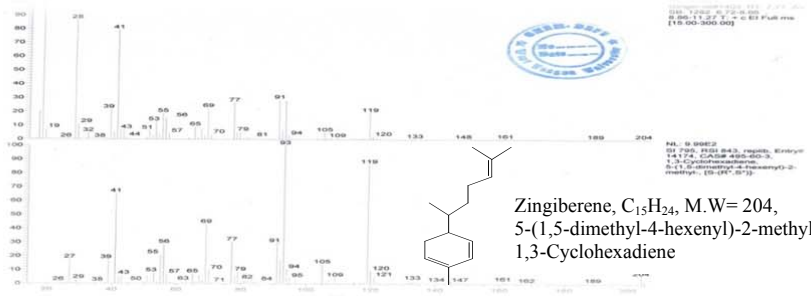


Figure9. Matching of the Mass Fragmentation Patterns of Prepared Compound at 7.77 min and that of Zingiberene from GC-MS Data Library

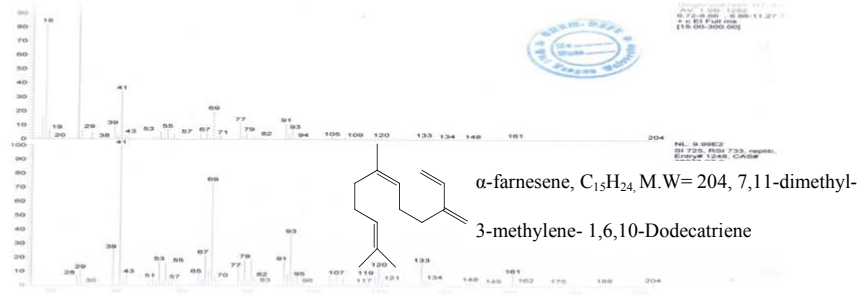


Figure10. Matching of the Mass Fragmentation Patterns of Prepared Compound at 8.05 min and that of α- Farnesene from GC-MS Data Library

Antimicrobial Screening of the Essential Oil from Ginger

According to antimicrobial screening, the ginger oil showed the high activities on tested microorganisms. The antimicrobial activities with *B. subtilis*, *S. aureus*, *B. pumilus*, *E.coli* showed the high potent. There were moderate antimicrobial activities with *P. aeruginosa* and *C. albicans*. According to literature survey, *B. subtilis* and *B. pumilus* can cause food poisoning, ear and ocular infections. *S. aureus* can stay on our skin and nose, it can cause illness infection. *E.coli* can stay in the lower intestine of warm-blood organisms in our body, it can cause severe abdominal cramps, bloody diarrhea and vomiting diseases. The ginger oil can effective against tested microorganisms. Therefore, it may be used in the medicinal formulation of human health. The results obtained are shown in Table 1.

Table 1. Results of Antimicrobial Activity of Essential Oil from Ginger

No.	**Organisms**	**Diameter of inhibition zone (mm)**	
		Ginger oil	**n-hexane (Control)**
1	*Bacillus subtilis*	25 mm (+++)	-
2	*Staphylococcus aureus*	30 mm (+++)	-
3	*Pseudomonas aeruginosa*	16 mm (++)	-
4	*Bacillus pumilus*	25 mm (+++)	-
5	*Candida albicans*	18 mm (++)	-
6	*E. coli*	22 mm (+++)	-

Agar well ~ 10 mm, 10 mm - 14 mm = (+), 15 mm - 19 mm = (++), 20 mm - above = (+++)

4. Conclusion

This research concerns with the GCMS analysis of prepared essential oil and antimicrobial screening of ginger oil. The preparation of essential oil from ginger was carried out by hydro distillation method. Then, the prepared essential oil was analyzed by GCMS method. The ginger essential oil could be deduced as α- phellandrene (3.54 min), cineole (3.57 min), α – citral and its isomer (5.55, and 5.83 min), nerol acetate (6.77 min), zingiberene (7.77 min) and α-farnesene (8.05 min). From the essential oil of ginger, α - citral was observed as the highest composition. According to literature, it can prove to have anticancer properties in various human cancer cells lines and useful in treating gastro-intestinal infections. From the essential oil of ginger, Zingiberene was present at 7.77 min. It is a carminative herbal compound. So, it can help fight infections caused by virus, protect against stomach ulcers, and ease the pain and discomfort caused by stomach gas. Ginger oil helps for the normal blood circulation and digestive problems.

The antimicrobial screening of ginger essential oil was carried out by agar well diffusion method. From the screening, the antimicrobial activities with *B. subtilis*, *S. aureus*, *B. pumilus*, *E.coli* showed the high potent. There were moderate antimicrobial activities with *P. aeruginosa* and *C. albicans*. According to literature survey, *B. subtilis* and *B. pumilus* can cause food poisoning, ear and ocular infections. *S. aureus* can stay on our skin and nose, it can cause illness infection. *E.coli* can stay in the lower intestine of warm-blood organisms in our body; it can cause severe abdominal cramps, bloody diarrhea and vomiting diseases. The ginger oil can effective against tested microorganisms. Therefore, it may be used in the medicinal formulation of human health.

Acknowledgements

We would like to express deep sense of gratitude to Rector Dr. Tin Maung Tun, West Yangon University for their kind provision of the research facilities. We also wish to express our profound gratitude to Dr Hlaing Hlaing Oo, Professor and Head of Chemistry Department, West Yangon University for their encouragement and comment without which this work would not have been completed.

References

[1] Sutarno, H., Hadad, E.A. and Brink, M., "*Zingiber officinale* Roscoe". - In: De Guzman, C.C, Siemonsma, J.S. (eds.) "Plant resources of South-East Asia: No.13 : spices". - Leiden (Netherlands): Backhuys, 1999, pp. 238-244.

[2] Zafar, Sultan, Misbah, Bhatti and Nawaz, H., "Chemical analysis of essential oil of ginger (*Zingiber officinales*)". *Pakistan Journal of Biological Sciences* (11). 2005, pp. 1576-1578.

[3] Mar Mar Nyein, Chit Maung, Mya Bwin and Tha, S.J., "*In Vitro* Testing of Various Indigenous Plant Extracts on Human Pathogenic Bacteria", Myanmar Health Science Research Journal, 1991, vol. 3, pp. 89-99.

Greensynthesis of Silver Nanoparticles from *Eupatorium odoratum* Linn. (Taw-Bizat) and *Cymbopogon citratus* Stapf (Lemon Grass) leaves

Nwe Thin Ni[1], Aung Kyaw Moe[2], Kyaw Swer Htun[3]

Abstract

The watery extracts of *Eupatorium odoratum* Linn. (Taw-Bizat) leaves and *Cymbopogon citratus* Stapf (Lemon Grass) leaves were mainly conducted for production of silver nanoparticles. Silver nitrate was used as a metal precursor and two selected leaves extracts were applied as reducing agent for synthesis of silver nanoparticles (AgNPs). The surface morphology of fabricated silver nanoparticles (AgNPs) were mentioned with FESEM (Field Emission Scanning Electron Microscopy). From the result of XRD (X-ray diffraction), the average particle size of TBAgNPs (32 nm) from *E. odoratum* and LGAgNPs (38 nm) from *C. citratus* were observed. The size distribution of each prepared (AgNPs) were analysed on advanced techniques Zeta potential-DLS (Dynamic Light Scattering). The localized surface plasmon resonance band for formation of TBAgNPs (440 nm), from leaves of *E. odoratum* and LGAgNPs (435 nm) from *C. citratus* in the ratio of 1:3, 1:5 were exhibited under UV-visible spectrometer. Moreover, the reducing agent (capping agent) of bio-based extracted matter such as proteins, phenols and amino acids were determined by using the FTIR (Fourier Transform-Infrared Spectroscopy). The role of selected stabilizing agent of *E. odoratum*, *C. citratus* leaves extract and the effect of stirring time on synthesis of AgNPs were reported. Furthermore, the laser beam of reflected rays were observed in the fabrication of AgNPs by the Tyndall effect. In addition, the antioxidant activity of TBAgNPs and LGAgNPs (49.27 μg/ml, 94.32 μg/ml) from two plants were determined by DPPH radical scavenging assay method. In the comparative zone diameter of antimicrobial activity of reducing agent of two kinds of pure leaves extract, prepared TBAgNPs and LGAgNPs were discussed against on different strains of microorganisms.

Keywords: green synthesis, fabrication, morphology, average particle size, antioxidant, antimicrobial

1. Introduction

Nowadays, the nanomaterials become critically important because of their unique properties such as physical, magnetic, structural, thermal, mechanical, chemical and electronic properties. Nanoparticles can be divided into two groups: (i) organic nanoparticles and (ii) inorganic nanoparticles. Organic nanoparticles contain carbon nanoparticles. Inorganic nanoparticles involve magnetic nanoparticles, noble nanoparticles (like gold and silver), semiconductor nanoparticles (like titanium dioxide) possess optical properties [1],[2]. The synthesis of NPs are broadly divided into two main classes: (1) bottom-up approach and (2) top-down approach [3]. Some researchers have been reported that silver nanoparticles were used in various fields, especially in biomedical industry or diagnosis, drug delivery, cell imaging, and implantation. Biosynthesis of silver nanoparticles could be advantages than photochemical reduction and chemical reduction methods [4], [5],[6]. Therefore, in this research proposal, biosynthesis of obtained silver nanoparticles (TBAgNPs, LGAgNPs) were conducted by using green synthesis of the two selected plants namely: *E. odoratum* and *C. citratus*. [7], [8]. Then, characterization of fabricated silver nanoparticles were studied by applying advanced modern

[1] Associate Professor, Dr., Department of Chemistry, Taungoo University
[2] Research Scientist, Chulalongkorn University, Petroleum & Petrochemical College, The Centre of Excellent in Petrochemical and Material Science, Bankok, Thailand
[3] Lecturer, Department of Pharmacology, DSMA

technique. In additional, the antioxidant activity and antimicrobial activity of fabricated AgNPs were carried out in this research work.

2. Materials and Methods

Sample Collection and Preparation of Extract of Reducing Agent and Silver nanoparticles]

The leaves of *E. odoratum* and *C. citratus* were collected from Hmon- Pyar village, Daw Khu quarter, Loikaw Township, Kayah State, Myanmar in the middle of November, 2017 [Figure 1 (a), (b)]. These selected plants were identified at the Department of Botany, University of Yangon [9], [10]. Dried powdered sample of *E.odoratum* and *C. citratus* (30 g) were boiled in 150 mL 5% of sodium bicarbonate solution under 48 h to obtain the extract. This obtained extract was filtered through Whatman filter paper No.1. These filtrate were cooled down at 4 °C. The extracted matter can be applied the capping agent as well as the reducing agent for the reduction of silver ions. In the preparation of 0.001 M of $AgNO_3$ solution,was used in this biosynthesis of silver nanoparticles. Two to three milliliter of prepared extracted matter from *E.odoratum* and *C. citratus* leaves was added to the 0.001 M of silver nitrate solution in 100 mL conical flask and incubated at 40°C for (20-60) min. Then, this reaction process was carried out in dark to avoid unnecessary photochemical reactions [11]. The colour change of silver nitrate solution was occurred and some phytochemical constituents such as amino acid, hydroxyl groups were observed under UV-vis spectroscopy. This obtained AgNPs were purified through centrifugation at 6000-8000 rpm for 20 minutes. The dispersion of AgNPs were washed with deionized water and dried in an oven at 100°C for 24h.

(a) (b)

Figure1. Plant of (a) *E. odoratum* (b) *C. citratus*

Characterization of Prepared AgNPs

The Field Emission Scanning Electron Microscopy (FESEM) technique was provided to analyzes the surface morphology of fabricated TBAgNPs and LGAgNPS . Then, the measurement of average particle size prepared AgNPs was detected under XRD (X-ray Diffractometer) by using Debye- Scherrer equation. In addition, determination of particle size distribution of AgNPs was measured by using Zeta potential-DLS instruments at 25°C with percent intensity. The localized surface plasmon resonance band of AgNPs were observed on Shimadzu UV-1800 spectrometer. Besides, the main chemical constituents of carbohydrate, and proteins etc., present in reducing agent of *E.odoratum*, *C. citratus*, fabricated TBAgNPs and LGAgNPs were mentioned by using the FTIR spectroscopic method.

Screening of Antioxidant Activity and Antimicrobial Activityof the Prepared AgNPs

Antioxidant activity of prepared TBAgNP and LGAgNPs in the ratio of 1:3 and 1:5 of the stirring time with one hour were determined UV-visible spectroscopically by using DPPH (1,1-diphenyl, 2-picryl, hydrazyl) radical scavenging assay method [12],[15]. Firstly, a blank solution a control solution, DPPH solution, and the sample solution were prepared with different concentrations (3.125, 6.25, 12.5, 25, 50, 100, 200 and 400 μg/mL) by using serial dilution method. The solutions were allowed to stand at room temperature for 30 min and absorbance were measured at 517 nm by UV-visible spectrophotometer and IC_{50} (50 % oxidative inhibitory concentration) was calculated by linear regressive excel program [12],[15]. Agar well diffusion method was employed for determining antimicrobial activity of the extracted reducing agent and prepared AgNPs by biosynthesis of two plants: *E.odoratum* and *C. citratus* against six pathogenic microorganisms namely *Bacillus subtilis*, *Staphylococus aureus*, *Pesudomonas aeruginosa*, *Bacillus pumilus*, *Candida albicans* and *Escherichia coli* [13],[14].

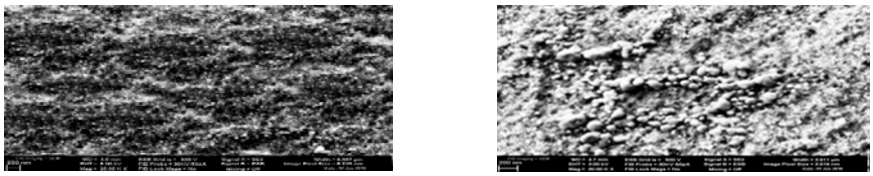
3. Results and Discussion

Sample Collection, Preparation of Reducing Agent and Silver Nanoparticles (AgNPs)

Currently, after cleaning, the leaves were air-dried at room temperature for three weeks and the dry sample were ground into powder and stored separately in air-tight containers to prevent moisture changes and other contamination. The leaves of *E.odoratum* and *C. citratus* was extracted with 5% sodium bicarbonate at alkaline medium and it was used as reducing agent as well as capping agent in the preparation of AgNPs. The solution of silver nitrate (0.001 M) was used as a metal precursor for this synthesis of silver nanoparticles. The fabricated silver nanoparticles (TBAgNPs, LGAgNPs) were mentioned under visual condition. AgNPs were formed with a colour change from yellow to brownish-black colour during the reaction period within 20 min. The two extracts of capping agent *E. odoratum* and *C. citratus* (20 mL) was added to different volume of silver nitrate solution (60, 80,100) mL. The various ratio of (reducing agent: $AgNO_3$) (1:3, 1:4, 1:5) solution were placed in a conical flask. The flask was heated with magnetic stirrer at 50°C. After stirring time for (20, 40, 60) min and it was kept in the dark place. The colour intensity was raised with the increased of stirring time.

Characterization of Fabricated AgNPs

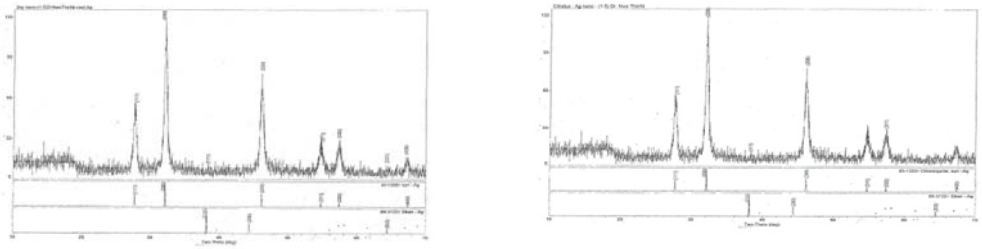
The surface morphology of prepared TBAgNP and LGAgNP were provided by the field emission scanning electron microscopy (FESEM) images in the ratio of (1:5) after 60 min stirring time. From these observation, the surface morphology of each prepared silver nanoparticles TBAgNPs were observed very smoothly and in more spherical nature than LGAgNPS respectively, [Figure 2 (a), (b)].



(a) (b)

Figure 2(a) FESEM spectrum of fabricated (a) TBAgNPs (b) LGAgNPs in the ratio of (1:5) (reducing agent:$AgNO_3$ solution) after 60 min stirring time

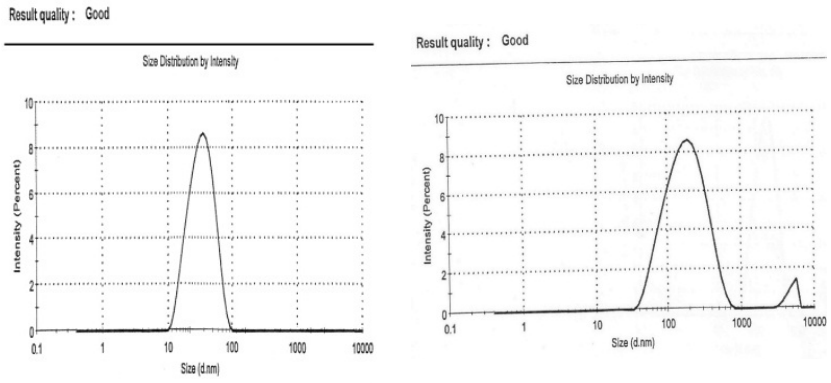
From XRD spectrum of the average crystalline size of TBAgNP, the four distinct diffraction peaks at 2θ values of (29.879, 30.128, 36.401 and 44.566 were indexed to (111, 200, 220 and 311) reflection planes of face centered cubic structure of silver. In addition, the average particle size of LGAgNP were calculated from three distant peaks (111, 220, 200) with 2θ values of (35.138, 40.401, 37.495). From the average particle size of TBAgNP (32 nm) from *E. odoratum* was occurred smaller than and LGAgNPS (38 nm) from *C. citratus* respectively, Figure 3 (a) and (b).



(a) (b)

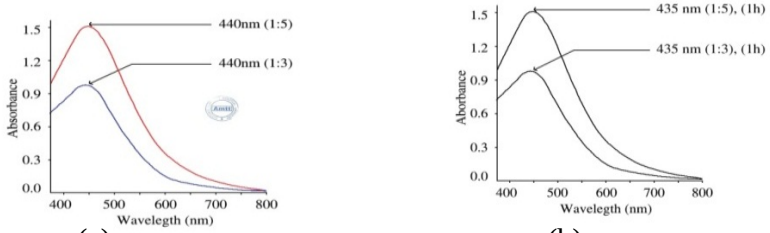
Figure 3(a). XRD spectrum of (a) TBAgNPs (b) LGAgNPs in the ratio of 1:5 (reducingagent:$AgNO_3$) after one hour stirring time

Furthermore, the size distribution of Fabricated AgNPs were reported with intensity using zeta potential-DLS, it is shown in Figure 4 (a) and (b). From this result, the size distribution of AgNPs were observed between (1-100) nm range. In addition, the localized surface plasmon resonance band of 1:3 and 1:5 ratio of reducing agent and $AgNO_3$ were observed at 440 nm for TBAgNPs and 435nm for LGAgNPs by using Shimadzu UV-1800 spectrometer. The increase in the concentration of the silver nitrate will be increased the absorbance intensity but the wavelength was not changed it is described in Figure 5 (a) and (b).



(a) (b)

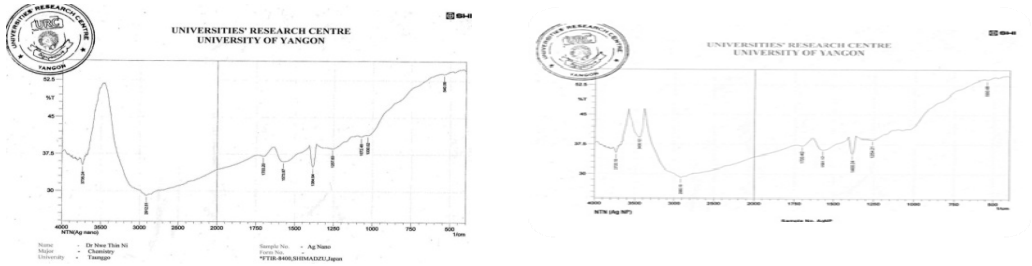
Figure 4(a). The average particle size of fabricated (a) TBAgNPS (b) LGAgNPS into 1:5 (reducing agent: AgNO3 solution) on zeta potential- DLS after 60 min stirring time



(a) (b)

Figure 5(a). Absorption spectra of (a) TBAgNPs (b) LGAgNPs in different ratio of (reducing agent: $AgNO_3$) after one hour stirring

According to FTIR spectral data, 3700-3400 cm^{-1} which may be due to the overlapping of O-H and N-H stretching bands, 2980- 2970 cm^{-1} represents aliphatic C-H stretching , 1700-1550 cm^{-1}indicates N-H bending, 1400-1040 cm^{-1}also indicates C-H bending of *E.odoratum and C. citratus*. After reaction with silver, the new moderate intensity peak Ag…O were observed at 500- 550 cm^{-1} from TBAgNP and LGAgNP. It is described in Figure 6 (a) and (b).



(a) (b)

Figure 6(a). FTIR spectrum of (a) TBZAgNPs (b) LGAgNPs in the ratio of 1:5, stirring time 1h

The silver nanoparticles can be scattered light, the Tyndall effect was occurred. If the colloidal particles are present, the laser beam passed and if the particles are absent, the beam did not pass through it. From these observation, the laser beam was completely passed through the two prepared nanoparticles of TBAgNPS and LGAgNPs,

Antioxidant Activity and Antibacterial Activity of Reducing Agent and Fabricated AgNPs

By using DPPH free radical scavenging assay method, the IC_{50} value of the prepared TBAgNPs (76.78, 49.27) µg/ml, LGAgNP (126.28, 94.32) µg/ml in the ratio of (1:3,1:5) and standard ascorbic acid (6.28µg/ml) were observed in antioxidant activity, Figure 7 and 8. Antibacterial activity was observed that the most potent activity of TBAgNPS in the ratio of 1:5 (reducing agent: AgNPS) (18 mm) than LGAgNPs (15 mm) against on *Escherichia coli* and *Bacillus pumilus*.

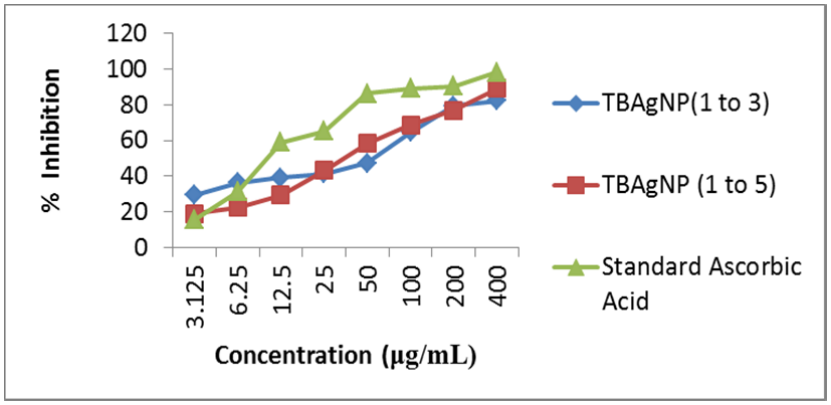


Figure 7. % inhibition of different concentration of prepared TBAgNP (1:3, 1:5)

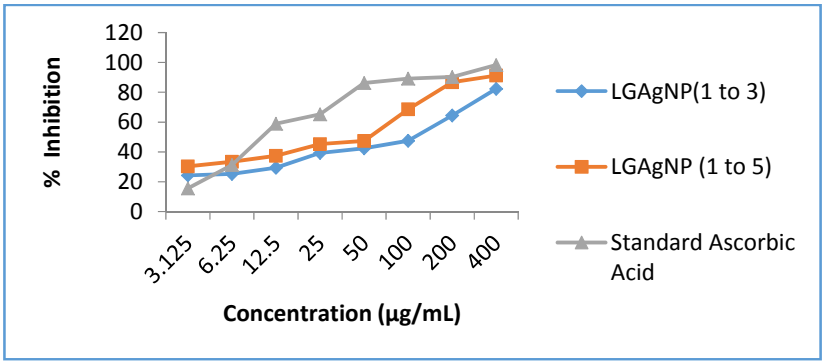


Figure 8. % inhibition of different concentration of prepared LGAgNPs (1:3, 1:5)

4. Conclusion

From this research work, biosynthesis of silver nanoparticles is environmental friendly and non-toxic effect in environment. In the preparation of AgNPs from *E.odoratum* (Taw-Bizat) leaves and *C. citratus* (Lemon-Grass) were used as reducing agent as well as capping agent. The surface morphology of TBAgNPs were predicted that more spherical shape and more smoothly than LGAgNPs from the result of FESEM. In addition, the particle size distribution of TBAgNPs and LGAgNPs were showed with intensity in the range of (10-100) nm range under the zeta

potential-DLS. The average particle size of TBAgNPs (32 nm) was smaller than LGAgNPs (38 nm) by applying the of XRD spectrum. The intensity colour of fabricated TBAgNPs (440 nm) and LGAgNPs (435 nm) in the ratio of 1:3 and 1:5 stirring time (1h) were conducted under the UV- visible spectrometer. According to FTIR analysis, the constituents of amino group present in the stabilizing agent of *E.odoratum* and *C. citratus* were denoted that reduction of Ag^{+} to metallic silver nanoparticles. In addition, according to Tyndall Effect a laser beam was passed presence of a colloidal suspension prepared TBAgNPs and LGAgNPs. Besides, if the nanoparticles were absent the beam did not pass through it and therefore the beam didn't pass through the pure $AgNO_3$ pounded. Furthermore, the antioxidant activity of prepared TBAgNPs in the ratio of 1:5 was more potent antioxidant activity than LGAgNPs (1:5). Furthermore, the evaluation of antimicrobial effect, by comparing the zone diameters, the fabricated TBAgNPs (18 mm) in the ratio of (1:5) was more antimicrobial activity than pure extracts of Taw-Bizat, Lemon-Grass and LGAgNPs (15 mm) by using agar well diffusion method.

Acknowledgements

We would like to express sincere gratitude to Rector Dr Tin Tun and Pro-rector Dr Yee Yee Oo for their guiding the good opportunities to do this research and for allowing to submit this paper in Science Council of Asia, SCA. We would like to express my deepest gratitude to Dr. Mi Mi Kyaing (Professor and Head) and Professor Dr. Nay Mar Soe, Taungoo University, for allowing us to carry out this research work and for providing all of department facilities and encouragement.

References

[1] M.G. Guzman, *et al*., "Synthesis of Silv**e**r Nanoparticle by Chemical Reduction Method and their Antibacterial Activity." World Acad Sci Eng Technol, 2008, Vol 4, pp.357-364.

[2] M.A. Albrecht, "Green Chemistry and the Health Implications of Nanoparticles", *J of Green Chemistry*, 2006, Vol 8, pp.417-432.

[3] R.Veerasamy, *et al.,* "Biosynthesis of Silver Nanoparticles Using *Mangosteen* Leaf Extract and Evaluation of their Antimicrobial Activities", *J of Saudi Chem, Society*, 2011, vol 15, pp**.**706.

[4] A. Saxena, *et al*.,"Green Synthesis of Silver Nanoparticles Using Aqueous Solutions of *Ficus Benghalensisn* Leaf Extract and Characterization of their Antibacterial Activity" *J of Materials*, 2012, vol.67, pp.100.

[5] A.F. Fatma, and A. N. Nivien, "Green Synthesis of Silver Nanoparticles Using Leaf Extract of *Rosmarinus officinalis* and its Effect on Tomato and Wheat Plants" *Journal of Agricultural Science*; 2015, vol.7, pp.11.

[6] K.R., Kumar, *et al.,* "Synthesis of Eco-friendly Silver Nanoparticles from *Morinda tinctoria* Leaf Extract and is Larvicidal Activity Against Culexque in quefasciatus" *J of Parasitol Research*, 2014, vol.114, pp.411-417.

[7] A. Emmanuel and A.Anthony, "Green Synthesis, Characterization and Biological Activities of Silver Nanoparticles from Alkalinized *Cymbopogon citratus* Stapf" Journal of Advances in Natural Sciences: Nanoscience and Nanotechnology, 2017,vol. 8, (1)

[8] S. Masurkar. *et al*., "Rapid Biosynthesis of Silver Nanoparticles Using *Cymbopogan Citratus* (Lemon Grass) and its Antimicrobial Activity"Micro & Nano Letters, 2011, vol. 3(3), pp.189-194.

[9] M-Tin Wa, , "Phytochemical Screening Method and Procedures", *Phytochemical Bulletin of Botanical Society of America Inc*. 1972, vol. 5 (3), pp. 4-10.

[10] J.B. Harborne *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*, Chapman and Hall, London, pp. 76-78, 1984.

[11] A. T. Harris, and R.Bali, "On the Formation and Extent of Uptake of Silver Nanoparticles by Live Plants." *Journal of Nanoparticle Research*, 2008, vol.10, pp.691-695.

[12]H B. alliwell, "Free Radicals and Antioxidants, Updating a Personal View", Journal of Nutrition Reviews, 2012, vol.70 (5), pp. 65-257.

[13] M. Balouiri, *et al.*,, "Methods for *in vitro* Evaluating Antimicrobial Activity", *J of Pharmaceutical Analysi*, 2016,vol. 6, pp 71-79.

[14] R. Cruickshank, *Medical Microbiology*, London, 1st Ed., E.E. Livingstone Ltd, pp 81-95, 1960.

[15] P. Kahlonene, "Antioxidant Activity of Plant Extracts Containing Phenolic Compounds", *Journal of Agriculture., Food Chemistry*., 1999,vol. 47 (3), pp.3954-3962.

Morphological, Phytochemical Investigation and Antimicrobial Activity on Roots of *Houttuynia cordata* Thunb.

Tin Tin Maw[1]

Abstract

The present studies provide an account of the knowledge on morphology, phytochemical investigation and antimicrobial activity on roots of *Houttuynia cordata* Thunb. It is an important medicinal plant widely distributed in East Asia, which is belonging to the family Saururaceae. The specimens were collected from Kyaing Tong Township and identified with the help of available literatures such as Heywood, 1978; Hooker, 1879; Lawrence, 1951; Hutchinson, 1967; Cronquist, 1981; Brummitt ,1992; Wu. *et al*., 2010. In morphological studies, this plant is perennial herbs; leaves simple, alternate; inflorescences terminal involucrate spike; flowers minute; stamens 3; ovary superior and fruits capsular. In phytochemical investigation of powdered roots were carried out British Pharmacopoeia, 1968; Marini Bettalo *et al*., 1981, Central Council for Research in Unani Medicine, 1987 and Trease and Evans, 2002, indicated the presence of carbohydrate, glycoside, phenol, α- amino acid, tannin, flavonoid, terpenoid, reducing sugar and starch, which may be bioactive compounds. In antimicrobial activities of root extracts is performed by using agar well diffusion method, methanol, ethyl acetate and ethanol extracts of roots are effective on six tested organisms and the ethyl acetate extract is found to be significant against *Pseudomonas aeruginosa*.

Keywords: *Houttuynia cordata* Thunb., morphology, phytochemical, investigation, antimicrobial activities

1. Introduction

There is a long history of herbal medicine in far Eastern countries; in Chinese people have utilized herb and plants to treat various diseases for more than 8000 years [15]. With the advance of modern medicine and drug research, chemical synthesis has replaced plants as the primary source of medicinal agents in industrialized countries. However, in 1985, the World Health Organization estimated that about 80% of the world's population relied on traditional medicine including herb medicines for their primary health care needs [14].

Houttuynia cordata Thunb. belongs to the family Saururaceae, also known as fish mint, fish leaf, rainbow plant, chameleon plant, heart leaf, fish wort, chinese lizard tail, or bishop's weed, is one of two species in the genus *Houttuynia* (the other being *H. emeiensis*). It is a flowering plant native to Southeast Asia [Website 1]. This plant is widely distributed in Kachin State, Mandalay Division and Shan State of Myanmar [11].

Several researches describes therapeutic efficacy of the whole plant and its extracts, fraction and isolated compounds in different diseased condition. Among the important pharmacological activity reported includes anti-mutagenic, anti-cancer, anti-obesity, hepatoprotective, anti-viral, anti-bacterial, anti-inflammatory, free radical scavenging, anti-microbial, anti-allergic, anti-leukemic, sinusitis and nasal polyps activities [Website 2]. During the period of Severe Acute Respiratory Syndrome (SARS), prevention formulas recognized by the Health Ministry of China. Recently, several studies also provided scientific data to support and unveil its anti-SARS [10]. The present research investigates the morphological, phytochemical constituents and antimicrobial activity on roots of *Houttuynia cordata* Thunb.

[1] Dr. Associate Professor, Department of Botany University of , Kyaing Tong, Myanmar, dr.tintinmaw 49@gmail.com.

The aim and objectives of the present research are mainly to record the knowledge on medicinal plant of *Houttuynia cordata* Thunb, to give medicinal information for native tribes and to help in improving human health care system of Myanmar.

Several researches describes therapeutic efficacy of the whole plant and its extracts, fraction and isolated compounds in different diseased condition. Among the important pharmacological activity reported includes anti-mutagenic, anti-cancer, anti-obesity, hepatoprotective, anti-viral, anti-bacterial, anti-inflammatory, free radical scavenging, anti-microbial, anti-allergic, anti-leukemic, sinusitis and nasal polyps activities [Website 2]. During the period of severe Acute Respiratory Syndrone (SARS), prevention formulas recognized by the Health Ministry of China. Recently, several studies also provided scientific data to support and unveil its anti-SARS [10]. The present research investigates the morphological, phytochemical constituents and antimicrobial activity on roots of *Houttuynia cordata* Thunb.

The aim and objectives of the present research are mainly to record the knowledge on medicinal plant of *Houttuynia cordata* Thunb, to give medicinal information for native tribes and to help in improving human health care system of Myanmar.

2. Methods

2.1. Samples collection, identification and preparation

The specimens were collected from Kyaing Tong Township, Eastern Shan State of Myanmar during July to December, 2018. The collected specimens were identified and described. According to resulting morphological characteristics, the specimen can be identified by the literatures [Heywood, 1978; Hooker, 1879; Lawrence, 1951; Hutchinson, 1967; Cronquist, 1981; Brummitt, 1992; Wu. *et al*., 2010].The roots of *Houttuynia cordata* Thunb. were washed with water and cut into small pieces. Then these samples were air dried in shade at room temperature for two to three weeks. After completely dried, the samples were ground by grinding machine to get powders and stored in air tight containers for further studies.

2.2. Phytochemical investigation of the samples

The phytochemical constituents of the samples were determined by the methods of British Pharmacopoeia, 1968; Marini Bettalo *et al*., 1981; Central Council for Research in Unani Medicine, 1987; Trease and Evans, 2002.

2.3. Antimicrobial activities of the samples

The powdered samples were used to measurement of antimicrobial activities. The samples were extracted with petroleum ether, methanol, ethyl acetate, ethanol, water. In this experiment, antimicrobial activities of five solvent extract samples were test on six organisms such as *Bacillus subtilis*, *staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumalis*, *Candida albicans*, *Escherichia coli*. Agar well diffusion method was used [5]. These investigations were carried out in Myanmar Pharmaceutical Industrial Enterprise Research Department, Ministry of industry, Insein, Yangon Division.

3. Results and Discussion

3.1. Morphological description

Family name : Saururaceae

Myanmar name : Htin-kae

English name : Heart-leaved houttuynia; chameleon

Flowering period : July to October

Part used : Roots

Houttuynia cordata Thunb. Kongl. Vetensk. Acad. Nya Handl. 4 : 149. 1783.

Perennial herbs with creeping rhizomatous root stalks, up to 25 cm high, with aromatic; branch puberulous. Leaves simple, alternate; stipules long, linear-oblong, membranous, adnate to the petiole; petiole sheathing at the base, 2.5-3 cm by 1.5-2.5 mm, grooved above; blades ovate-cordate, 4-6 cm by 3.5-6 cm, widely cordate at the base, entire along the margin, acute to acuminate at the apex, hairy on both surfaces, thinly papery, densely glandular glabrous. Inflorescences terminal involucrate spike, 1-1.5 cm long, becoming longer in fruiting; involucral bracts usually 4, oblong, 7-9 mm by 3.5-4.5 mm, white, glabrous, rounded at the apex. Flowers sessile, congested, minute. Perianth absent. Stamens 3, free, exserted; filaments filiform, white, glabrous, minute, anthers dithecous, basifixed, yellow, minute. Ovary trilocular, two ovules in each locule on parietal placenta; white, glabrous, minute; stigma 3, simple. Fruits capsular, subglobose, 2-3 mm long, with persistent styles. Seeds globose [Figure 1].

Distribution : Siam, China, Japan [7]. India, Korea, Myanmar, Nepal, Thailand [Website 3]. India to Indochina, China, Taiwan and Japan [Website 4]. Kress *et. al.* (2003) stated that this species was distributing in Kachin State, Mandalay Division and Shan State of Myanmar. Cultivated and wild species were found in Kyaing Tong Township.

Specimen examined : Eastern Shan State, Kyaing Tong Township, Dr. Tin Tin Maw, August 5, 2018.

Uses : Rhizome is used in stomach ulcer. Boiled extract of rhizome is taken for muscular pains [Website 5]. In Kyaing Tong, The roots are taken raw as salad. The roots are sometimes ground and used along with chilies, citrus fruit and soy sauce.

Habit Flower Roots Roots

Figure1. Morphological characters

3.2. Phytochemical investigation

Phytochemical test showed the presence of carbohydrate, glycoside, phenol, α-amino acid, saponin, tannin, flavonoid, terpenoid reducing sugar and starch. Alkaloid, steroid and cyanogenic glycoside are absent [Table 1].

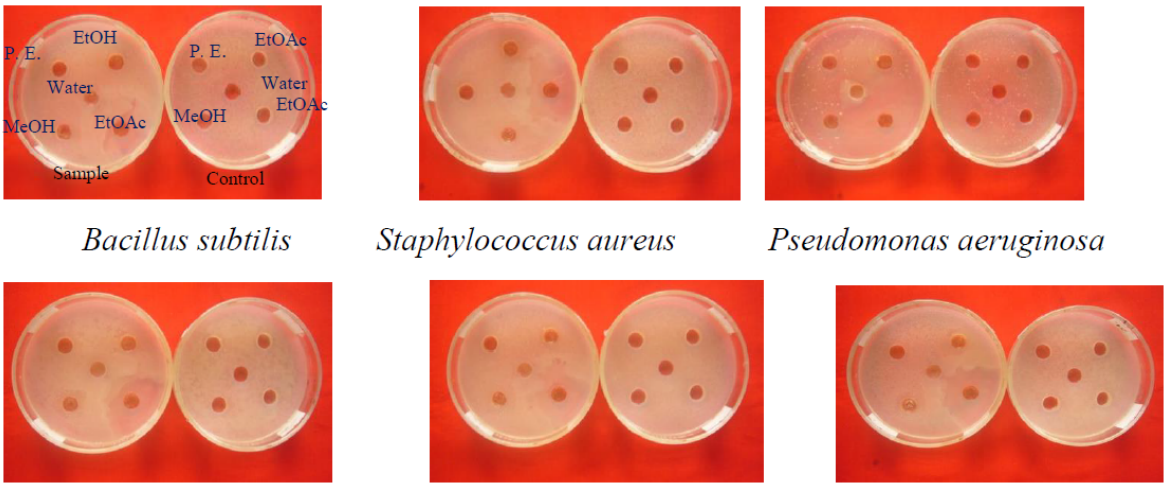
Table 1. Phytochemical investigation of samples

No.	Tests	Extracts	Reagents	Observations	Results
1.	Alkaloid	1% HCL	Mayer's reagent	No ppt	-
			Wagner's reagent	No ppt.	
			Dragendroff's reagent	No ppt.	
			Hager's reagent	No ppt.	
2.	Carbohydrate	H_2O	10% α-naphthol & H_2SO_4	Red ring	+
3.	Glycoside	H_2O	10% Lead acetate solution	White ppt.	+
4.	Phenol	H_2O	5% $FeCl_3$ solution	Greenish brown ppt.	+
5.	α-amino acid	H_2O	Ninhydrin reagent	Purple colour	+
6.	Saponin	H_2O	Distilled water	No persistent foam	-
7.	Tannin	H_2O	1% Gelatin & NaCl solution	ppt.	+
8.	Flavonoid	70% EtOH	Mg ribbon & Conc: HCl	Pink colour	+
9.	Steroid	Petroleum ether	Acetic anhydrate & Conc: H_2SO_4	-	-
10.	Terpenoid	Petroleum ether	Acetic anhydrate & Conc: H_2SO_4	Pink	+
11.	Reducing sugar	H_2O	Fehling's solution	Brick red ppt.	+
12.	Starch	H_2O	Iodine solution	Bluish brown	+
13.	Cyanogenic glycoside	Powder	Distilled water, Conc: H_2SO_4, Sodium picrate paper	No colour change	-

(+) = presence **(-) = absence** ppt = precipitate

3.3. Antimicrobial activities

The antimicrobial activities of petroleum ether extract, methanol extract, ethyl acetate extract, ethanol extract, water extract of *Houttuynia cordata* Thunb. roots were studied by Agar well diffusion method against various microorganisms.



P.E = Petroleum ether, EtOH = Ethanol, MeOH = Methanol, EtOAc = Ethayl acetate

Figure 2. *Antimicrobial activities of different solvent extracts of Houttuynia cordata Thunb. Roots*

No	Solvents	Organisms					
		Bacillus subtilis	***staphylococcus aureus***	***Pseudomonas aeruginosa***	***Bacillus pumalis***	***Candida albicans***	***Escherichia coli***
1.	Petroleum ether	-	-	-	-	-	-
2.	Methanol	12 mm (+)	13 mm (+)	12 mm (+)	13 mm (+)	13 mm (+)	13 mm (+)
3.	Ethyl acetate	28 mm (+++)	30 mm (+++)	35 mm (+++)	30 mm (+++)	28 mm (+++)	33 mm (+++)
4.	Ethanol	15 mm (++)	14 mm (+)	15 mm (++)	14 mm (+)	15 mm (++)	14 mm (+)
5.	Water	-	-	-	-	-	-

Agar well ~ 10 mm, 10 ~ 14 mm (+), 15 mm ~19 mm (++), 20 mm above (+++)

In antimicrobial activities, methanol, ethyl acetate and ethanol extracts of roots are effective on six tested organisms. But petroleum ether and water extracts of roots are no effective on all tested organisms. Among them, ethyl acetate extracts of roots exhibit the largest inhibition zones. It is more sensitive against six organisms. The more large inhibition zone showed on *Pseudomonas aeruginosa* (35 mm). Ethanol extracts of roots sample responds medium activity on all tested organisms but methanol extracts of roots sample gave low activity on all tested organisms [Table 2, Figure 2].

In morphology studies, the plant is perennial herbs; leaves simple, alternate; inflorescences terminal involucrate spike; flowers minute; stamens 3; ovary superior and fruits capsular [Figure 1]. *Houttuynia cordata* Thunb. included the IUCN (International Union for the Conservation of Nature) Red list of threatened species [Website 6]. In photochemical tests showed the present of carbohydrate, glycoside, phenol, α-amino acid, saponin, tannin, flavonoid, terpenoid reducing sugar and starch [Table 1]. Carbohydrate will provide energy for human

body and brain function. It decrease disease risk; improve the health of digestive system and weight control [Website 7]. Glycoside showed significant antioxidant activity, anticancer and antitumor activity, hepatoprotective activity, anti-inflammatory activity, anti-diabetes activity and antifungal activity [Website 8]. Phenol treat Parkinson' disease, cerebral palsy, sore throat [Website 7]. Amino acid increase muscle growth, decrease muscle soreness and benefit liver disease [Website 9]. Tannin showed anti-carcinogenic activity, anti-mutagenic activity and antimicrobial activity [Website 8]. Flavonoids are reduced risk of a number of chronic diseases including cancer, cardiovascular disease and neurodegenerative disorders [Website 8]. Terpenoid may help to produce anti-inflammatory, antibacterial and antidepressant [Website 10]. Reducing sugar promotes weight loss, lower cholesterol level and blood pressure level, reduce inflammation [Website 11]. Starch reduces colon cancer, diabetes and heart disease [Website 12]. In antimicrobial activities of various extracts of roots showed active against six microorganisms. The methanol, ethyl acetate and ethanol extracts of roots played antibacterial activity against *Bacillus subtilis*, *staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus pumalis*, *Escherichia coli* and antifungal activity against *Candida albicans* [Table 2, Figure 2]. So roots of *Houttuynia cordata* Thunb. can be used for illness, food poisoning, sore throat, skin infection, toxic shock, eye infection syndrome, respiratory tract infection, dermatitis, soft tissue infection, joint infection, gastrointestinal infection, cancer and AIDS, diarrhea, pneumonia, urinary tract infections, genital yeast infection.

4. Conclusions

In this research works, determination of morphological, phytochemical investigation and antimicrobial activity on roost of *Houttuynia cordata* Thunb. were carried out. The morphological characters were recorded for other researchers. Phytochemical investigation contains bioactive compounds and antimicrobial activities can be used to treat in many diseases. *Houttuynia cordata* Thunb. has also been observed in medicinal value of plant. So this paper gives medicinal information for native tribes. Finally, it is also hope that this research paper will help in improving human health care system of Myanmar.

Acknowledgements

I would like to express my deep gratitude to Dr San San Mar, Rector and Dr Myat Nyunt, Pro-rector, Kyaing Tong University, for their permission to conduct this research paper. I wish to greatly thanks Dr San San Oo, Professor and Head, Dr Moe Moe Lwin, Professor, Department of Botany, Kyaing Tong University, for their invaluable suggestion and permission to this paper.

References

[1.] British Pharmacopoeia, "The Pharmaceutical Press", London and Bradford, 17 Bloomsbury Square, London, 1968.

[2.] Brummitt, R. K., "Vascular Plant Families and Genera", Royal Botanical Garden, Kew, Printed and bound by Whistable Litho Ltd., Great Briantain. 1992.

[3.] Central Council for Research in Unani Medicine, "Phytochemical Standads of Unani Formulation", Ministry of Health and Family Welfare, India, New Delhi, 1987.

[4.] Cronquist, "A integrated system of classification of Flowering plants", Columbia University Press, New York, 1981.

[5.] Cruickshank, R. J. P., "Medicinal microbiology", Landon: Livingstone Led., 1975.

[6.] Heywood, V.H., "Flowering plants of the World", Oxford University Press, London, 1978.

[7.] Hooker, J. D.,"The Flora of British India", L. Reeve & Co. 5 Henrietta Street, Covent Garden London, 1879.

[8.] Hutchinson, J., "Key to the Families of Flowering Plants of the World", Claredon Press Oxford, 1967.

[9.] Hundley, H.G. "List of Trees, Shrubs, Herbs and Principal Climbers, etc". fourth Revised edition Shwe Daw Oo Press, Mayangon Yangon, Myanmar, 1987.

[10.] K. M. Lau, K.-M. Lee, C.-M. Koon, C.S.-F. Cheung, C.-P. Lau, H.-M. Ho, M.Y.-H. Lee, S. W.-N. Au, C. H.-K. Cheng, C. B.-S Lau,et al., "Immunomodulatory and Anti-SARS Activities of *Houttuynia cordata* ", Journal of Ethnopharmacology, 2008, vol. 118, no. 1, pp. 79-85

[11.] Kress, J. *et al*., "A Checklist of the Trees, Herbs and Climbers of Myanmar", Department of Systematic Biology-Botany, National Museum of Natural History, Washington DC, USA, 2003.

[12.] Lawrence, George H. M. "Taxonomy of Vascular Plants", the Macmillan Company, New York, 1951.

[13.] Marini Bettolo, G. B. M. Nicolettic and M Patamia, "Plant Screening by Chemical Chromatographic Procedure under Field Conditions", Journal of Chromatogram, 1981.

[14.] N. R. Farnsworth, O. Akerele, A. S. Bingel, D. D. Soejarto and Z. Guo, "Medicinal Plants in Therapy", Bulletin of the Whorl Health Organization, 1985, vol. 63, No. 6, pp. 965-968.

[15.] P. Darsar and J. Moravcova, "Recent Advances in Analysis of Chinese Medicinal Plants and Traditional Medicine", Journal of Chromatography B, 2004, vol. 812, no. 1-2, pp. 3-21.

[16.] Trease and Evan, "Pharmacognosy", 11th Ed. Edinburgh, London, New York, 1978.

[17.] Wu, Z. Y. Raven, P. H. & Hong, D. Y, "Flora of China (Cycadaceae through Fagaceae)", , Science Press & Missouri Botanical Garden Press, Beijing & St. Louis., 1999, vol. 4. pp.109.

Websites

[1] https:// en.m.wikipedia.org > wiki.

[2] https:// www.ncbi.nlm.nih.gov > pmc.

[3] https:// indiabiodiversity.org. > show

[4] https:// uses.plantnet.project.org. > H.

[5] www. flowers of indica. net.> slides.

[6] www. iucngisd.org > gisd > species

[7] https:// www. healthline. com > health

[8] https:// www. ncbi.nlm.nih.gov > pub.

[9] https:// www. healthline. com > nutrition

[10] https:// www. abstraxtech. com > education

[11] https:// www. customhelthcenters.. com.

[12] https:// www. healthline. com > some.s.

Information System Development of Hotels in Naypyitaw, Myanmar

Kyi Kyi Thant[1]

Abstract

With the advent of information technology, hotels make development of information system to create efficient internal operations and effective connection with associated parties. This study aims to identify the information system development and to analyze the effects of information system development on organizational effectiveness of hotels. The primary data was collected from responsible persons in 24 hotels in Naypyitaw by using structured questionnaire during July 2019. The respondents were selected with simple random sampling method. The secondary data was collected from the records of the Ministry of Hotels and Tourism, Myanmar. Descriptive statistics and multiple regression analysis were mainly applied in this study. Accounting information system development show the maximum mean score comparatively. According to the multiple regression analysis result, it was found that accounting information system development, human resources information system development, and integrated information system development show positive and significant effects on organizational effectiveness. Remarkably, marketing information system development shows negative but insignificant effect on organizational effectiveness. It was highlighted that integrated information system development was most important to contribute to the improvement of organizational effectiveness.

Keywords: Information system development, Organizational effectiveness

1. Introduction

System, strategy, and structure are essential components of an organization [1] and they are being developed all the time to achieve organizational effectiveness. Nowadays, organizations make changes components by coping with the rapid advancement of information technology. They make continuous and small changes or drastic and large changes in their organizational design. In shifting their design, all firms including service, distribution, and manufacturing firms are applying information technology fostering to fulfill customer orders at the right place and the right time. To be responsive to customer needs, decision makers are required to have timely and accurate information so that they can make arrangement correctly. Luxury and upscale hotels developed their systems by applying information technology comparatively [2]. Thus, they prioritize developing information system such as accounting information system, marketing information system, human resources management information system, and integrated information system respectively in their organizations.

Currently, hotels can make accounting information system development without disturbing the current system [3]. By using accounting information system, budgeting, inventory control, and cost control can be implemented effectively in hotels [4]. As the effects of accounting information system, planning, controlling, and decision making are put in the study of hotels [5]. Hotels need to make improvement in accounting information system to cope with the new invention of information technology [6]. Development in accounting information improves the capability of producing large amount of information and quality of decisions in hotels [7].

[1] Dr Lecturer, Department of Management Studies. Meiktila University of Economics, kyikyithant@gmail.com

The collection, storage, retrieval, and dissemination of market information are required for hotels and information processing capability can be enhanced by marketing information system [8]. First class and luxury hotels mostly use integrated marketing information system through the use of information and communication technology to keep existing customers' information which help implementing customer loyalty program [9].

Similarly, the impact of integrated marketing communication on hotel brand equity, which is comprised of brand image, perceived quality, and brand loyalty, is positive and significant [10]. In measuring the effectiveness of marketing information system, increasing functional effectiveness, improving organizational climate, adapting market conditions, and responding customer demand are used as indicators [11].

The previous empirical studies highlighted the importance of human resource information system in business organizations [12]. Hotels are able to take strategic and operational advantages through implementing human resources information system [13]. Staff is trained on working activities to utilize effectively the information technology so that human resources management decisions can correctly be made in hotels [14]. It is observed that cloud human resource information systems show impact on human resource activities in hotels [15].

All functions in operations management and continuous business process reengineering are implemented in hotels with the application of information system [16]. Integrated information system development provides information among different departments in hotels and it can minimize unnecessary activities [17]. The effectiveness of human resource information system contributes to the strategic direction of businesses [18].

This study aims to identify the information system development of hotels in Naypyitaw and to analyze the effects of information system development on organizational effectiveness of hotels in Naypyitaw. Based on the previous literature, the conceptual framework depicting the effects of information system development on organizational effectiveness is developed.

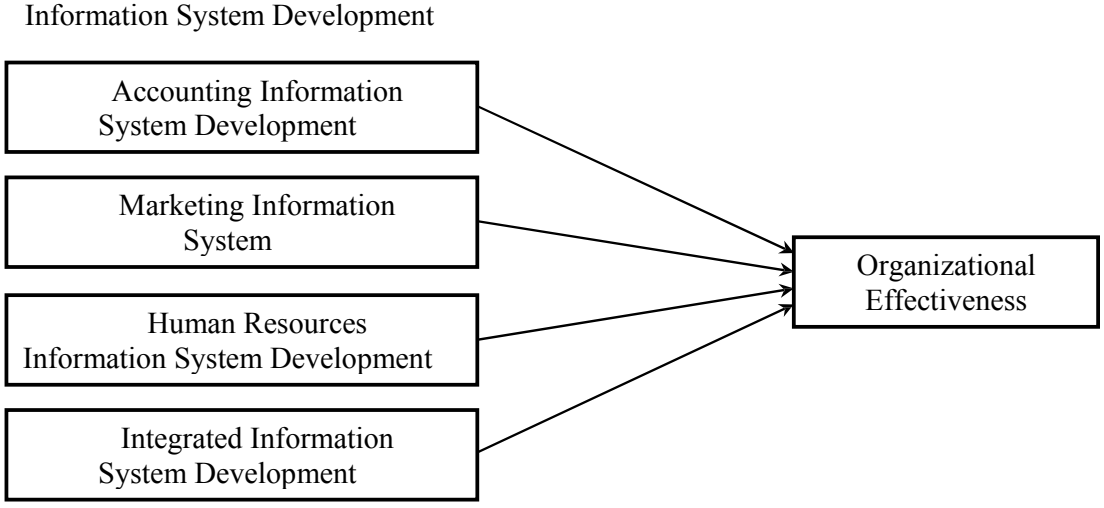


Figure1. Conceptual framework of the study

The study focuses on information system developments: accounting information system development, marketing information system development, human resources information

system development, and integrated information system development. These were used as independent variables and organizational effectiveness was used as dependent variable in this study.

2. Methods of the Study

The primary data was collected from responsible persons of 24 hotels out of 65 registered hotels in Naypyitaw. The sample was selected by using simple random sample method and it represents (37) percent of total population. The primary data was collected by using structured questionnaire measured with five point Likert scale during July 2019. The secondary data was collected from the records of the Ministry of Hotels and Tourism, Myanmar. Descriptive statistics was used to reveal the mean values of information system development and multiple regression analysis were mainly applied to analyze the effects of information system development on organizational effectiveness of hotels in Naypyitaw.

3. Results and Discussion

In identifying the information system development of hotels in Naypyitaw, the mean values are firstly described in Table (1).

Table (1) Descriptive statistics

Sr.	Variables	Mean	SD	Items	Alpha
1	Accounting Information System Development	4.00	1.092	6	0.790
2	Marketing Information System Development	3.92	0.800	6	0.835
3	Human Resources Information System	3.16	1.318	6	0.769
4	Integrated Information System Development	2.51	1.316	6	0.838
5	Organizational Effectiveness	3.71	0.953	6	0.738

Source: Survey Data 2019)

The mean value indicates the average perception of respondents on information system development; the standard deviation indicates the extent of deviation from the mean values; items show the number of items for each variable; and the alpha value reveals the internal consistency among variables.

It is found that accounting information system development reveals the maximum mean value in this study. The majority of hotels are using accounting software and application for the advancement of handling accounting data. By making accounting information system development, hotels can assess sales revenues and expenses timely and make decisions correctly. However, it can be concluded that some hotels are still using manual accounting procedure as the standard deviation shows more than one.

It is observed that marketing information system development is above the neutral level. It explains that hotels are currently using own web page, facebook page, platform such as agoda.com, birma.com, and mymagicalmyanmar.com to reach their updated information to prospective customers. In addition, customers can make reservation and cancellation easily through internet; and they can acquire information and can give feedback as well. Moreover, they make customers convenient for their payment through using visa card and mobile wallets.

The expansion of human resources information system development is required to be made by hotels in Naypyitaw because it is at the neutral level. Hotels are traditionally implementing human resources management activities especially employee attendance, training and development, compensation and benefits, and performance appraisal although the recruitment is made through online. The linkage among human resources management activities is not strong enough so that managers can use those data during the short period.

Although the integration of departments in hotels is of vital importance, the integrated information system development reveals the minimum mean value. It shows under the neutral level and thus it needs to improve the cooperation among individuals and departments.

Table (2) Correlation between information system development and organizational effectiveness

Sr	Variables	1	2	3	4	5
1	Accounting Information System	1				
2	Marketing Information System	0.701**	1			
3	Human Resources Information	0.523**	0.311	1		
4	Integrated Information System	0.240	0.190	0.606**	1	
5	Organizational Effectiveness	0.758**	0.452*	0.770**	0.604**	1

Note: ** and * are significant at 1% and 5% levels respectively. Source: Survey Data (July 2019)

Before analyzing with multiple regression analysis, the correlation between variables is firstly calculated as shown in Table (2). It reveals that the correlation between the independent variables and dependent variable. Specifically, accounting information system development, marketing information system development, human resources information system development, and integrated information system development are positively and significantly correlated with organizational effectiveness.

To prove the effects of information system development on organizational effectiveness, multiple regression analysis is conducted as shown in Table (3).

Table (3) Multiple regression analysis

Variables	Unstandardized		Standardized	T	Sig.	VIF
		Std.				
Constant	0.931	0.469				
Accounting Information System	0.539**	0.133	0.618	4.042	0.001	2.525
Marketing Information System Development	-0.158	0.162	-0.133	-0.974	0.342	2.003
Human Resources Information System	0.225*	0.101	0.311	2.220	0.039	2.117
Integrated Information System Development	0.212*	0.089	0.293	2.395	0.027	1.619
R-square	0.908					
Adjusted R^2	0.824					
F	22.278**					

Dependent Variable: Organizational effectiveness

Note: ** and * are significant at 1% and 5% levels respectively. Source: Survey Data (July 2019)

According to Table (3), accounting information system development is related to organizational effectiveness (b=0.539, p<0.01). It explains that accounting information system development has positive and significant effects on organizational effectiveness at 1% level. It means that one unit increase in accounting information system development leads to 0.539 unit increase in organizational effectiveness of hotels in Naypyitaw. Accounting information system development indicates the positive and significant effects on organizational effectiveness of hotels. It is prominent that providing the exact payment information to customers leads to attaining trust from them. Hotels have to keep the records of customers concerning with their stay and frequency of visit and calculate differently for the loyal customers. In such situation, the discounted amount has to be calculated correctly. If there is an error in asking for bill, customers will be frustrated and it is not probable to come back to the hotels again. Thus, accounting information system is crucial for creating customer satisfaction and positive word-of-mouth. In addition, the usage of accounting information system is able to reduce the fraud of employees and to control the accounts internally. Managers can make cost analysis so that the unnecessary expenses can be alleviated timely. Hence, accounting information system is required for achieving organizational effectiveness of hotels in Naypyitaw.

However, marketing information system development is not related to organizational effectiveness (b=-0.158, p>0.5). It reveals that marketing information system development has negative but insignificant effects on organizational effectiveness. Today, hotels make changes in marketing activities such as developing new products and services for solving customer problems well, using high-tech payment system for reducing customer cost, applying virtual network to make customers convenient, and making contact with customers for providing updated information such as promotion programs. As their functions mainly depend on information technology, hotel staff needs to be proficient technically for responding customers. They sometimes have difficulties in human error or machine error in handling virtual network and advanced technology. In this condition, customers feel inconvenient, complain hotel's supporting services, and reconsider to visit there again. Even though the hotels are making marketing information system development extensively, their effects describe negative.

Human resources information system development is related to organizational effectiveness (b=0.225, p<0.05). It explains that human resources information system development has positive and significant effects on organizational effectiveness at 5% level. It means that one unit increase in human resources information system development leads to 0.225 increase in organizational effectiveness. Human resources are the valuable assets as they directly contact with customers and thus are major service providers of hotels. Human resources management functions such as recruitment and selection, training and development, performance appraisal, and compensation and benefits can be conducted by using information technology. The attendance of employees can be recorded with the help of machines which data automatically send to the calculation of compensation of benefits, and training can be provided with the use of internet by uploading text, audio files, and video files. To conduct human resources management activities effectively, hotels are increasingly using human resources information system. It is observed that human resources information system development indicates positive and significant effects on organizational effectiveness.

Likewise, integrated information system development is related to organizational effectiveness ($b=0.212$, $p<0.05$). It pinpoints that integrated information system development has positive and significant effects on organizational effectiveness at 5% level. It means that one unit increase in integrated information system development lead to 0.212 unit increase in organizational effectiveness. The cooperation among departments such as security, front office, housekeeping, food and beverage departments is essential to provide services to customers satisfactorily. According to the findings, integrated information system development shows positive and significant effects on organizational effectiveness of hotels. The internal linkage makes customers feel convenient and impressed on hotels because they are not willing to wait for long time during connecting each other. Front office department has to inform housekeeping department to be ready before customer arrival; security department has to contact front office department car parking situations; and food and beverage has to send bill to front office department. The disruption among departments make customers feel dissatisfied and hotels cannot maintain current customers to stay long and visit next time. Thus, integrated information system development plays vital role in increasing organizational effectiveness of hotels.

4. Conclusion

The information system development is increasing in hotels especially with increasingly entering international software developing companies into Myanmar. As the availability of standardized and customized software in the market, hotels apply it to make decisions correctly. The study highlights accounting information system development which represents the maximum mean value relatively. On the other hand, integrated information system development indicates the minimum mean value. Although hotels in Naypyitaw widely access accounting information system development, a few of them uses integrated information system development. As accounting software has come out more than one decade ago and is cheaply available in the market at present, most hotels are applying accounting information system largely. However, the use of integrated information system is in weak position as it is required to have customized software which can be acquired from the software company expensively.

The effects of accounting information system development, human resources information system development, and integrated information system development on organizational effectiveness are prominent. As it reveals the importance of information system development in hotels, it is recommended that hotels in Naypyitaw should adopt and make development in these systems. Among them, the accounting information system development shows the most significant effects on organizational effectiveness. Thus, it is suggested that hotels have to use accounting information system development to sustain efficient operations, to make corrective decision, and to achieve customer satisfaction. Although the effect of marketing information system development on organizational effectiveness is not significant, it will be beneficial that hotel staff and customers are familiar with using pages, websites, and applications. Thus, hotels are recommended to take time for training employees to be proficient in using information technology.

The study focuses only on information system development of hotels in Naypyitaw and its effects on organizational effectiveness. Further studies can emphasize hotels situated in

other areas to prove the effects of information system development of hotels in Myanmar. Besides, the effects of sub-systems on organizational effectiveness can be analyzed to give the specific recommendation to the hotels. The study can be extended by exploring the driving forces of information system development of hotels. The causal effects of information system development of hotels can be analyzed in further studies.

Acknowledgements

My special thanks go to Professor Dr. Tun Aung, Rector of the Meiktila University of Economics for his continuous encouragement for conducting qualified researches. My great appreciation also goes to Professor Dr Thida Kyu, Pro-Rector of the Meiktila University of Economics for her sustained support for publishing academic researches. It would not be possible to accomplish this research without the supervision of Professor Dr Khaing Mar Hlaing, Head of the Department of Management Studies, Meiktila University of Economics. My heartfelt thanks go to the managers working at the hotels in Naypyitaw as well.

References

[1] Philip Sadler, "Designing Organizations. The Foundations for Excellence", Kogan Page India Private Limited, 991.

[2] Judy A. Siguaw, Cathy A. Enz, Karthik Namasivayam, "Adoption of Information Technology in U.S. Hotels: Strategically Driven Objectives", Journal of Travel Research, 2000, vol. 39, pp. 192-201.

[3] Majed Adel Alsharayri, "The E-Commerce Impact on Improving Accounting Information System in Jordanian Hotels", International Research Journal of Finance and Economics, 2011, ISSN 1450-2887, pp.14-23.

[4] Vincent Cho, James Wong, "Measuring Service Quality of the Computerized Food and Beverage Cost Control System in Hong Kong Hotels Using a Gaps Model Approach", Journal of Hospitality and Tourism Research, 1998, vol. 22, pp. 268-287.

[5] Omar A. A. Jawabreh, Ali Mahmoud Abdallah Alrabei, "The Impact of Accounting Information System in Planning, Controlling, and Decision-Making Processes in Jodhpur Hotels", Asian Journal of Finance and Accounting, 2012, vol. 4, pp. 173-188.

[6] Mohammad Nayef ALsarayreh, Omar A. A. Jawabreh, Muneer Mohamad Falah Jaradat, Sameer Ahmed ALamro, "Technological Impacts on Effectiveness of Accounting Information Systems (AIS) Applied by Aqaba Tourist Hotels", European Journal of Scientific Research, 2011, vol. 59, pp. 361-369.

[7] Nina Downie, "The Use of Accounting Information in Hotel Marketing Decisions", International Journal of Hospitality Management, 1997, vol. 16, pp. 305-312.

[8] Kalliopi C Chatzipanagiotou, Aikaterini Vassilikopoulou, George J Siomkos, "An Empirical Investigation of the Relationship between Market Orientation and MrkIS Effectiveness in Upscale Hotels in Greece", Journal of Targeting, Measurement, and Analysis for Marketing, 2008, vol. 16, pp. 285-297.

[9] Maja Šerić, Irene Gil-Saura, "Integrated Marketing Communications and Communication and Information Technology in the Hotel Sector: An Analysis of Their Use and Development in Dalmatian First-Class and Luxury Hotels", Journal of Retail and Leisure Property, 2011, vol. 9, pp. 401-414.

[10] Maja Šerić, Irene Gil-Saura, María Eugenia Ruiz-Molina, "How can Integrated Marketing Communications and Advanced Technology Influence the Creation of Customer-Based Brand Equity? Evidence from the Hospitality Industry", International Journal of Hospitality Management, 2014, vol. 39, pp. 144-156.

[11] Spiros P. Gounaris, George G. Panigyrakis, Kalliopi C. Chatzipanagiotou, "Measuring the Effectiveness of Marketing Information Systems", Marketing Intelligence and Planning, 2007, vol. 25, pp. 612-631.

[12] Amir Shani, Dana V. Tesone, "Have Human Resource Information Systems Evolved into Internal E-Commerce?", Worldwide Hospitality and Tourism Themes, 2010, vol. 2, pp. 30-48.

[13] Karam Zaki, Hisham Saad, "Adoption of Cloud Human Resource Information System in Egyptian Hotels: An Experimental Design Research", International Journal of Heritage, Tourism, and Hospitality, 2018, vol. 12, ISSN 12734/2006.

[14] Haiyan Sun, Baozhen Han, Chuanbao Yu, "Research and Application on Human Resource Management Information System in China First-Class Hotels", Proceedings of the 2015 International Conference on Education Technology, Management, and Humanities Science, 2015, ISSN 2352-5398.

[15] Karam Zaki, Hisham Saad, "Adoption of Cloud Human Resource Information System in Egyptian Hotels: An Experimental Design Research", International Journal of Heritage, Tourism, Hospitality, 2018, vol. 12, pp. 233-245.

[16] Dimitrios Buhalis, "Strategic Use of Information Technologies in the Tourism Industry", Tourism Management, 1998, vol. 19, pp. 409-421.

[17] Safarini Osama, "Integrated Information System for Reserving Rooms in Hotels", International Journal of Advanced Computer Science and Applications, 2011, vol. 2, pp. 48-52.

[18] Shammy Shiri, "Effectiveness of Human Resource Information System on HR Functions of the Organization - A Cross Sectional Study", US-China Education Review, 2012, ISSN 1548-6613, pp. 830-839.

The Strategic Analysis for Tourism Sector Development in Myanmar

Yin Myat Phyu Win[1]

Abstract

In the context of both rural and urban tourism sector development, little attention has been paid by academics and the sector is largely neglected. The purpose of the study is to identify the deficiencies in ethical issues, facilities, standards, services, etc. at the touristic destinations in Myanmar. The SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, the method allegedly originated from Albert Humphrey, is used to strategically identify internal and external factors affecting the sustainable development of the industry. The internally-related strengths and weaknesses, and the external environment of opportunities and threats were focused through the analysis of online survey data and documents. The result showed that although sustainable development is repeatedly mentioned by the authorities, there are still fewer implementations and initiatives to achieve the development goal. It is hoped that this research contributes some knowledge to the people from the tourism sector by identifying the gap and promoting some socio-cultural initiatives and implementing them into practice.

Keywords**:** sustainable development, strengths, weaknesses, threats, opportunities

1. Introduction

Situated between the two populous countries of China and India, the geographically strategic country Myanmar opened its doors after its political reform. Diverse landscapes, over one hundred ethnic groups' unique traditions and cultures, rich cultural heritage sites are attracting tourists from the whole world. However, there are many limitations left to make their visits convenient and a success. For the sustainable development of Myanmar's tourism sector, government and private sectors awareness are needed to be raised as the tourism sector is closely related to international trades, and a close tie between borders is for the economic development of the country.

To support the tourism and hospitality sector, banking system and money transaction processes are started to be planned well. According to the Directorate of Investment and Company Administration, between the FY 2018/19 and early May, Myanmar's hotel and tourism sector have attracted $60 million of a total of $2.5 billion in foreign direct investment (FDI). Backed by the Myanmar Tourism Federation, the first branch of Myanmar Tourism Bank (MTB), funding provided by 26 shareholders from the local tourism industry, was opened in Yangon in May 2019. The opening of Myanmar's the very first tourism bank proved that Myanmar tourism and hospitality sector began to be supported and encouraged by the government bodies to be flourished in the upcoming years.

Aim and Objectives

Currently, Myanmar's domestic tourism has faced its competitiveness and has to try to survive among conflicts and instabilities. If the domestic tourism gains its momentum, then it will largely contribute to the less privileged communities, those who live in the rural, hilly or remote areas. That is why, the aim of this paper is to identify the deficiencies in ethical issues, facilities, standards, services, etc., the weaknesses of the current situation of tourism industry are to be pinpointed and searched for ways to promote Myanmar as a tourism destination of the

[1] Dr Associate Professor, Department of English, Yangon University of Foreign Languages.

world. To achieve the aim of the paper, the following preliminary questions have been raised and the objectives of the study are specified.

(1) What would be our greatest strength to draw the attention of our prospective customers?

(2) Which opportunities can we exploit or grasp?

(3) What are our deficiencies to be corrected?

(4) What sorts of threats or challenges are we facing?

Based on the research questions mentioned above, the objectives have been specified as follows:

- to search for our greatest strength that is to be promoted to the largest degree
- to study our would-be chances for exploitation
- to upgrade our deficiencies, including our outdated intellectual properties
- to identify the external factors that threaten us

2. Methodology

For the evaluation of Strengths, Weaknesses, Opportunities and Threats of a business project, an American business and management consultant Albert Humphrey developed SWOT analysis. This analysis is to specify the objectives of the marketing or business projects, and then, identify the external and internal factors that can give a positive or negative impact on the set objectives. As we need to bring our country on the world's tourism map as a holiday destination, in this study, SWOT method was used to strategically identify internal and external factors that affect the sustainable development of Myanmar's tourism industry. The survey data were randomly collected from the currently running hotels and tour businesses, medium and small local enterprises and tourists visiting Myanmar. The internally-related strengths and weaknesses, and the external environment of opportunities and threats were the focus subject matter of the data collection.

Analysis of Data

The collected data of the survey results are classified under Humphrey's four categories of Strength, Weaknesses, Opportunities and Threat, and then, analyzed.

Strength

Altogether 135 ethnic groups with their own traditions and culture showcase the diversified local communities, in which the use of different dialects and languages are one of the key attractions to the visitors.

The locals have a more natural and less aggressive attitude to tourists, compared to other countries. Myanmar welcomes foreigners with smiles. Locals are eager to deal with them and treat them as "guests" and try to show Myanmar families' hospitability. This is another key attraction to visitors.

The diverse and different landscapes of hilly highlands, low-lying areas, scenic beauty in temperate, favorable climate, especially in December and January i.e. the holiday seasons for most tourists, are attractions to those from the severe weather conditions, and to those who have to survive within heaters or cooling systems.

Weaknesses

Compared to our neighboring countries, the hotel occupancy rates are comparatively high, especially for local visitors, but the quality of service and the provision of facilities are, to some extent, poor. For foreigners, the infrastructure along the ways to the tourist destination areas is needed to be promoted.

The level of prices is comparatively higher, unstable and this is unacceptable for cost conscious tourists. Myanmar's handicrafts and the souvenirs are needed to be diversified and upgraded. Moreover, well-qualified products are needed to create more.

For the influx of tourists, government's policy of issuing different types of visas or visa-free entry to some Asian countries should be changed.

As tourism is a sector where many young and unskilled workers can learn a trade, it offers equal opportunities to all genders in different education levels without any discrimination. Hotels, transportation services, catering services, tour operations, entertainment, garment, souvenir shops, etc. are different work places for different education levels. As all inclusive service-businesses are to serve customers professionally, both at the management levels and at working group levels, all working bodies are needed to be trained well when we are approaching the sustainable development goal.

Opportunities

The development of tourism sector can improve locals' awareness for the conservation of their identity as well as their cultural values. The more they value their culture and their identity, the more they conserve them. The result is we do not need to worry about the extinction of our distinctive cultures and traditions. This is one of the opportunities that the booming tourism can give to us all.

As the developments can provide local peoples with lots of job opportunities and high income rates, it can automatically reduce unemployment rates and consequently, reduce the crime rates. Increased income can uplift standards of living and educated ratio, and this additionally can attract more and more tourists for safe environs.

In Myanmar, commodity prices are comparatively low. Organic foods are plentiful and available in low prices. This amazingly low cost expenditure is a new experience for tourists, one of the significant changes from their lifestyles.

Threats

Our neighboring countries are making different promotion systems, e.g. using media as a powerful tool in their advertising, to boom up their different types of tourism by upgrading their industries as highly-yield tourism, instead of high volume tourism. In this case, if we cannot upgrade our systems to modern standards, we would lose our customers who expect our quality and services up to the highest level.

Concerning prices, we need to be honest with our customers. Between buyers and sellers, most Myanmar shoppers, sellers and businesspersons usually try to add skyrocketing prices to

foreigners. In some situation, the prices become doubled compared to the original prices. The negotiated prices can never get the trust of the customers and so, such dishonest manners should definitely be avoided. In doing smokeless businesses, if we do not correct our characters in time, the morals that all humans respect and pay heed to will teach us lessons that we could never be corrected again and get regrets in some days of our very future. At the same time, our people and the country will sooner or later be downgraded as notorious and the unsafe place to visit.

Food safety is a matter to be considered. Currently, the government bodies cannot handle it effectively. People have to wisely choose for their own healthy living. It is a matter for the less-privileged communities, and for the ones who tour from places to places are difficult to be choosy under different circumstances. If it is not handled effectively in the long run, it would still be one of the major threats for the sustainable tourism development. From the national level, it should be effectively reinforced with policy, planning, laws and judicial systems.

3. Findings and Discussion

For the future development, suggestions and recommendation are to be provided as follows:

The areas where there is a potential for the booming of tourism industry are to be selected and then try to transform the areas into the tourist zones. The tourist destination zones are to be created for educational tourism, business tourism, historic-related tourism, rural observatory, ecotourism, sports tourism, etc.

Connections and alliances are the major factors to achieve the success of any businesses. Thus, for preparation and planning for the influx flow of visitors in the long run, to set up networks with the inland and outbound alliances are of crucial importance.

Business licenses should be provided only to those who offer a certain standard of services and quality. Government should implement control system to guarantee and assure the production of quality products for the promising future.

In any cases, funding is needed to be sufficient enough. Thus, investments in and abroad are important to be invited because these investments can determine technological development, infrastructure development, prestige of tourism industry, good accommodation, better transportation, catering and magnificent entertainment, etc.

Vocational training schools should be established to meet the needs of professional services and skills jobs, as well as for the productions of quality products. Moreover, management training schools should also be set up for small business enterprises to improve managerial skills for small and medium business levels.

4. Conclusion

Rich national resources can make Myanmar a strong competitive destination in the tourism market. Varieties of high-quality products and souvenirs in reasonable prices, three to five stars hotels with the provisions of state-of-the-art technology, good transportation systems, low crime rates with high security standard, honest and reliable locals, healthy catering services, etc. are all essential elements for the sustainable developments of Myanmar's tourism sector. Tourism development processes should also be based on the private and public sector co-

operation. All working groups from all walks of life should carry out matters hand-in-hand in unity, and should solve unexpected problems co-operatively.

Acknowledgements

First and foremost, I would profoundly like to express my deepest gratitude to Sayagyi Dr. Kyi Shwin, Rector, Yangon University of Foreign Languages, from whom I have always received kindness and moral courage. I would like to thank him for his invaluable advice, guidance and encouragement to do this research analysis, and for his valuable suggestions.

I would profoundly like to express my gratitude to Dr. Thi Thi Tun, Professor, Department of English, Dagon University, for her invaluable advice, guidance, kindness and help in various ways during my data collection and data analysis period.

My sincere thanks are extended to all responsible persons and owners of hotels, restaurants, souvenir shops and guesthouses in Bagan, Bago, Inlei, and Yangon where I have collected my data and to all those who patiently gave me answers to my questions and shared their opinions to me.

I am also indebted to all my teachers who taught and trained to broaden my knowledge throughout my school, university days and in my work places.

Further acknowledgements go to my colleagues, Dr. Khin Moe Moe Kyu and Dr. Thida Oo, who kindly helped and encouraged me, without whom this research paper would never come into existence.

References:

Coccossis, H., & Mexa, A. (2004) *The Challenge of Tourism Carrying Capacity Assessment*. Burlington: Ashgate.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. London: Sage Publications.

Djachenko, L. P. (2007). *Tourism Business and Economy.* Kiev: Sage Publications.

Formica, S. & Kothari, T. (2008). Strategic Destination Planning: Analyzing the Future of Tourism. *Journal of Travel Research*

Hall, C. M. (2000). *Tourism Planning: Policies, Processes and Relationships*. Harlow: Pearson Education Ltd.

Krippendorff, K. (2004). *Content Analysis: Introduction to its Methodology* (2nd ed.). California. Sage Publications.

Malska, M. P., Antonuk, N. V., & Ganuch, D. (2008). *International Tourism and Hospitality.* Lviv: Open University Publication.

Malska, M. P. & Burdun, O. J. (2003). *Tourism Policy and Planning.* Lviv: Open University Publication.

Online Resources:

https://oxfordbusinessgroup.com/news/how-myanmar-aims-stimulate-investment-tourism

Proposal of the Simple Rapid Measurement on the Airborne Bacterial Concentration for the Quality Control in the Industry

Ze Liu[1], Takehiro Tanaka[2], Shuji Fujii[3]

Abstract

Airborne microbes are examined generally by sampling them on culture media and counting the number of their colonies formed. However, because it takes at least two days for bacteria and five days for fungi to be cultivated, the obtained data may not be usable to monitor in the industry. Therefore, the simple and quick detection methods are required to be applicable in the industry. In this study, rapid detection methods of indoor airborne bacteria are reviewed and examined for monitoring the indoor bacterial contamination risk in the industry at first. As the simple rapid methods, ATP method and Bioluminescence/fluorescence method are selected and the experimental surveys are carried out. The authors propose that these methods are applicable to monitor the airborne bacteria in the industry by a shorter time.

Keywords**:** Rapid measuring method, Fluorescent vital staining, ATP, Industry, Quality control

1. Introduction

Airborne microbes are examined generally by sampling them on culture media and counting the number of their colonies formed. However, because it takes at least two days for bacteria and five days for fungi to be cultivated, the obtained data may not be usable to monitor in the industry. Therefore, the simple and quick detection methods are required to be applicable in the industry. Rapid detection methods of indoor airborne microbes are reviewed and examined for monitoring the indoor bacterial contamination risk in the industry at first. As the simple rapid methods, ATP method and bioluminescence/fluorescence method are selected and the experimental surveys are carried out.

2. Rapid detection methods

Rapid measuring methods are outlined in Table 1. They are classified into direct methods or indirect methods. Direct methods include solid-phase cytometry and flow cytometry. Indirect methods include immunological methods such as nucleic acid amplification, bioluminescence (ATP etc.), micro colony method, gas measuring method, fatty acid profile, genetic finger-printing method (DNA). These are using bacterial physiological activities and intracellular components such as antigen, nucleic acid, ATP, growth, fatty acid, cell component, DNA.

As the direct bacteria fluorescent counting method by flow cytometry, ATP method and bioluminescence/fluorescence method are selected for the suitable monitoring methods in this study, ATP method are mainly used for bacteria detection. The micro-colony method is applied to the ATP method to amplify the intention and the bioluminescence/fluorescence method are used for the reference. The direct bacteria fluorescent counting method is not dealt

[1] Toyo University, hiya3506@gmail.com
[2] Toyo University, tanaka@toyo.jp
[3] Toyo University, Tokyo Institute of Technology, sf0007@yahoo.co.jp

in this study because the commercial instrument is expensive to apply simple rapid method at present.

2.1 Direct bacteria fluorescent counting method

Particle Counters are commonly used to measure particle concentration. Microbes are known to have characteristics to generate fluorescence by irradiation with ultraviolet rays. Recently the measuring instrument applied with the characteristics, Instantaneous Microbial Detection (IMD) system, is developed and commercially supplied. Yanagi et. al.[1)] surveyed and studied the system. The IMD value was nearly 100 times more than that of colony forming unit with the simultaneous measurements of the IMD and general colony forming method. That means that the IMD value shows total number of bacteria but colony forming method shows only the colony formed bacteria. This IMD system as the direct bacteria fluorescent counting method is applicable for the rapid measuring method but is not dealt in this study because the commercial instrument is expensive to apply simple rapid method at present.

2.2 Sampling of indoor airborne bacteria

In this study, the membrane filter technique are used for sampling indoor airborne bacteria with pump. Isopore filter (Merck Millipore GTBP04700) is selected for the membrane filter of bacteria sampling because the bacteria should be sampled on the filter surface. The filter diameter is 47 mm and pore size is 0.4 micro meters. Durapore filter (Merck Millipore HVLP04700) is also used for the case the more sampling air volume is needed.

2.3 ATP

ATP is the abbreviation for “Adenosine Tri-Phosphate,” which is an energy-carrying molecule found in the cells of any plants, animals and microbes, exhibiting a molecular structure shown in Figure 1. ATP is a chemical compound used by all living things to provide energy in many metabolic processes: e.g. cell proliferation, muscle contraction, photosynthesis by plants, bacterial respiration, and yeast fermentation. ATP is contained in all organic matters (living things and their traces) including foods, bacteria, molds and other microbes. In this context, ATP detected on the surface and in the washing water suggests the presence of biological substances (e.g. food residue) which may promote contamination or proliferation of microbes invisible to the naked eye. ATP is released from microorganisms on the basis of luminous or fluorescence phenomena occurred by enzyme reaction. Recently ATP measuring instruments are commercially usable to apply bacterial measurements on surfaces or liquids. This instrument is recently applied to monitor the surface cleanliness in the several fields such as food industry, medical fields by swab or wash technology. The authors apply the instruments to measure the surface concentration of membrane filter. This can make rapid estimation of sampled airborne bacteria on the membrane filter. It may take less than one hour to apply this method compared to the conventional cultivated method which takes several days.

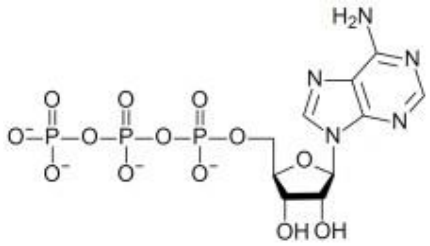


Figure1. Molecular structure of ATP

2.4 ATP instrument

The principle of ATP measurement is based on the mechanism of firefly bioluminescence as shown in Figure 2 which makes it possible to measure an extremely small quantity of ATP. In the ATP assay, specific reagents are applied to ATP samples swabbed off or contained in water to let the following chemical reaction occur and the amount of luminescence produced in the reaction is measured.

This study used the Lumitester (Kikkoman Biochemifa Company) for the ATP measuring instrument.

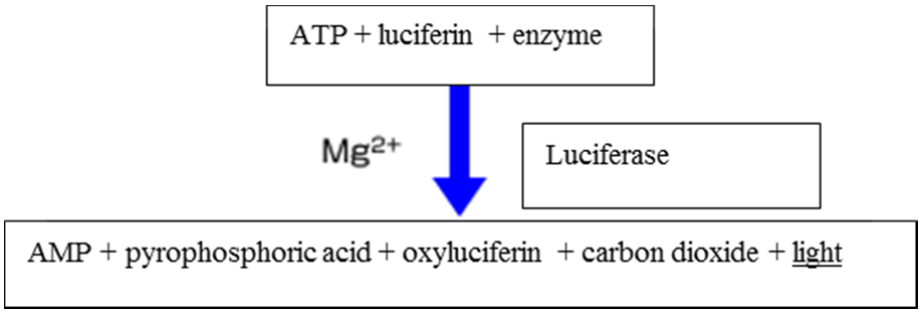


Figure 2. Principle of ATP measurement

Table1. Outline of rapid measurement method

Techniques	Target substance	Principles/characteristics
1) Direct methods		
Solid-phase cytometry	Bacterial cell	Signals emitted by bacteria trapped on a filter or other carriers are Directly detected. Signals related to physiological activities can be picked up depending on the kind of stain, or autofluorescence may be also used. In some cases, gene probes, antibodies or fluorescent Labeled phages are utilized to selectively detect specific bacteria. Various types of optical devices such as fluorescence microscopes and laser microscopes are used as detectors/measuring instruments.

Techniques	Target substance	Principles/characteristics
Flow cytometry	Bacterial cell	Signals emitted by bacteria passing through passages are directly Detected. Signals related to physiological activities can be picked up depending on the kind of stain, or auto fluorescence may be used. In some cases, gene probes, antibodies or fluorescent labeled phages are utilized to selectively detect specific bacteria. As detectors/ measuring instruments, various types of optical devices are used.
2) Indirect methods		
Immunoassay	Antigen	Bacterial antigen is made to react with specific antibodies, and their color development and fluorescence are visually observed or assessed with a microplate reader. Immunological chromatography is one of the simplified methods.
Nucleic acid amplification	Nucleic acid	Microbial nucleic acids, amplified by applying specific primer to target microbes, are detected. Quantitative PCR is also applicable.
Bioluminescence/ biofluorescence	ATP etc.	ATP contained in bacterial cells is assessed in the luminescent/ fluorescent phenomena induced by enzymatic reactions.
Microcolony analysis	Proliferation potency (microcolony)	Microcolonies in the early development stage are detected and counted. The requirements for their cultivation (*e.g.* medium composition and temperature) are the same as those of plate culture.
Impedance	Proliferation potency (electric characteristics)	This method focuses on the change of electric characteristics in growing metabolites produced by bacteria as they proliferate in use of medium components.
Gas measurement	Proliferation potency (gas production)	This method focuses on the change in the quantity of gases, including carbon dioxide produced and oxygen consumed when bacteria proliferate.
Fatty acid analysis	Bacterial fatty acid	The difference in the composition of bacterial fatty acid depending on the bacterial type is taken into consideration in the analysis.
Infrared absorption spectrometry	Bacterial component	Bacteria are exposed to infrared rays and the pattern of their infrared absorption spectrum is examined.

Techniques	Target substance	Principles/characteristics
Mass spectrometry	Bacterial component	Bacterial components are evaluated with a mass spectrometer and collated with the database.
Fingerprinting	DNA	DNA extracted from a sample is cut with a restriction enzyme, and the migration pattern of DNA fragments is analyzed. They are identifiable by reference to the database. T-RFLP is effective in analyzing the structure of microbial communities.
High-throughput sequencing	Nucleic acid	The arrangements of nucleic acids extracted from various bacteria in a sample are determined, based on which the community structure is analyzed.

(Source: Japanese Pharmacopoeia) Notes) PCR: polymerase chain reaction

T-RFLP: terminal restriction fragment length polymorphism

3. Bioluminescence/fluorescence method

For the reference method, Bioluminescence/fluorescence method is used in this study. The Bioluminescence/fluorescence method studied by Nasu et al. had been developed in the 1970s and implemented since1990s. But in the field of indoor environments, there are almost no studies and it is not applied jet. Table 2 shows fluorescent stains used for microorganism detection. It is necessary to select stains effective to the measurement and establish a method for analysing the concentration of indoor airborne bacteria.

Table 2. Fluorescent stains used for microorganism detection

Fluorescent stain	Excitation nm	Fluorescent nm	Tet	Main application
FITC	490	520	protein	intracellular proteins
Rhodamine 123	507	529	cell membrane	cell membrane activity
Acridine orange	490	626, 650	Nucleic acid	Nucleic acid staining, RNA / DNA ratio measurement
Chronomycin A3	450	570	G-C	DNA quantification
DAPI	358	461	A-T	DNA quantification
Hoechst 33258	352	461	A-T	DNA quantification
Ethidium bromide	545	605	Nucleic acid	DNA quantification, dead cell detection
Propidium ipdide	530	615	Nucleic acid	DNA quantification, dead cell detection
SYTOX Green	502	523	DNA	DNA quantification, dead cell detection

SYBR Green	497	520	DNA	DNA quantification, virus detection
CFDA	495	520	esterase	Live cell detection
Calcein-AM	490	525	esterase	Live cell detection
CTC	488	602	breathing	Live cell detection
TRITC	542	572		Labeling of probe for FISH
Texas Red	568	610		Labeling of probe for FISH
Cy3	550	570		Labeling of probe for FISH
Cy5	649	670		Labeling of probe for FISH

ATP measurement of airborne bacteria

(1)Result of ATP method

The results of these experiments are shown in Table 3 and Table 4. The experimental results show that as time increases, the increase in the number of bacteria in the descent method (sedimentation method) can be clearly seen. The authors consider that the collection method results in a relatively close number of bacteria due to the collection of microorganisms are located at the side surface of pore structure of membrane filter.

Table3. Experimental results of Falling bacteria

Falling bacteria	
Time(H)	RLU(relative light unit)
24	17
24	16
48	39
48	27
96	43
96	30

Table4. Experimental results of Airborne bacteria

Airborne bacteria		
Time(H)	Flow rate	RLU(relative light unit)
1	5L/min	12
2	5L/min	13
1	10L/min	14
2	10L/min	12
1	15L/min	30
2	15L/min	15

(2) Micro-colony method

The authors try to introduce micro-colony method to apply the ATP method to amplify the intention. In the micro-colony method, after airborne bacteria is sampled on a membrane

filter and incubated with glucose for 1 or 2 hours on 35 degree C in incubator, the bacteria is grown up to micro-colony. The concentration of glucose ranged from one to four percent.

The Experimental results are shown in Table 5. The empirical data displayed no significant difference.

Table5. Experimental results of Micro-colony method

Test site: laboratory	**RLU**	**Test conditions**
① 1-h sampling, 1.5 L/min	15	1% glucose, Cultured at 35℃ for one hour, 0.45 μm Durapore
② 1-h sampling, 1.5 L/min	12	1% glucose, Cultured at 35℃ for one hour, 0.45 μm Durapore
③ 1-h sampling, 1.5 L/min	14	2% glucose, Cultured at 35℃ for one hour, 0.45 μm Durapore
④ 1-h sampling, 1.5 L/min	10	2% glucose, Cultured at 35℃ for one hour,0.45 μm Durapore
⑤ 1-h sampling, 1.5 L/min	15	3% glucose, Cultured at 35℃ for two hours, 0.2 μm Isopore
⑥ 1-h sampling, 1.5 L/min	9	3% glucose, Cultured at 35℃ for two hours, 0.2 μm Isopore
⑦ 1-h sampling, 1.5 L/min	15	4% glucose, Cultured at 35℃ for two hours, 0.2 μm Isopore
⑧ 1-h sampling, 1.5 L/min	12	4% glucose, Cultured at 35℃ for two hours, 0.2 μm Isopore
⑨ 1-h sampling, 1.5 L/min	14	Not cultured, 0.2 μm Isopore
⑩ 1-h sampling, 1.5 L/min	10	Not cultured, 0.2 μm Isopore

Examples of results by bioluminescence/fluorescence method

Figure 3 and Figure 4 shows an image of the fluorescent staining detection method under the microscope. This test results are using another type of membrane filter, which collect particle or bacteria on the surface and inside the filter. So almost all collected samples are located at the side surface of pore structure of membrane. Importance of surface collection technique is found out through the test measurements.

In future experiments, we will change the type of filter and use the method of surface collection methods such as impaction.

In addition, the fluorescent staining method are conducted for the comparison of the ATP method. Based on the results of future experiments, we hope to be able to confirm these data in

this experiment. If it is not the cause of the filter, we may need to consider the experiment again.

Figure3. An image illuminated under a light source of a specific wavelength

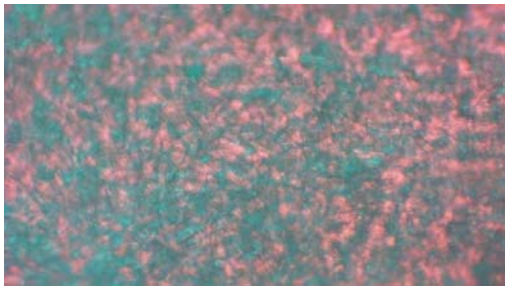


Figure4. An image illuminated at a specific wavelength of light and under microscope light.

4. Summary and future issues

In this study, the simplified methods for monitoring airborne bacteria were examined for the improvement of quality and environmental management in the Japanese food industry. The execution of the membrane filter technique to collect indoor airborne microbes and the fluorescent staining technique to evaluate cleanliness would realize a highly accurate monitoring. The Micro-colony method are used for the reference. In addition, for strict evaluation, the A3 assay (ATP + ADP + AMP) is proposed as a comparison. In the future experiments, ATP measurement methods will be introduced for further inspection, and the simplified monitoring methods developed in this study will be put into practical use in the future.

Acknowledgments

We owe our deep gratitude to Masao Nasu, the professor emeritus of Osaka University, and Hiroki Arakawa, the researcher of Takasago Thermal Engineering for their support to establish our simplified monitoring methods.

References

[1] Yanagi, U. (2018). Current status of rapid microbial detection systems. *Journal of Japan Air Cleaning Association, 56(1).*

[2] Nasu, M. (2016). To understand environmental microbes from a new viewpoint - From household to space living. *Lecture and Abstract for the proceedings of the 33rd Annual Technical Meeting on Air Cleaning and Contamination Control*.

[3] Fujii, S., Yagani, U., Tanaka, T., Tomizuka, K., Arakawa, H., & Nasu, M. (April 2019). Study on the simplified rapid measurement of airborne microbial concentration. *The proceedings of the 36th Annual Technical Meeting on Air Cleaning and Contamination Control*.

[4] Kikkoman Biochemifa Websitehttps://biochemifa.kikkoman.co.jp

[5] Kikkoman. AMP-based measurement technique. Japanese patent: No. 3409962.

[6] Ze Liu, Takehiro Tanaka. Examination on Risk Prevention Measures for Environment and Safety of Food Plants in Japan, EDP Sciences Journal／E3S Web of Conferences, Vol.53, (03075), 2018.09

[7] Inoue, F. (October, 1996). Bacteriological inspections for environmental management of food factories. *es, No. 6*.

[8] Ministry of Health, Labour and Welfare (Ed.). (2004). *Standard Methods of Analysis in Food Safety Regulation for Microorganisms.*

[9] Tomizuka, K, Fujii, S, Yagani, U, Tanaka, T, Arakawa, H. Examination of Simple Monitoring Method of Airborne Bacteria for the Application of Quality Control in the Industry、*Proceedings of the Symposium of the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan.*

Occurrence of some insects pests and their predators on pigeonpea, *Cajanus cajan* L. in Shwe Zaloke Area, Monywa Township

Cho Cho Win[1]

Abstract

Pigeonpea (*Cajanus cajan* L.) is a perennial legume crop and providing high quality vegetable protein, animal feed, and firewood. The present study was carried out from June to November 2018 at Shwe Zaloke Area, Monywa Township. A total of 15 insect pest species and six predatory species belonged to six orders, 18 families and 21 genera. Order Lepidoptera represented the highest number of species composition followed by Hemiptera, Coleoptera, Diptera, Odonata and Mentodea. Insect pests feeding on flowers, pods, and seeds were the most important biotic constraint affecting pigeonpea yields. In this study, the most pest and predatory species numbers were investigated in August and first week of September because this period is vegetative, flowering and pod stages in this crop. This study summarizes the feeding types of pests and their predators on the pigeonpea plants.

Keywords: Pigeonpea, *Cajanus cajan*, Insect, Pest, Predator,

1. Introduction

Insects are small animals without backbone. They have an external skeleton, which is mainly hard but with membranous areas at the joints. The body is segmented and has three pairs of jointed legs and one or two pairs of wings. The body is divided into three segments, head, thorax and abdomen (Borror, Triplehorn and Johnson, 1992)

Pigeonpea (*Cajanus cajan* L.) is a perennial legume crop and belongs to family Fabaceae. It is leguminous shrub that can attain height of 5 m. Leaves are trifoliate and spirally arranged on the stem. Flowers occur in terminal or axillary racemes and are usually yellow, sometimes flocked or streaked with purple or red. Pods are flat, usually green in color, sometimes hairy or streaked or colored dark purple, with 2-9 seeds / pod. Seeds contain high quality dietary protein and are consumed in several ways (Ranga Rao and Shanower1999).

Pigeonpea is grown in 50 countries in Asia and Africa. Unlike other grain legumes, pigeonpea production is concentrated in developing countries particularly in a few South East Asian countries. In Myanmar, it is the second most important crop next to chickpea. It is cultivated worldwide on 4.42 million hectares. In Myanmar, it is extensively cultivated on 5, 80,000 hectares (Chitralekha, 2014).

Shinde and Patel (2014) studied succession of insect pests and their natural enemies on pigeonpea. Lingaraju and Biradar (2015) described seasonal abundance of major sucking insect pests of pigeonpea and their natural enemies in northern dry zone of Karnataka. Aye Thandar Win (2014) studied on investigation on some insects of pigeonpea in Zaloke Agricultural Center, Monywa.

Many different species of insect might be present in a crop but not all of them are pests. More than 250 species of insects live and feed on pigeonpea. Insect pests have natural enemies (predatory insects) such as other insects and spiders, and it is therefore very important to

[1] Dr Associate Professor, Department of Zoology, University of Kalay, winc21091@gmail.com, 09-256308276

correctly identify insect species before attempting any control measures in a crop. Biological control is the reduction of pest populations. Effective biological control often requires a good understanding of the biology of the pests and its natural enemies in the field. Effective biological control has many advantages, especially if it is of the self-sustaining type. A substantial effort in locating species-specific pests or predators is necessary (Gullan and Cranston, 2010). Therefore, the present study was undertaken on pigeonpea plants in study area.

2. Materials and Methods

Shwe Zaloke Quarters (391.7342 ha) is located in Monywa Township, Sagaing Region. The study area was conducted in (1.0117) ha pigeonpea field (Figure 1). Insect pests and their predators occurring on pigeonpea plants were observed weekly in the study area, during the period from June to November 2018. Collection was done twice a week from 7:00 to 10:00 am in the mornings and 4:00 to 6:00 pm in the evenings on ten randomly selected plants at the study area. The immature (larvae/nymphs) forms were reared in the plastic boxes (18×13×6.5cm) up to adult stage. Fresh pigeonpea leaves and pods were fed every day. The emerged adults were provided with cotton wool soaked in honey solution. The insects were identified according to Pol, Belfied and Martin (2010), Crowson (2012), Ranga Rao and Shanower (1999). The classification suggested by Borror, Triplehorn and Johson (1992) was used in the present study.

Figure1. Pigeonpea field of study area

3. Results and Discussion

In the present study, a total of 21 species belonging to six orders, 18 families and 21 genera was identified from the study area (Table 1). From the study, 15 species are pests and the remaining *Pantala flavescens, Archimantis* spp., *Oechalia schellenbergii, Menochilus sexmaculatus, Zosteria* sp. *and Syphus* sp.are predatros (Table 2 and 3) respectively.

Aye Thandar Win (2014) studied 13 species of insects of pigeonpea in Zaloke Agricultural Center, Monywa. She described three orders of insect pests on pigeonpea. In the present study six orders were observed. Order Odonata, Mantodea and Diptera were not found in her study. The most species numbers percentage were observed in order Hemiptera (38.10%), followed by Lepidoptera (28.57%), Coleoptera (14.29%), Diptera (9.52%), Odonata and Mentodea (Figure 2).

Dasbak *et al.* (2012) described eight pest species on pigeonpea. They mentioned that the insect pest infestation was high at the reproductive stage because of the pod flies, pod-sucking bugs and pod borers which inflicted damage to pigeonpea flowers and pods. In the present study

Clavigralla gibbosa and Helicoverpa armigera were observed in maturation stage of the crop. The results of the present study were similar to above mentions.

Srilaxmi and Ravindra Paul (2010) reported that 18 species of insect pests on the pigeonpea crop during the vegetative, flowering and pod maturity stages and the highest species numbers occurred during the vegetative and pod filling stages of the crop, a few during flowering stage while the pod borers attacked the crop from flowering stage to pod-maturity stage. The pod sucking bugs, *C. gibbosa* and *Riptortus serripes* appear during the pod maturity while *Nezara viridula* during flowering and pod filling stage (Table 4).

Most insects that attack on pigeonpea crops are readily controlled by predators. Shinde and Patel (2014) and Lingaraju and Biradar (2015) studied succession of insect pests and their natural enemies on pigeonpea. They described that many species of insects and other animals are found on pigeonpea plants and a substantial number of these are beneficial, feeding on the pests, either as predators or parasitoids.

In the present study, praying mantis is highly predaceous and feed on other insects. *Oechalia schellenbergii* bug insects suck the juice of its prey. The larvae and adults of lady beetles feed on aphids and larvae of moths. The robber flies inject to the prey by strong proboscis and then suck the liquefied material from the prey. Adult dragonflies and larvae of hoverflies prey on small moths, aphids, and other plant- sucking insects (Table 5). Virtually all pests have natural enemies, and many pests can be controlled by managing these natural enemies or predators.

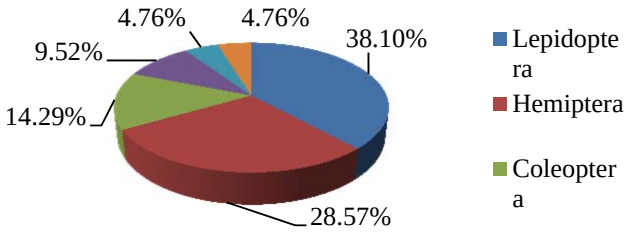


Figure2. Recorded insect species percentage in different orders within the study area

Table 1. List of pests and predators on pigeonpea plants from the study area

Order	**Family**	***Scientific Name***	**Common Name**
Odonata	Libellulidae	*Pantala flavescens*	Wandering glider
Mantodea	Mantidae	*Archimantis spp.*	Praying mantis
Hemiptera	Coreidae	*Clavigralla gibbosa*	Spiny brown bug
	Alydidae	*Riptortus serripes*	Large bean brown bug
	Pentatomidae	*Oechalia schellenbergii*	Stink bug
		Nezara viridula	Green stink bug
	Membracidae	*Oxyrachis tarandus*	Treehopper or cow bug
	Aphididae	*Aphis craccivora*	Cowpea aphid
Coleoptera	Coccinellidae	*Menochilus sexmaculatus*	Six-spotted ladybug
	Curculionidae	*Hypomeces squamosus*	Gold-dust weevil
		Phyllobius pomaceus	Nettle weevil
Diptera	Asilidae	*Zosteria sp.*	Robber fly
	Syrphidae	*Syphus sp.*	Hoverflies
Lepidoptera	Tortricidae	*Archips micaceana*	Leaf-roller moth
	Pterophoridae	*Exelastis atomosa*	Plume moth
	Pyralidae	*Maruca vitrata*	Legume pod borer
	Crambidae	*Spoladea recurvalis*	Beet webworm moth
	Noctuidae	*Helicoverpa armigera*	Seasame bollworm
	Erebidae	*Mocis trifasciata*	Three barred moth
	Noctuidae	*Chrysodeixis eriosoma*	Green garden lopper
		Spodoptera littoralis	Beet armyworm

Table2. Weekly occurrence of pest species during July to September 2018

Scientific Name	July (Weekly)				August (Weekly)				September(Weekly)			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Clavigralla gibbosa	-	-	-	-	+	+	+	+	+	+	+	+
Riptortus serripes	-	-	-	-	+	+	+	+	+	+	+	+
Nezara viridula	-	+	+	+	+	+	+	+	+	-	-	-
Oxyrachis tarandus	-	-	-	+	+	+	+	+	+	+	+	+
Aphis craccivora	+	+	+	+	+	+	+	+	+	-	-	-
Hypomeces squamosus	-	-	-	+	+	+	+	+	-	-	-	-
Phyllobius pomaceus	-	-	+	+	+	+	+	+	+	+	-	-
Archips micaceana	+	+	+	+	+	-	-	+	+	-	-	-
Exelastis atomosa	+	+	+	-	+	+	+	+	+	-	-	-
Maruca vitrata	-	-	-	+	+	+	+	+	+	+	+	+
Spoladea recurvalis	-	+	+	+	+	+	-	-	-	-	-	-
Helicoverpa armigera	-	-	+	+	+	+	+	+	+	+	+	+
Mocis trifasciata	+	+	+	-	+	+	+	-	-	-	-	-
Chrysodeixis eriosoma	-	-	-	+	+	+	+	+	+	-	-	-
Spodoptera littoralis	+	+	+	+	+	+	+	-	-	-	-	-
Total species numbers	5	7	9	11	15	15	13	13	11	6	5	5

Table3. Weekly occurrence of predators during July to September 2018

Scientific Name	July (Weekly)				August (Weekly)				September(Weekly)			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Pantala flavescens	+	+	+	+	+	+	+	+	+	+	+	+
Archimantis spp.	+	+	+	+	+	+	+	+	+	+	+	+
Oechalia schellenbergii	-	-	-	+	+	+	+	+	+	+	+	+
Menochilus sexmaculatus	+	+	+	+	+	+	+	+	+	+	+	+
Zosteria sp.	-	-	-	-	-	+	+	+	+	+	+	+
Syphus sp.	-	-	-	-	+	-	+	+	+	+	+	+
Total species numbers	3	3	3	4	5	5	6	6	6	6	6	6

Table4. Feeding habits of insect pests on different parts of pigeonpea plants from the study area

Species	Pigeonpea plant			
	Stem	Leaves	Flowers	Pods
Clavigralla gibbosa	-	-	+	+
Riptortus serripes	-	-	+	+
Nezara viridula	-	+	+	+
Oxyrachis tarandus	+	+	+	+
Aphis craccivora	+	+	+	-
Hypomeces squamosus	+	+	-	-
Phyllobius pomaceus	-	+	+	-
Archips micaceana	-	+	+	-
Exelastis atomosa	-	-	+	+
Maruca vitrata	-	+	+	+
Spoladea recurvalis	-	+	-	-
Helicoverpa armigera	-	+	+	+
Mocis trifasciata	-	+	-	-
Chrysodeixis eriosoma	-	+	+	-
Spodoptera littoralis	-	+	-	-

Table5. Feeding habits of predators on different stages of other insect pests from the study area

Species	Insect pests		
	Eggs	Larvae	Adults
Pantala flavescens	-	Moths	Moths
Archimantis spp.		Moths	Moths
Oechalia schellenbergii	-	Moths, Grasshoppers	-
Menochilus sexmaculatus	Aphis, Moths	Aphis, Moths	Aphis,Moths
Zosteria sp.	-	-	Moths
Syphus sp.	-	-	Aphis, Moths

4. Conclusions

From above results it can be concluded that natural enemies or predators occurred in pigeonpea crop and preyed on the young larvae of other insect pests. Among them praying mantids and Coecinellids have the potential in regulating the pest suppression on pigeonpea crop. Lady beetles are possibly the most universally recognized group of beneficial insects. Local cultivators need to grow awareness about the relationships between the pests and predators. This could be suggested that the natural enemies may be utilized by mass rearing and releasing in pigeonpea field.

Acknowledgements

I am grateful to Department of Zoology, Monywa University for financial support this research work. May I extend my profound gratitude to Professor Dr Khin Soe Win, Head of Zoology Department, Monywa University, for providing all the departmental facilities during the preparation of this paper.

References

[1] Aye Thandar Win, "An investigation on some insects of pigeonpea in Zaloke Agricultural Centre", Monywa. *MSc thesis*, Department of Zoology, Monywa University, 2014

[2] Borror, D.J, Triplehorn, C.A., Johnoson, N.F, "An introduction to the study of insects" 6th edition, Saunders College Publishing, New York, 1992, P. 875.

[3] Chitralekha, "Bionomics and behaviour of tur pod bug (*Clavigralla gibbosa* Spinola) on pigeonpea", *MSc thesis*, Chaudhary Charan Singh Haryana Agricultural University, Haryana, India, 2014.

[4] Crowson, R.A, "Handbooks for the identification of British insects" Royal Entomological Society, England, 2012, P. 134.

[5] Dasbak, M.A., Echezona, B.C., Asiegbu, J.E, "Field insect pests and crop damage assessment of pigeonpea (*Cajanus cajan* L.) grown under Ratoon and in mixture with maize", Chilean Journal of Agricultural Reserach, 2012, vol. 72, pp. 45-52.

[6] Gullan, P.J., Cranston, P.S, "An outline of Entomology" In: The insects, 4th edition, John Wiley & Sons Limited, 2010, P. 564.

[7] Lingaraju, G.H., Biradar, A.P, "Seasonal abundance of major sucking insect pests of pigeonpea and their natural enemies in northern dry zone of Karnataka", Karnataka J. Agric. Sci., 2015, vol. 28, pp. 274-276.

[8] Pol, C., Belfield, S., Martin, R, "Insects of upland crops in Cambodia", Australian Centre for International Agricultural Research, Canberra, 2010, P.132.

[9] Ranga Rao, G.V., Shanower, T.G, "Indentification and management of pigeonpea and chickpea insect pests in Asia", ICRISAT, Andhra Pradesh, India, 1999, P. 96.

[10] Shinde, Y.A., Patel, B.R, "Succession of insect pests and their natural enemies on pigeonpea", Insect Environment, 2014, vol.19, pp. 253-256.

[11] Srilaxmi, K., Paul, R, "Diversity of insect pest of pigeonpea (*Cajanus cajan* L.) and their succession in relation to crop phenology in Gulbarga, Karnataka", The Ecoscan., 2010, vol. 4, pp. 273-276.

Synthesis and Characterization of Lithium Iron Phosphate for Solid Oxide Fuel Cell Application

Aye Aye Lwin[1], Win Kyaw[2], San San Wai[3]

Abstract

Lithium Iron Phosphate ($LiFePO_4$) solid electrolyte was prepared by solvothermal method. Structural, microstructural, vibrational and optical characteristics were studied by XRD, SEM, FTIR and UV-VIS-NIR spectroscopic techniques. XRD pattern indicated that the sample analogous to orthorhombic structure with the lattice parameters a = 10.22 Å, b = 6.15 Å and c = 4.70 Å. The average crystallite size was obtained as 44.62 nm. SEM micrograph revealed that the sample was spherical shape with the grain sizes in the range of 0.10 μm – 0.25 μm. Four fundamental modes of PO_4^{3-} were found by in FTIR spectrum. UV-VIS-NIR transmission spectrum showed that a low cut off wavelength 397 nm along with a large transmission window in the entire visible and near infrared region of 455 nm – 900 nm. The optical band gap was obtained as 2.38 eV from Tauc's relation of $(\alpha h\upsilon)^2$ vs $h\upsilon$ graph. For the application of solid oxide fuel cell material, the sample was made into the pellet and temperature dependent electrical conductivity was investigated in the temperature range of 299 K – 873 K. The sample exhibited as a superionic conductor in the temperature range of 473 K – 873 K. The activation energy E_a was obtained as 0.11 eV.

Keywords**:** $LiFePO_4$, XRD, SEM, UV-VIS-NIR, electrical conductivity.

1. Introduction

Solid state ionic conductors are important from an industrial viewpoint. A variety of such conductors have been found. In order to understand the reasons for high ionic conductivity in these solids, there have been a number of experimental, theoretical and computational studies in the literature [1]. There exist many solids with high ionic conductivity ($>10^{-6}$ S m^{-1}) and they are of immense use in diverse technological applications. Some of these solids which are also good electronic conductors, are often referred to as 'mixed conductors', while the term 'superionic conductor' or 'fast ion conductor' is reserved for good ionic conductors with negligible electronic conductivity [2, 3]. One of the most important use of superionic conductors is, as electrolytes in battery applications and hence, often, they are referred to as 'solid electrolytes' as well. There are many advantages in electrochemical devices using solid electrolytes instead of liquid electrolytes. These include, among others, longer life, high energy density, no possibility of leak etc., and are particularly suitable in compact power batteries used in pace-makers, mobile telephones, laptops etc. [4 – 6]. For the application of solid oxide fuel cell (SOFC) material, in this paper, SOFC material of $LiFePO_4$ was prepared by solvothermal method and its structural, microstructural, vibrational and optical characteristics were reported by XRD, SEM, FTIR and UV-VIS-NIR spectroscopic techniques. Furthermore, the sample was made into circular shaped pellet and temperature dependent electrical conductivity was reported for the application of fuel cell material in rechargeable battery.

[1] Dr Associate Professor, Department of Physics, Loikaw University, Loikaw, Myanmar, *ayeayelwin635@gmail.com*
[2] Associate Professor, Department of Physics, Pyay University, Pyay, Myanmar
[3] Professor and Head, Department of Physics, Loikaw University, Loikaw, Myanmar

Lithium-ion batteries are widely utilized as the power sources in a wide range of applications, such as mobile phones, laptop computers, digital cameras, electrical vehicles, and hybrid electrical vehicles. Rechargeable lithium battery is of present interest. There are many kinds of rechargeable lithium batteries. They have different classifications according to the forms of lithium (e.g. lithium metal as anode directly, we call it lithium battery. For lithium trans-metal salt as anode, we call it lithium ion battery. Usually, we simply call them lithium battery). There are many types of electrolytes (such as lithium aqueous battery, lithium-organic battery), and the kinds of cathodes (such as lithium cobalt oxide battery, lithium nickel oxide battery, lithium manganese oxide battery, lithium iron phosphate battery, sulfur battery). [5 – 7]

2. Materials and Method

Preparation of $LiFePO_4$ Sample

$LiFePO_4$ was prepared by solvothermal method. Analytical reagent (AR) grade $FeSO_4.7H_2O$, H_3PO_4, and LiOH were used to prepare the sample with the composition of (3:1:1) molar ratio. The mixed solution was stirred and heated from 29°C (ambient) to 170°C to decompose and dehydrate of the precursor solution. After reaching the temperature at 170°C, sugar was added as an agent to form precipitated particles. The precipitates were collected by filtration and dried at 60°C for 3 h. The collected samples were heated at 500°C for 1 h in the vacuum chamber to form as-prepared $LiFePO_4$. Photographs showing the experimental setup of sample preparation system and as-prepared $LiFePO_4$ are shown in Figures 1(a) and (b).

(a) (b)

Figure1. (a) Experimental setup of sample preparation system and (b) as-prepared $LiFePO_4$

XRD, SEM, FTIR, UV-VIS-NIR and Temperature Dependent Electrical Resistance Measurements

To determine the phase formation temperature of the sample, the precipitated $LiFePO_4$was first investigated by Thermogravimetric Analysis and Differential Thermal Analysis (TG-DTA) technique. TG-DTA thermograms were observed by DTG-60H Thermal Analyzer. XRD measurement was carried out by using RIGAKU MULTIFLEX X-Ray Diffractometer with CuK_α radiation (λ=1.54056 Å) to investigate the structural phase formation of the sample. Microstructural characteristic was examined by using JEOL JSM-5610LV SEM with the accelerating voltage of 15 kV, the beam current of 50 mA and 10,000 times photo magnification. FTIR transmission spectrum was observed by SHIMADZU FTIR-8400 Spectrophotometer in the wavenumber range of 400 cm^{-1} – 4000 cm^{-1} to analyze the vibrational characteristics of

constituent molecules of the sample. TG-DTA, XRD, SEM and FTIR measurements were performed at Universities' Research Centre (URC), University of Yangon, Yangon, Myanmar. UV-VIS-NIR transmission spectrum of the sample was observed by SHIMADZU UV-1800 Spectrophotometer in the wavelength range of 350 nm – 900 nm to investigate the region of optical window and to determine the optical energy band gap.

For the electrical resistance measurement, the sample was made into circular shape pellet (1.14×10^{-4} m^2 in area and 5.05×10^{-3} m in thickness) by SPECAC hydraulic pellet-maker using 70 MPa. The silver paste was made over the sample to ensure good electrical contacts. The electrical resistances were observed by FLUKE 189 digital multi-meter in the temperature range of 299 K – 873 K with the step of 20 K. In this measurement, Autonics TCN4L – 24R Temperature Controller (up to 1273 K), K-type thermocouple and 300 W heater rods were used as the temperature controller, temperature sensor (up to 993 K) and heating elements. Experimental setup of electrical resistance measurement and thickness of the pellet are shown in Figure 2.

(a) (b) (c)

Figure2. (a) Experimental setup of electrical resistance measurement, (b) Autonic TCN4L – 24R and (c) thickness measurement of sample

3. Results and Discussion

Thermal Analysis of Coordination Compound

The TG-DTA thermograms of precipitated $LiFePO_4$ are shown in Figure 3. The decomposition temperatures of precipitate to as-prepared sample are found in the temperature range of 35°C – 500°C in TG thermogram with the mass variation of 63.35% due to the dehydration and decomposition of starting materials and organic solvent such as sulphate and water. A deep endothermic peak around 67°C indicates the dehydration of water in DTA thermogram. A broad exothermic reaction peak around 346°C indicates the decomposition of sulphate from the starting materials. An exothermic reaction peak at 436°C and beyond indicate by the combustion reaction was completed or the formation of the desired $LiFePO_4$ sample. Thus, the desired phase formation temperature of the precipitates is well determined around 500°C.

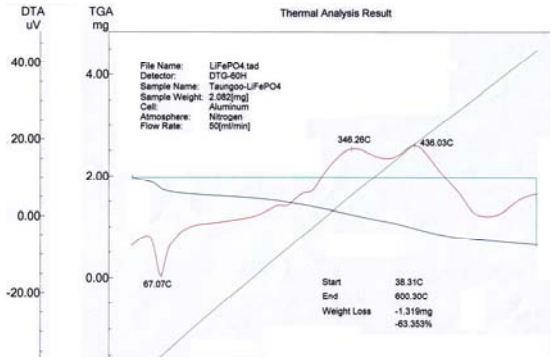


Figure3.TG-DTA thermograms of precipitated LiePO4

XRD, SEM, FTIR and UV-VIS-NIR Study

XRD pattern of $LiFePO_4$ is shown in Figure 4. The observed XRD lines were identified by using file of Cat. No. 81-1173, to assign the collected XRD lines. The appearance of the diffraction peaks demonstrated that the fabricated specimen is $LiFePO_4$. XRD pattern shows that $LiFePO_4$ analogous to orthorhombic structure. The lattice parameters were evaluated by

$$\frac{1}{d^2} = \frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2} = \frac{4\sin^2\theta}{\lambda^2},$$

where d is the atomic spacing (Å), λ is the wavelength of incident X-ray (Å), θ is the diffraction angle of the peak under consideration at FWHM (°), a, b and care the lattice parameters and (hkl) is the Miller indices. The lattice parameters were obtained as a = 10.22 Å, b = 6.15 Å and c = 4.70 Å respectively. Volume of the unit cell is 295.74 $(Å)^3$. Whittingham, et.al. (2004) reported that the $LiFePO_4$ was orthorhombic structure with the lattice parameters a = 10.33 Å, b = 6.01 Å and c = 4.69 Å respectively. The observed XRD data of the sample are listed in Table 1. The crystallite size of sample was estimated by using the Scherrer formula, D = (0.9λ/B cosθ), where D is the crystallite size (nm) and B is observed FWHM (rad). The average crystallite size of the sample was obtained as 44.62 nm.

SEM micrograph of the sample is shown in Figure 5. Scanning electron microscopy studies showed a gray color was found in the case of the samples. The grain shape was spherical with extremely fine particles and the grain sizes were in the range of 0.10 – 0.25 μm. Some pores were found due to the decomposition of starting materials.

FTIR spectrum of the sample is shown in Figure 6. Vibrational characteristics and corresponding mode assignments of molecules are tabulated in Table 2. As shown in FTIR spectrum, ten absorption lines were observed and nine absorption lines represented the vibrational characteristics of (two different types of molecules) PO_4^{3-} and Li^{3+}—PO_4^{3-}—Fe^{3+}.

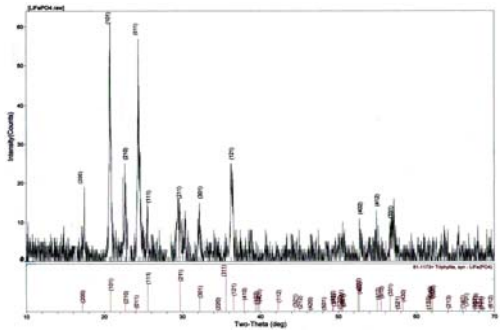
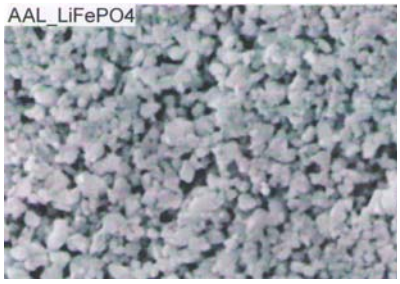


Figure4. XRD pattern of $LiFePO_4$

Table 1. XRD data of $LiFePO_4$

2θ (º)	(hkl)	d (Å)	FWHM (º)	Height (%)	D (nm)
20.78	(101)	4.27	0.21	100.00	37.89
22.66	(210)	3.92	0.15	25.30	54.01
25.61	(111)	3.48	0.14	22.80	58.18
29.44	(211)	3.03	0.23	50.60	35.71
32.23	(301)	2.77	0.21	24.10	39.37
36.52	(121)	2.46	0.32	31.60	25.52
46.55	(420)	1.95	0.16	10.10	54.04
52.94	(600)	1.73	0.17	12.70	52.20



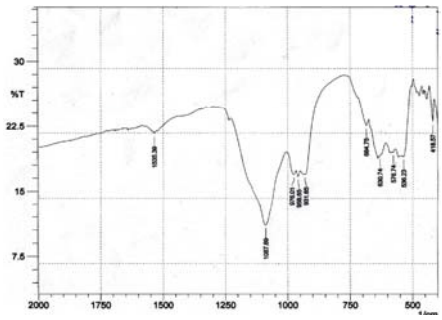


Figure5. SEM micrograph of LiFePO4 Figure 6. FTIR spectrum of LiFePO4

Table 2**.**Wavenumbers and corresponding vibrational characteristics and mode assignments of $LiFePO_4$

Wavenumber (cm^{-1})	**Vibrational Characteristics**	**Mode Assignment**
419	Bending	$\upsilon_2(PO_4^{3-})$
536, 577	Polarization (splitting)	$\upsilon_4(PO_4^{3-})$
631	Librational wagging	$\upsilon_\omega(Li^{3+}—PO_4^{3-}—Fe^{3+})$
685	Librational twisting	$\upsilon_\tau(Li^{3+}—PO_4^{3-}—Fe^{3+})$
932, 959, 976	Symmetric-stretching(splitting)	$\upsilon_1(PO_4^{3-})$
1088	Dipole	$\upsilon_3(PO_4^{3-})$
1535	Bending	$\upsilon_2(H_2O)$

UV-VIS-NIR spectrum of the sample is shown in Figure 7. The sample demonstrates that less than 100% transmittance throughout the UV-VIS-NIR region. In the wavelength range of

393 nm – 455 nm, the transmission of the UV and VIS light rapid increased and in 455 nm – 900 nm, the transmission of the high UV, VIS and NIR light slowly increased. It is evident that the sample has a low cut off wavelength about 393 nm along with a large transmission window in the entire visible region. The theory of optical transmission gives the relationship between the absorption coefficient α and the photon energy has a relation; α = -ln (1/T). Figure 8 shows the plot of the variation of $(\alpha h\nu)^2$ with photon energy hν of the sample. The average band gap E_g was determined from the interception of linear portion of the $(\alpha h\nu)^2$ versus hν graph on hν axis. The optical energy

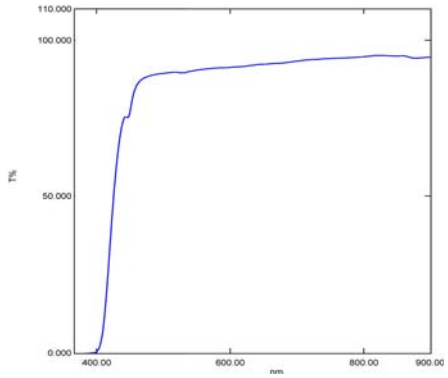


Figure7. UV-VIS-NIR spectrum of LiFePO4

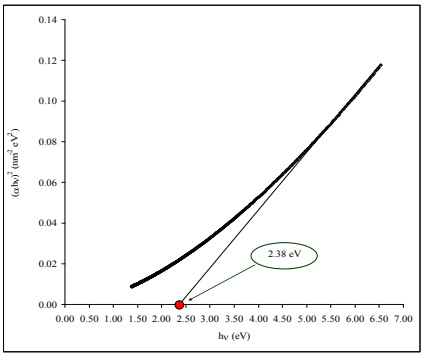


Figure 8. Plot of the (αhυ)2 versus hυ graph of LiFePO4

band gap of the sample was obtained as 2.38 eV. Zhang, et.al. (2012) reported that the energy band gap of the bulk $LiFePO_4$ was 2.38 eV [7]. The obtained energy band gap, thus, was found to be agreed with the result of Zhang et.al.\

Temperature Dependence Electrical Property Study

Figure 9(a) shows the variation of electrical conductivity σ with increase in temperature T of the sample. It was found that electrical conductivity increased with increase in temperature. The sample exhibited as the superionic conductor (SIC) in the temperature range of 473 K – 873 K because it electrical conductivity was greater than 1×10^{-3} S m^{-1}. The electrical conductivities were obtained as 1.13×10^{-3} S m^{-1} at 473 K and 4.35×10^{-3} S m^{-1} at 873 K. In a wide temperature range, the dependence of the dc conductivity σ of an ionic material and other disordered systems approximately follows the Arrhenius form, $\sigma = \sigma_0 \exp(-E_a/kT)$, where σ is the conductivity), σ_0 is the pre-exponential factor, E_a is the activation energy, k is the Boltzmann constant and T is the absolute temperature. Arrhenius plot of the variation of dc electrical conductivity in the temperature range of 299 K – 873 K is shown in Figure 9(b). It can be seen that the electrical conductivity increased with increase in temperature. The conductivity in the solid state depends on the concentration of charge carriers, temperature of the crystal, the availability of vacant-accessible sites and the ease with which an ion can jump to another site etc. The activation energy E_a can be evaluated by using the slope of the $\ln(\sigma)$ versus 10^3/T graph and obtained as 0.11 eV. Since, the activation energy E_a of normal ionic conductors (NICs) have greater than 1 eV (E_a> 1 eV) and E_a of superionic conductors have smaller than 1 eV (E_a < 1 eV). The obtained activation energy E_a (E_a = 0.11 eV) in this work is reliable with theoretical point of view. Variation of the dc electrical resistivity (ρ) with temperature is shown in Figure 9(c). The electrical resistivity ρ rapid decreased with temperature (metal like behavior), followed by a decrease in resistivity above the metal to semiconductor transition temperature. The metal-

semiconductor transition (MST) region of the sample is found in the temperature range of 395 K – to 535 K. Such resistivity-temperature behavior can be attributed to several factors like occurrence of phase transition, cation migration, cation re-ordering and presence of impurities.

4. Conclusion

Lithium Iron Phosphate, $LiFePO_4$, was successfully synthesized by solvothermal method. XRD pattern shows that the $LiFePO_4$ analogous to orthorhombic structure with the lattice parameters a = 10.22 Å, b = 6.15 Å and c = 4.70 Å. The crystallite size was obtained as 44.62 nm. Microstructural study showed that the spherical shape of fine particles was found with the grain sizes in the range of 0.10 µm to 0.25 µm. FTIR spectrum indicated that four fundamental modes of PO_4^{3-}andthe librational wagging and twisting vibrations of Li^{3+}—PO_4^{3-}—Fe^{3+} molecular networks in the crystalline environments of Li^{3+} and Fe^{3+}. From the UV-VIS-NIR transmission spectrum, the sample has a low cut off wavelength about 393 nm and a large transmission window in the entire visible region. The optical energy band gap was obtained as 2.38 eV. The sample exhibited as a superionic conductor in the temperature range from 473 K to 873 K. The activation energy was obtained as 0.11 eV. According to the experimental results of superionic conductor with low activation energy, the sample can be used as the solid oxide fuel cell for rechargeable battery devices.

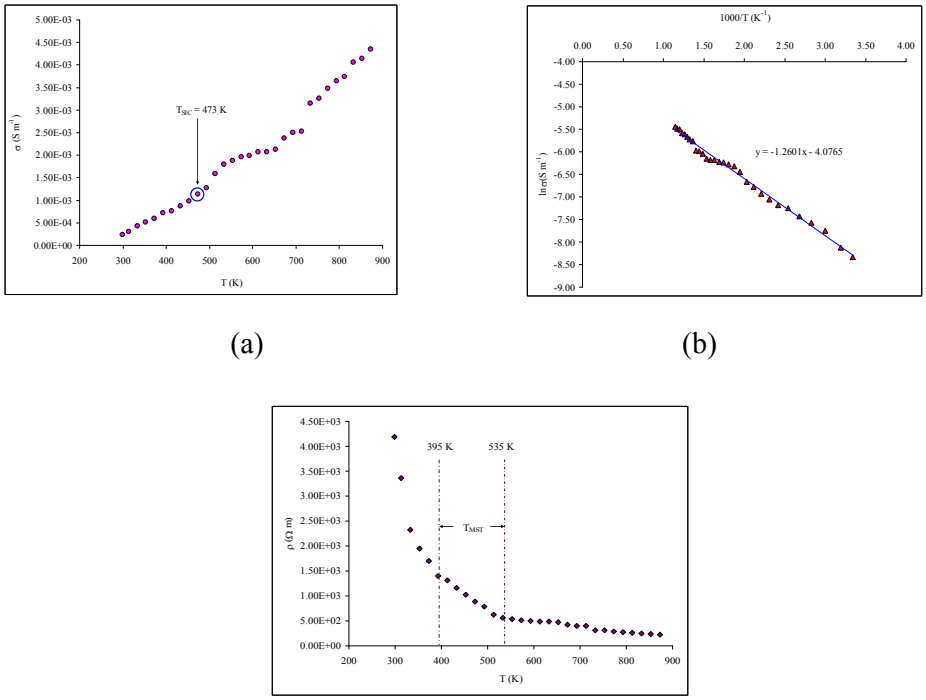


Figure 9(a). Plot of the variation of electrical conductivity with temperature and (b) Arrhenius plot of the electrical conductivity with reciprocal temperature and (c) Plot of the variation of electrical resistivity with temperature of $LiFePO_4$

Acknowledgements

The authors would like to acknowledge Professor Dr Ye Chan, Head of Universities' Research Centre (URC), University of Yangon, Yangon, Myanmar, for his kind permission to use laboratory facilities in URC.

References

[1] J. Molenda, "Lithium-ion batteries – state of art Novel phospho-olivine cathode materials", Materials Science-Poland, 2006, vol. 24(1), pp. 61-67.

[2] G. Arnold, J. Garche, R. Hemmer, S. Strobele, C. Vogler, M. Wohlfahrt-Mehrens, "Fine-particle lithium iron phosphate $LiFePO_4$ synthesized by a new low-cost aqueous precipitation technique", Journal of Power Sources, 2003, vol. 119-121, pp. 247-251.

[3] Hong-Chang Wong, James R. Carey, Jenn-Shing Chen, "Physical and Electrochemical Properties of $LiFePO_4$/C Composite Cathode Prepared From Aromatic Diketone-Containing Precursors", International Journal of Electrochemical Science, 2010, vol. 5, pp. 1090-1102.

[4] Hyeokjo Gwon, Dong-HwaSeo, Sung-Wook Kim, Jongsoon Kim, Kisuk Kang, "Combined First-Principle Calculations and Experimental Study on Multi-Component Olivine Cathode for Lithium Rechargeable Batteries", Advanced Functional Materials, 2009, vol. 19, pp. 3285-3292.

[5] M. Stanley Whittingham, "Lithium Batteries and Cathode Materials", Chemical Review, 2004, vol. 104, pp. 4271-2301.

[6] B. Jin, Q. Jiang, "$LiFePO_4$ Cathode Materials for Lithium-Ion Batteries", Nova Science Publishers, Inc. 2009.

[7] P. Zhang, D. Zhang, L. Houng, Q. Wei, M. Lin, X. Ren, "First-principles study on the electronic structure of a $LiFePO_4$ (010) surface adsorbed with carbon", Journal of Alloys and Compounds, 2012, vol. 540, pp. 121-126.